Mercy NWA 7th Floor ICU Fit-Out
Rogers, AR

HFG Project No. H AR MRCY 24100

Division 21 through 28 Specifications

November 26, 2024

HFG Architecture
Professional Engineering Consultants

SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following items which apply to all Division 21 sections:
   1. Submittals.
   2. Coordination drawings.
   3. Record documents.
   4. Maintenance manuals.
   5. Piping materials and installation instructions common to most piping systems.
   6. Transition fittings.
   7. Dielectric fittings.
   8. Mechanical sleeve seals.
   9. Sleeves.
   10. Grout.
   11. Flashing.
   12. Through penetration firestop assemblies.
   13. Fire protection demolition.
   14. Equipment installation requirements common to equipment sections.
   15. Painting and finishing.
   16. Concrete bases.
   17. Supports and anchorages.

B. Section includes pipe, fittings, valves, and connections for sprinkler standpipe, combination sprinkler and standpipe systems, firestopping relating to fire suppression work and firestop accessories.

C. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
   2. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
   3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   5. ASME B16.25 - Buttwelding Ends.
   6. ASME B16.3 - Malleable Iron Threaded Fittings.
   7. ASME B16.4 - Gray Iron Threaded Fittings.
   8. ASME B16.5 - Pipe Flanges and Flanged Fittings.
   9. ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
   10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.

B. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
3. ASTM A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe.(Metric)
4. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
5. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
6. ASTM B32 - Standard Specification for Solder Metal.
7. ASTM B75 - Standard Specification for Seamless Copper Tube.
8. ASTM B75M - Standard Specification for Seamless Copper Tube (Metric).
9. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
10. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
11. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
12. ASTM B251M - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube (Metric).

C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:
1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

E. National Fire Protection Association:
1. NFPA 13 - Installation of Sprinkler Systems.
2. NFPA 14 - Standard for the Installation of Standpipe, Private Hydrants and Hose Systems.
3. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.

F. UL Solutions:
1. UL 1887 - Fire Tests of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.

1.03 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

G. Firestopping (Through-Penetration Protection System): Sealing of stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.04 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.05 SUBMITTALS

A. Product Data for each kind of product used in the project.

B. Submittal of shop drawings, product data, and samples will be accepted only when signed and submitted by this Contractor and the General Contractor. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.

C. Shop drawings submitted without this Contractor's signature or approval and verification will not be approved. Quantities will not be checked or verified. It is the Contractor's responsibility to provide the proper quantities required to complete the job.

D. Portions of the work requiring a shop drawing submittal shall not begin until the shop drawing has been approved by the Engineer.

E. Submit wiring diagrams for all equipment requiring field wiring clearly showing all required connections. This Contractor will send one copy of Engineer approved shop drawings to the Electrical Contractor with a transmittal letter. Forward one copy of the transmittal letter to the Engineer's office.

F. Where catalog cuts are used, mark them to indicate equipment, capacities, controls, fittings, valves, sizes, etc.

G. Reference each item to applicable specification paragraph number and plan sheet number. Reference items not appearing in base specification to applicable alternate numbers, change order numbers, letters of authorization, etc.

H. Engineers acceptance of Compliance Submittals will not relieve Contractor from his responsibility for any deviations from the requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation at the time of submission and Engineer has given written approval to the specific deviation, nor shall any acceptance by Engineer relieve Contractor from responsibility for errors or omissions in Compliance Submittals.

I. See other Division 21 sections for specific requirements regarding submittal of delegated design items.

J. Firestopping Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.06 GENERAL WORK REQUIREMENTS

A. Permits:

1. Obtain and pay for all licenses and permits, fees, inspection and certificates required for the execution of this work.
2. Pay fees and charges for connection to outside services and use of property.
3. Deliver permits and certificates to the Architect to be transmitted to the Owner.

1.07 RESPONSIBILITY

A. This Contractor will be held responsible for any and all damage to any part of the building or to the work of other contractors, as may be caused through his operation.

B. This contractor shall make all provisions for entry of equipment, installed under this contract, to the installed location. This contractor shall provide openings in existing construction if necessary. This contractor shall do all repair necessary to restore the building to the original condition.

During the period of entry of equipment and removal of trash, no disruption of the Owner's normal business shall occur.

C. This Contractor shall fully coordinate equipment installation requirements with other trades. Any revisions or adjustments required to be made by other trades due to deviations from the basis of design equipment shall be the financial responsibility of this Contractor.

1.08 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of components and tag numbering.

C. Operation and Maintenance Data: Submit spare parts lists.

1.09 QUALITY ASSURANCE

A. Execute work in compliance with all applicable Federal, State and Municipal laws, codes, ordinances, and local customs regarding the trade to perform the work. The Contractor is required to verify that all installations comply with applicable codes. The codes applicable to this specific project may be listed on the Architect's code compliance sheet. If not, it is the Contractor's responsibility to determine which codes apply to the installations. Where code requirements conflict with those shown on the drawings and specifications, the code requirements shall take precedence. The Contractor shall notify the Architect immediately of any discrepancies between the applicable code requirements and the documents. Changes made to comply with the applicable requirements shall not justify an additional cost.

B. Inspect the existing site and conditions and check the drawings and specifications to be fully informed of the requirements for completion of the work. Lack of such information shall not justify an extra to the contract price.

C. The Fire Protection Work shall include labor, materials, and equipment to install systems and place in proper working order, as shown on plans and hereinafter specified. The installation shall include all labor, materials, tools, transportation, equipment, services and facilities, required for the complete, proper and substantial installation of all mechanical work shown on the plans, and/or outlined in these specifications. The installation shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the drawings, but which are necessary to make a complete working installation of all mechanical systems.

D. Material and equipment shall be new, of best quality and design and free from defects. A manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating manufacturer's name, address and catalog number.

E. Furnish testing equipment and test all piping systems under methods and conditions as specified.

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

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

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

H. Electrical Characteristics for Fire Protection Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

I. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 and ASTM E814 with 0.10-inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

a. Floor Penetrations within Wall Cavities: T-Rating is not required.

J. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.

1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

K. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

L. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10-inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

M. Surface Burning Characteristics: 25/50 flame spread/smoke developed index when tested in accordance with ASTM E84.

N. Provide fire sprinkler piping located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with UL 1887.

O. Surface Burning Characteristics: Maximum 25/50 flame spread/smoke developed index when tested in accordance with ASTM E84.

P. Perform Work in accordance with NFPA 13 standard.

1.10 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Deliver and store valves in shipping containers, with labeling in place.

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

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

E. Furnish cast iron and steel valves with temporary protective coating.

F. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.12 WORKMANSHIP AND COORDINATION

A. Make installation substantially as shown on plans.

B. Pipe and duct routing and equipment location shown on the drawings are schematic in nature. Make alterations in location of apparatus or piping as may be required to conform to building construction without extra charge.

C. Equipment service clearances, per equipment manufacturer's specifications, shall be maintained from general construction. No pipe shall be installed within these clearances. No piping shall be installed above electrical panels, starters or switchgear, or in elevator equipment rooms.

D. Cooperate with other contractors in their installation of work.

E. The ductwork shall take precedence over all pipe work except where it is necessary to maintain an even grade on the piping.

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

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

H. Coordinate requirements for access panels and doors for Fire Protection items requiring access that are concealed behind finished surfaces.

I. Use only experienced mechanics.

1.13 ENVIRONMENTAL REQUIREMENTS

A. Do not apply sealants, caulking, or mastic materials outside the range of the manufacturer's installation instructions.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

1.14 ELECTRONIC DOCUMENT REQUESTS

A. The Contractor may request the use of the bidding documents in electronic format (CAD, BIM, PDF etc.) for use in preparation of shop drawings and coordination drawings.

B. Professional Engineering Consultants, P.A. (PEC) reserves the right to refuse requests for electronic files at its sole discretion. The format of the files will be at PEC's sole discretion.

C. All electronic documents provided are provided on an as-is basis and are utilized by the Contractor at his own risk. All files provided by the Engineer are subject to PEC's standard "CADD/Electronic File Disclaimer". This disclaimer can be provided upon request.

D. At PEC's sole discretion, per sheet fee of up to $50 may be required to cover the costs of preparing the electronic files for transmission.

E. By obtaining the bid document CAD or BIM files, the Contractor is not relieved from his duty to create construction, shop and coordination drawings.

1.15 FIRE PROTECTION COORDINATION DRAWINGS

A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of Fire Protection equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of piping, equipment, hangers, and materials. Include the following:
    a. Clearances for installing and maintaining insulation.
    b. Clearances for servicing and maintain equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
    c. Equipment connections and support details.
    d. Exterior wall and foundation penetrations.
    e. Fire-rated wall and floor penetrations.
    f. Underground piping.
    g. Sizes and locations of required concrete pads and bases.
    h. Numbered valve location diagrams.
    i. Valve stem movement.
    j. Pipe expansion loops.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Submit drawing to Architect to review for completeness. These drawings will be reviewed and returned with comments. They will not be approved as a shop drawing.

1.16 RECORD DOCUMENTS

A. Prepare record documents in accordance with Division 1. These drawings shall reflect the actual "As-Built" condition including any change orders, of the mechanical systems and installation. In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Identification Section. Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, contract modifications, and actual equipment and materials installed.

1.17 MAINTENANCE MANUALS

A. Prepare Maintenance Manuals in accordance with Division 1 Sections. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control stopping, shutdown, and emergency instructions.
3. Maintenance procedures for routing preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Approved shop drawing submittals.
5. Servicing instructions and lubrication charts and schedules.
6. Copy of valve tag chart.

1.18 FINAL ELECTRONIC SUBMITTAL

A. In addition to the hard-copy record documents above, provide a set of electronic documents in PDF formats on an USB drive. The electronic shall include the following:

1. Floor plans, O&M manuals, approved shop drawings, and valve tag schedules.
2. The floor plans shall contain labels and links for each piece of equipment specified in this Division. The equipment links shall open the O&M manual for the respective piece of equipment with a single mouse click. Valve tag links shall open the appropriate portion of the valve tag schedule.
3. It is anticipated that there will be separate PDF floor plan documents for each class of equipment, and separate PDF valve tag floor plan(s) for each unique system. The exact format and quantity of PDF documents shall be submitted to the Owner for approval prior to creation of the comprehensive final submittal.

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified or pre-approved equals.

2.02 PIPE, TUBE, AND FITTINGS

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

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

2.03 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials.

2.04 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

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

C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

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

2.05 MECHANICAL SLEEVE SEALS

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

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.06 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

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

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

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

1. Underdeck Clamp: Clamping ring with set screws.

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

F. PVC Pipe: ASTM D 1785, Schedule 40.

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

2.07 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.08 FLASHING

A. Metal Flashing: 26 gage (0.5 mm) thick galvanized steel.

B. Metal Counterflashing: 22 gage (0.8 mm) thick galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb./sq. ft (24.5 kg/sq m) sheet lead.
2. Soundproofing: 1 lb./sq. ft (5 kg/sq m) sheet lead.

D. Flexible Flashing: 47 mil (1.2 mm) thick sheet of material compatible with roofing. Coordinate with Architectural roofing specifications.

E. Caps: Steel, 22 gage (0.8 mm) minimum; 16 gage (1.5 mm) at fire resistant elements.

2.09 FIRESTOPPING

A. Manufacturers:

1. Hilti Corp.
2. 3M fire Protection Products
3. Specified Technologies, Inc.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Single or multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single or multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer’s full range of colors.

D. Coordinate the above requirements with Division 7.

2.10 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

C. General:

1. Furnish UL listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

D. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

2.11 ACCESS DOORS

A. If specified in Division 7 that section shall apply. Where not specified in Division 7 provide access doors as follows.

B. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

C. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

D. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

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

1. Bar-Co., Inc.
2. J.L. Industries.
3. Karp Associates, Inc.
4. Milcor Div. Inryco, Inc.
5. Nystrom, Inc.

2.12 DRIP PANS

A. Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drainline connections. Reference Installation of Drip Pans section below for location requirements.

2.13 PIPE HANGERS AND SUPPORTS

A. Conform to NFPA 13 and NFPA 14.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm): Carbon steel, adjustable swivel, split ring.

C. Hangers for Pipe Sizes 2 inch (50 mm) and Over: Carbon steel, adjustable, loop.

D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

E. Wall Support for Pipe Sizes to 3 inches (80 mm): Cast iron hook.

F. Wall Support for Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.

G. Vertical Support: Steel riser clamp.

H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

PART 3 EXECUTION

3.01 FIRE PROTECTION DEMOLITION REQUIREMENTS

A. The existing areas surrounding the remodel area are fully occupied and shall remain operational throughout the duration of this project.

B. This contractor shall closely coordinate with the Owner and/or his representative the timing and schedule for any temporary cutoffs of any mechanical systems. The valve location and scheduled shutdown shall be closely coordinated with the Owner. It is recognized that temporary shutdown of systems will be required. These shall be scheduled in advance with Owner's representatives and restored to full service at the end of the work period.

C. Disconnect, demolish, and remove Fire Protection systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

D. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

E. Contractor shall provide protective plastic drop cloths to protect the existing occupied areas and equipment from dust and debris during the construction work and shall clean the areas of all construction dirt daily, and upon completion of the work.

F. Connection to existing piping for HVAC, medical gas, fire sprinkler or domestic water will require temporary shutdown of those mains to accomplish the new tie-ins. Closely coordinate and schedule this work with the Owner. Perform such work on weekends or nights as required by Owner's use and schedule.

G. All drained piping risers and mains shall be refilled with fluid and properly vented by this Contractor.

H. Coordinate with General Contractor the removal and replacement of all existing ceilings, walls, etc. as required for mechanical demolition work.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping in accordance with NFPA 13 for sprinkler systems, NFPA 14 for standpipe and hose systems, and NFPA 24 for service mains.

B. Pipe Hangers and Supports:

1. Install in accordance with NFPA 13 and NFPA 14.
2. Install hangers to with minimum 1/2-inch (15 mm) space between finished covering and adjacent work.
3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
4. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

C. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.

D. Do not penetrate building structural members unless indicated and/or approved by the Structural Engineer of Record.

E. Install piping according to the following requirements and Division 21.

F. Sections specifying piping systems.

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

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

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

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

K. Install piping to permit valve servicing.

L. Install piping at indicated slopes.

M. Install piping free of sags and bends.

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

O. Install piping to allow application of insulation.

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

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

1. New Piping:
    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    c. Insulated Piping: One-piece, stamped-steel type with spring clips.
    d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.
    e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type or stamped steel with polished chrome-plated finish.
    f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw.
    g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
    h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
2. Existing Piping: Use the following:
    a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.
    d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.
    e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
    f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
    g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

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

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

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

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

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

3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).

b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

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

1) Seal space outside of sleeve fittings with grout.

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

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

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

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

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

U. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

V. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.03 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. The Contractor shall field verify all existing conditions and dimensions. The Contractor shall make field adjustments as required to accommodate the new work.

B. Verify final equipment locations for roughing-in.

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

3.04 PIPING JOINT CONSTRUCTION

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

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

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

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

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

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

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

3.05 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric nipples and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.06 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

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

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

D. Install equipment to allow right of way for piping installed at required slope.

3.07 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1. In addition to the requirements specified in Division 1, the following requirements apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.

3.08 PAINTING

A. Painting of Fire Protection systems, equipment, and components is specified in other divisions.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.09 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor Fire Protection materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.11 GROUTING

A. Mix and install grout for Fire Protection equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.12 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs. Refer to Division 7.

B. Seal floor, shower, and mop sink drains watertight to adjacent materials.

3.13 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating. Install per manufacturer's instructions to comply with appropriate listing.

D. Fire Rated Surface:

1. Seal openings as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
    b. Size sleeve allowing minimum of 1-inch (25 mm) void between sleeve and building element.
    c. Pack void with backing material.
    d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

E. Non-Rated Surfaces:

1. Seal openings, where required by code, through non-fire rated openings as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.

b. Size sleeve allowing minimum of 1-inch (25 mm) void between sleeve and building element.

c. Install type of firestopping material recommended by manufacturer.

2. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.

3. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and pipe.

F. Inspect installed firestopping for compliance with specifications and submitted schedule.

G. Clean adjacent surfaces of firestopping materials.

3.14 INSTALLATION OF ACCESS DOORS

A. Provide access doors in construction wherever access is required for valves, dampers, equipment, etc.

B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.15 INSTALLATION OF DRIP PANS

A. Locate drip pans under piping passing within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection and run to nearest Fire Protection drain or elsewhere as indicated.

3.16 CLEANING

A. Refer to Division 1 for general requirements for final cleaning.

B. Contractor shall clean work area of all construction dirt and debris at the end of each workday.

3.17 WARRANTIES

A. Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties as specified into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. This Contractor shall warrant all material and equipment installed by him for a period of one year after completion of the project.

END OF SECTION 210500

SECTION 21 05 48
VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Isolation mounts.
   3. Restrained elastomeric isolation mounts.
   4. Restraining braces.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. Building has been assigned a classification as a Seismic Design Category C as defined in IBC.
      a. Component Importance Factor: 1.5.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:
   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 seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
   2. Seismic-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces

transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.05 INFORMATIONAL SUBMITTALS

A. Product Data.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC and NFPA 13 unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

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

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

2.02 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti, Inc.
5. Kinetics Noise Control.
6. Loos & Co.; Cableware Division.
7. Mason Industries.
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

E. 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.

F. 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.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

H. 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. Minimum length of eight times diameter.

I. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl 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.

2.03 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings 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 will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127 and NFPA 13.
2. Brace a change of direction longer than 12 feet (3.7 m).

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. 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.

G. 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.

H. 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 structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed 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.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for piping flexible connections.

END OF SECTION 21 05 48

SECTION 21 13 13
WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gages.

B. Related Documents:

1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.03 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa).

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.04 SYSTEM DESCRIPTIONS

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

1.05 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. High-Pressure Piping System Component: Listed for 250-psig (1725-kPa) minimum working pressure.

C. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, or NICET Level 3+ certified Contractor, using performance requirements and design criteria indicated.

1. Obtain copy of fire-hydrant flow test records or contact local water and/or fire departments to perform a fire-hydrant flow test. Include flow test results with hydraulic calculations:

D. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, fittings, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications per NFPA 13.
3. Minimum Density for Automatic-Sprinkler Piping Design per NFPA 13.
4. Minimum Density for Deluge-Sprinkler Piping Design per NFPA 13.

5. Maximum Protection Area per Sprinkler: Per UL listing.
6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

F. Water Quality Testing and Treatment:

1. The Fire Protection Contractor shall obtain samples of the supply water for the proposed location. The Fire Protection Contractor shall perform testing of this water to determine:
   a. The presence of properties which may lead to accelerated corrosion of the sprinkler piping, including corrosion due to microbially influenced corrosion (MIC). Based on the determination of these tests, the contractor shall provide water treatment systems, or piping which is specially manufactured to resist the properties present in the water, required to protect the piping from premature corrosion.
   b. The presence of solids and minerals in the water which may lead to sediment buildup that will negatively affect system performance. Based on the determination of these tests, the contractor shall provide water treatment systems, filtration, alternate water supplies, or return bends to maintain required system performance.

1.06 SUBMITTALS

A. Product Data: For each type of product used in the project. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For all sprinkler systems, including analysis data signed and sealed by the qualified professional engineer or Contractor responsible for their preparation. Engineer shall be licensed in the state where project is located.

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the electrical, plumbing, HVAC, structural and other building systems are shown and coordinated with each other, using input from installers of the items involved.

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

1. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

F. Fire-hydrant flow test report.

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

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

1.07 QUALITY ASSURANCE

A. Installer Qualifications:

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

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

C. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
   1. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.08 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of sprinkler service.
   2. Do not proceed with interruption of sprinkler service without Architect's written permission.

1.09 COORDINATION

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

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include sprinklers and wrench for each type of sprinkler used on Project.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.02 STEEL PIPE AND FITTINGS

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

B. Thinwall Galvanized and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

C. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.

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

E. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

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

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

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

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

J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

K. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. Corcoran Piping System Co.
   c. National Fittings, Inc.
   d. Shurjoint Piping Products.
   e. Tyco Fire & Building Products LP.
   f. Victaulic Company.
2. Pressure Rating: 175 psig (1200 kPa) for standard pressure systems; minimum.
3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 536, ductile-iron casting; with dimensions matching steel pipe. Short-pattern, with flow equal to standard pattern fittings.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and ASTM A449 compliant bolts and nuts.
   a. Rigid: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with NFPA-13. Installation-Ready, for direct stab installation without field disassembly. Couplings shall be fully installed at visual pad-to-pad offset contact. Couplings that require gapping of bolt pads or specific torque ratings for proper installation are not permitted.
   b. Flexible: Use in locations where vibration attenuation and stress relief are required.

2.03 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

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

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

E. Grooved Joint Lubricants: Lubricate gaskets with lubricant supplied by the coupling manufacturer in accordance with published installation instructions. The lubricant shall be approved for the gasket eleastomer and system media.

2.04 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).

B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. Victaulic Company.
2. Standard: UL 1091 except with ball instead of disc.

3. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
4. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
5. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. Anvil International, Inc.
   c. Clow Valve Company; a division of McWane, Inc.
   d. Fire-End & Croker Corporation.
   e. Kennedy Valve; a division of McWane, Inc.
   f. Mueller Co.; Water Products Division.
   g. NIBCO INC.
   h. Potter Roemer.
   i. Reliable Automatic Sprinkler Co., Inc.
   j. Tyco Fire & Building Products LP.
   k. Victaulic Company.
   l. Viking Corporation.
   m. Watts Water Technologies, Inc.
2. Standard: UL 312.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Type: Swing check; spring-assisted for vertical or horizontal installation.
5. Body Material: Cast ductile iron.
6. End Connections: Flanged or grooved.

D. Bronze OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. United Brass Works, Inc.
2. Standard: UL 262.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Bronze.
5. End Connections: Threaded.

E. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. Anvil International, Inc.
   c. Clow Valve Company; a division of McWane, Inc.
   d. Fire-End & Croker Corporation.

e. Kennedy Valve; a division of McWane, Inc.
f. Mueller Co.; Water Products Division.
g. NIBCO INC.
h. Potter Roemer.
i. Reliable Automatic Sprinkler Co., Inc.
j. Tyco Fire & Building Products LP.
k. Victaulic Company.
l. Viking Corporation.
m. Watts Water Technologies, Inc.

2. Standard: UL 262.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

F. Indicating-Type Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. Fivalco Inc.
   c. Global Safety Products, Inc.
   d. Kennedy Valve; a division of McWane, Inc.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Shurjoint Piping Products.
   h. Tyco Fire & Building Products LP.
   i. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Valves NPS 2 (DN 50) and Smaller:
   a. Valve Type: Ball or butterfly.
   b. Body Material: Bronze or brass.
   c. End Connections: Threaded or grooved.
5. Valves NPS 2-1/2 (DN 65) and Larger:
   a. Valve Type: Butterfly.
   b. Body Material: Cast or ductile iron.
   c. End Connections: Flanged, grooved, or wafer.
   d. Seat: Pressure responsive elastomer.
   e. Stem: Stainless steel.
6. Valve Operation: Weatherproof actuator housing with two integral electrical, [125] [115] - V ac, prewired, two-circuit, supervisory switch visual indicating device.

G. NRS Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. American Valve, Inc.

c. Clow Valve Company; a division of McWane, Inc.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kennedy Valve; a division of McWane, Inc.
f. Mueller Co.; Water Products Division.
g. NIBCO INC.
h. Tyco Fire & Building Products LP.
i. Victaulic Company.

2. Standard: UL 262.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Cast iron with indicator post flange.
5. Stem: Nonrising.
6. End Connections: Flanged or grooved.

H. Indicator Posts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. American Valve, Inc.
   c. Clow Valve Company; a division of McWane, Inc.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Kennedy Valve; a division of McWane, Inc.
   f. Mueller Co.; Water Products Division.
   g. NIBCO INC.
   h. Tyco Fire & Building Products LP.
   i. Victaulic Company.
2. Standard: UL 789.
3. Body Material: Cast iron with extension rod and locking device.
4. Operation: Wrench.

2.05 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum.

B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Affiliated Distributors.
   b. Anvil International, Inc.
   c. Barnett.
   d. Conbraco Industries, Inc.; Apollo Valves.
   e. Fire-End & Croker Corporation.
   f. Fire Protection Products, Inc.
   g. Flowserve.
   h. FNW.
   i. Jomar International, Ltd.
   j. Kennedy Valve; a division of McWane, Inc.

k. Kitz Corporation.
l. Legend Valve.
m. Metso Automation USA Inc.
n. Milwaukee Valve Company.
o. NIBCO INC.
p. Potter Roemer.
q. Red-White Valve Corporation.
r. Southern Manufacturing Group.
s. Stewart, M. A. and Sons Ltd.
t. Tyco Fire & Building Products LP.
u. Victaulic Company.
v. Watts Water Technologies, Inc.

2.06 SPECIALTY VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
a. Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFAC Inc.
b. Globe Fire Sprinkler Corporation.
c. Reliable Automatic Sprinkler Co., Inc.
d. Tyco Fire & Building Products LP.
e. Venus Fire Protection Ltd.
f. Victaulic Company.
g. Viking Corporation.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Valve internal components shall be replaceable without removal of valve from installed position.
5. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
6. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
7. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFAC Inc.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.

2. Standard: UL 1726.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4 (DN 20).
6. End Connections: Threaded.

2.07 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. National Fittings, Inc.
   c. Shurjoint Piping Products.
   d. Tyco Fire & Building Products LP.
   e. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGF Manufacturing Inc.
   b. Reliable Automatic Sprinkler Co., Inc.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum for low pressure systems.
4. Body Material: Cast-bronze or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved ends.

C. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkhart Brass Mfg. Company, Inc.
   b. Fire-End & Croker Corporation.
   c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Brass.

5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGF Manufacturing Inc.
   b. Triple R Specialty.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.
   e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast-bronze or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CECA, LLC.
   b. Corcoran Piping System Co.
   c. Merit Manufacturing; a division of Anvil International, Inc.
2. Standard: UL 1474.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fivalco Inc.
   b. FlexHead Industries, Inc.
   c. Gateway Tubing, Inc.
   d. Victaulic Company.
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with open-gate bracket for connection to ceiling grid.
4. The drop shall include a UL approved Series AH2 or AH2-CC braided hose with a bend radius to 2” to allow for proper installation in confined spaces.
5. Union joints shall be provided for ease of installation.
6. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 or AB2 bracket. The bracket shall allow installation before the ceiling tile is in place.

7. Pressure Rating: 175 psig (1200 kPa) minimum.
8. Size: Same as connected piping, for sprinkler.

2.08 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFAC Inc.
   2. Globe Fire Sprinkler Corporation.
   3. Reliable Automatic Sprinkler Co., Inc.
   4. Tyco Fire & Building Products LP.
   5. Victaulic Company.
   6. Viking Corporation.

B. General Requirements:
   1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   2. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
   3. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.

C. Automatic Sprinklers with Heat-Responsive Element:
   1. Early-Suppression, Fast-Response Applications: UL 1767.
   2. Nonresidential Applications: UL 199.
   3. Residential Applications: UL 1626.
   4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
   5. Quick response for healthcare applications.

D. Dry Pendant Automatic Sprinkler Heads:
   1. Dry pendent style sprinklers
   2. Sprinkler and deflector shall be of all brass frame construction attached to a 1” diameter galvanized extension nipple of specified length, having a machined 1” NPT thread. Extension nipple shall have an extended inlet above the thread. Internal construction shall consist of an inner tube/yoke assembly with orifice adapter consisting of all brass parts. Inlet seal assembly shall consist of a Teflon-coated spring washer with brass cap. Sprinklers shall have a frangible glass bulb thermal operating element with sealed adjustable seat adapter in conformance with UL requirements.
   3. Dry pendent sprinklers shall be capable of providing 1-1/2” (38 mm) of escutcheon adjustment
   4. Characteristics: Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

E. Sprinkler Finishes:
   1. Chrome plated.
   2. Bronze.
   3. Painted.

F. Special Coatings:
   1. Wax.
   2. Corrosion-resistant paint.

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

1. Ceiling Mounting: chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment, or plastic, white finish, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel one piece, flat or plastic, white finish, one piece, flat.

H. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.
   d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

I. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.09 ALARM DEVICES

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

B. Water-Motor-Operated Alarm:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Globe Fire Sprinkler Corporation.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.
   d. Viking Corporation.
2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 10-inch (250-mm) diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4 (DN 20).
8. Outlet: NPS 1 (DN 25) drain connection.

C. Electrically Operated Alarm Bell:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fire-Lite Alarms, Inc.; a Honeywell company.
   b. Notifier; a Honeywell company.
   c. Potter Electric Signal Company.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch (150-mm) minimum- diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ADT Security Services, Inc.

b. McDonnell & Miller; ITT Industries.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.
e. Viking Corporation.
f. Watts Industries (Canada) Inc.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

E. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AFAC Inc.
   b. Barksdale, Inc.
   c. Detroit Switch, Inc.
   d. Potter Electric Signal Company.
   e. System Sensor; a Honeywell company.
   f. Tyco Fire & Building Products LP.
   g. United Electric Controls Co.
   h. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fire-Lite Alarms, Inc.; a Honeywell company.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Potter Electric Signal Company.
   d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Potter Electric Signal Company.
   b. System Sensor; a Honeywell company.
2. Standard: UL 346.

3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.10 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMETEK; U.S. Gauge Division.
   2. Ashcroft, Inc.
   3. Brecco Corporation.
   4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

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

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

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 (DN 50) and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

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

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

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

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

N. Fill sprinkler system piping with water.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21.

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21.

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21.

3.02 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 above-ground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

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

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

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

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

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

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606 in accordance with the manufacturer’s published instructions. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints. Grooved coupling manufacturer’s factory trained field representative shall provide on-site training for contractor’s field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606 in accordance with the manufacturer’s published instructions. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. Grooved coupling manufacturer’s factory trained field representative shall provide on-site training for contractor’s field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

K. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

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

3.03 VALVE AND SPECIALTIES INSTALLATION

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

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

C. Install backflow preventers in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.04 SPRINKLER INSTALLATION

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

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

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

D. Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or a cracked bulb.

3.05 IDENTIFICATION

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

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.07 CLEANING

A. Clean dirt and debris from sprinklers.

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

3.08 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.09 PIPING SCHEDULE

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

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

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Standard-weight, galvanized or black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, galvanized or black-steel pipe with plain ends; steel welding fittings; and welded joints.
3. Thinwall Schedule 10, black-steel pipe with plain ends; welding fittings; and welded joints.

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

1. Standard-weight, galvanized or black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
2. Standard-weight or Schedule 30, galvanized or black-steel pipe with plain ends; steel welding fittings; and welded joints.
3. Thinwall 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.
4. Thinwall Schedule 10, black-steel pipe with plain ends; welding fittings; and welded joints.

3.10 SPRINKLER SCHEDULE

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

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Dry sprinklers Sidewall or pendent, dry sprinklers.
5. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.

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

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
3. Wax coated or painted with corrosion resistant paint where exposed to acids, chemicals, or other corrosive fumes.
4. Field painting of sprinkler heads will not be allowed in any situation.

END OF SECTION 21 13 13

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following items which apply to all Division 22 sections:
   1. Submittals.
   2. Coordination drawings.
   3. Record documents.
   4. Maintenance manuals.
   5. Piping materials and installation instructions common to most piping systems.
   6. Transition fittings.
   7. Dielectric fittings.
   8. Mechanical sleeve seals.
   9. Sleeves.
   10. Escutcheons.
   11. Grout.
   12. Flashing.
   13. Through penetration firestop assemblies.
   14. Plumbing demolition.
   15. Equipment installation requirements common to equipment sections.
   16. Painting and finishing.
   17. Concrete bases.
   18. Supports and anchorages.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.

4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

H. Firestopping (Through-Penetration Protection System): Sealing of stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.03 SUBMITTALS

A. Product Data for each kind of product used in the project.

B. Submittal of shop drawings, product data, and samples will be accepted only when signed and submitted by this Contractor and the General Contractor. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.

C. Shop drawings submitted without this Contractor's signature or approval and verification will not be approved. Quantities will not be checked or verified. It is the Contractor's responsibility to provide the proper quantities required to complete the job.

D. Portions of the work requiring a shop drawing submittal shall not begin until the shop drawing has been approved by the Engineer.

E. Submit wiring diagrams for all equipment requiring field wiring clearly showing all required connections. This Contractor will send one copy of Engineer approved shop drawings to the Electrical Contractor with a transmittal letter. Forward one copy of the transmittal letter to the Engineer's office.

F. Where catalog cuts are used, mark them to indicate equipment, capacities, controls, fittings, valves, sizes, etc.

G. Reference each item to applicable specification paragraph number and plan sheet number. Reference items not appearing in base specification to applicable alternate numbers, change order numbers, letters of authorization, etc.

H. Engineers acceptance of Compliance Submittals will not relieve Contractor from his responsibility for any deviations from the requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation at the time of submission and Engineer has given written approval to the specific deviation, nor shall any acceptance by Engineer relieve Contractor from responsibility for errors or omissions in Compliance Submittals.

1.04 GENERAL WORK REQUIREMENTS

A. Permits:
   1. Obtain and pay for all licenses and permits, fees, inspection and certificates required for the execution of this work.
   2. Pay fees and charges for connection to outside services and use of property.
   3. Deliver permits and certificates to the Architect to be transmitted to the Owner.
   4. This Contractor shall bear all permit fees and expense involved for the complete septic tank and lateral field installation. Verify complete installation with the authorities having jurisdiction.

1.05 RESPONSIBILITY

A. This Contractor will be held responsible for any and all damage to any part of the building or to the work of other contractors, as may be caused through his operation.

B. This contractor shall make all provisions for entry of equipment, installed under this contract, to the installed location. This contractor shall provide openings in existing construction if necessary. This contractor shall do all repair necessary to restore the building to the original condition. During the period of entry of equipment and removal of trash, no disruption of the Owner's normal business shall occur.

C. This Contractor shall fully coordinate equipment installation requirements with other trades. Any revisions or adjustments required to be made by other trades due to deviations from the basis of design equipment shall be the financial responsibility of this Contractor.

1.06 QUALITY ASSURANCE

A. Execute work in compliance with all applicable Federal, State and Municipal laws, codes, ordinances, and local customs regarding the trade to perform the work. The Contractor is required to verify that all installations comply with applicable codes. The codes applicable to this specific project may be listed on the Architect's code compliance sheet. If not, it is the Contractor's responsibility to determine which codes apply to the installations. Where code requirements conflict with those shown on the drawings and specifications, the code requirements shall take precedence. The Contractor shall notify the Architect immediately of any discrepancies between the applicable code requirements and the documents. Changes made to comply with the applicable requirements shall not justify an additional cost.

B. Inspect the existing site and conditions and check the drawings and specifications to be fully informed of the requirements for completion of the work. Lack of such information shall not justify an extra to the contract price.

C. The Plumbing Work shall include labor, materials, and equipment to install systems and place in proper working order, as shown on plans and hereinafter specified. The installation shall include all labor, materials, tools, transportation, equipment, services and facilities, required for the complete, proper and substantial installation of all mechanical work shown on the plans, and/or outlined in these specifications. The installation shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the drawings, but which are necessary to make a complete working installation of all mechanical systems.

D. Material and equipment shall be new, of best quality and design and free from defects. A manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating manufacturer's name, address and catalog number.

E. Furnish testing equipment and test all piping systems under methods and conditions as specified.

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

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

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

H. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

I. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 and ASTM E814 with 0.10-inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
    a. Floor Penetrations within Wall Cavities: T-Rating is not required.

J. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.

1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.

2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

K. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

L. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10-inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

M. Surface Burning Characteristics: 25/50 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.07 DELIVERY, STORAGE, AND HANDLING

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

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

1.08 WORKMANSHIP AND COORDINATION

A. Make installation substantially as shown on plans.

B. Pipe and duct routing and equipment location shown on the drawings are schematic in nature. Make alterations in location of apparatus or piping as may be required to conform to building construction without extra charge.

C. Equipment service clearances, per equipment manufacturer's specifications, shall be maintained from general construction. No pipe shall be installed within these clearances. No piping shall be installed above electrical panels, starters or switchgear, or in elevator equipment rooms.

D. Cooperate with other contractors in their installation of work.

E. The ductwork shall take precedence over all pipe work except where it is necessary to maintain an even grade on the piping.

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

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

H. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

I. Use only experienced mechanics.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Do not apply sealants, caulking, or mastic materials outside the range of the manufacturer's installation instructions.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

1.10 ELECTRONIC DOCUMENT REQUESTS

A. The Contractor may request the use of the bidding documents in electronic format (CAD, BIM, PDF etc.) for use in preparation of shop drawings and coordination drawings.

B. Professional Engineering Consultants, P.A. (PEC) reserves the right to refuse requests for electronic files at its sole discretion. The format of the files will be at PEC's sole discretion.

C. All electronic documents provided are provided on an as-is basis and are utilized by the Contractor at his own risk. All files provided by the Engineer are subject to PEC's standard "CADD/Electronic File Disclaimer". This disclaimer can be provided upon request.

D. At PEC's sole discretion, per sheet fee of up to $50 may be required to cover the costs of preparing the electronic files for transmission.

E. By obtaining the bid document CAD or BIM files, the Contractor is not relieved from his duty to create construction, shop and coordination drawings.

1.11 PLUMBING COORDINATION DRAWINGS

A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of piping, equipment, hangers, and materials. Include the following:
   a. Clearances for installing and maintaining insulation.
   b. Clearances for servicing and maintain equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
   c. Equipment connections and support details.
   d. Exterior wall and foundation penetrations.
   e. Fire-rated wall and floor penetrations.
   f. Underground piping.
   g. Sizes and locations of required concrete pads and bases.
   h. Numbered valve location diagrams.
   i. Valve stem movement.
   j. Pipe expansion loops.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Submit drawing to Architect to review for completeness. These drawings will be reviewed and returned with comments. They will not be approved as a shop drawing.

1.12 RECORD DOCUMENTS

A. Prepare record documents in accordance with Division 1. These drawings shall reflect the actual "As-Built" condition including any change orders, of the mechanical systems and installation. In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Identification Section. Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, contract modifications, and actual equipment and materials installed.

1.13 MAINTENANCE MANUALS

A. Prepare Maintenance Manuals in accordance with Division 1 Sections. In addition to the requirements specified in Division 1, include the following information for equipment items:

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

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control stopping, shutdown, and emergency instructions.
3. Maintenance procedures for routing preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Approved shop drawing submittals.
5. Servicing instructions and lubrication charts and schedules.
6. Copy of valve tag chart.

1.14 FINAL ELECTRONIC SUBMITTAL

A. In addition to the hard-copy record documents above, provide a set of electronic documents in PDF formats on an USB drive. The electronic shall include the following:
1. Floor plans, O&M manuals, approved shop drawings, and valve tag schedules.
2. The floor plans shall contain labels and links for each piece of equipment specified in this Division. The equipment links shall open the O&M manual for the respective piece of equipment with a single mouse click. Valve tag links shall open the appropriate portion of the valve tag schedule.
3. It is anticipated that there will be separate PDF floor plan documents for each class of equipment, and separate PDF valve tag floor plan(s) for each unique system. The exact format and quantity of PDF documents shall be submitted to the Owner for approval prior to creation of the comprehensive final submittal.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified or pre-approved equals.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

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

2.04 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
B. Insulating Material: Suitable for system fluid, pressure, and temperature.
C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.05 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.06 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

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

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

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

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

F. PVC Pipe: ASTM D 1785, Schedule 40.

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

2.07 ESCUTCHEONS

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

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

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed set screw or spring clips, and chrome-plated finish.

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

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

2.08 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.09 FLASHING

A. Metal Flashing: 26 gage (0.5 mm) thick galvanized steel.

B. Metal Counterflashing: 22 gage (0.8 mm) thick galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb./sq. ft (24.5 kg/sq m) sheet lead.
2. Soundproofing: 1 lb./sq. ft (5 kg/sq m) sheet lead.

D. Flexible Flashing: 47 mil (1.2 mm) thick sheet of material compatible with roofing. Coordinate with Architectural roofing specifications.

E. Caps: Steel, 22 gage (0.8 mm) minimum; 16 gage (1.5 mm) at fire resistant elements.

2.10 FIRESTOPPING

A. Manufacturers:

1. Hilti Corp.
2. Specified Technologies, Inc.
3. 3M fire Protection Products

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Single or multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single or multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

D. Coordinate the above requirements with Division 7.

2.11 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

C. General:

1. Furnish UL listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

D. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

2.12 ACCESS DOORS

A. If specified in Division 7 that section shall apply. Where not specified in Division 7 provide access doors as follows.

B. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

C. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

D. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

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

1. Bar-Co., Inc.
2. J.L. Industries.
3. Karp Associates, Inc.
4. Milcor Div. Inryco, Inc.
5. Nystrom, Inc.

2.13 DRIP PANS

A. Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drainline connections. Refer to Installation section below for location requirements.

PART 3 EXECUTION

3.01 PLUMBING DEMOLITION REQUIREMENTS

A. The existing areas surrounding the remodel area are fully occupied and shall remain operational throughout the duration of this project.

B. This contractor shall closely coordinate with the Owner and/or his representative the timing and schedule for any temporary cutoffs of any mechanical systems. The valve location and scheduled shutdown shall be closely coordinated with the Owner. It is recognized that temporary shutdown of systems will be required. These shall be scheduled in advance with Owner's representatives and restored to full service at the end of the work period.

C. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

D. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

E. Contractor shall provide protective plastic drop cloths to protect the existing occupied areas and equipment from dust and debris during the construction work and shall clean the areas of all construction dirt daily, and upon completion of the work.

F. Connection to existing piping for HVAC, medical gas, fire sprinkler or domestic water will require temporary shutdown of those mains to accomplish the new tie-ins. Closely coordinate and schedule this work with the Owner. Perform such work on weekends or nights as required by Owner's use and schedule.

G. All drained piping risers and mains shall be refilled with fluid and properly vented by this Contractor.

H. Coordinate with General Contractor the removal and replacement of all existing ceilings, walls, etc. as required for mechanical demolition work.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

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

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

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

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type or stamped steel with polished chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:
a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

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

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 for flashing.
1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Sections for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.03 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. The Contractor shall field verify all existing conditions and dimensions. The Contractor shall make field adjustments as required to accommodate the new work.

B. Verify final equipment locations for roughing-in.

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

3.04 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

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

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

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

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

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

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

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

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

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.05 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric nipples and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.06 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

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

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

D. Install equipment to allow right of way for piping installed at required slope.

3.07 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1. In addition to the requirements specified in Division 1, the following requirements apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.

3.08 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in other divisions.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.09 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100mm) larger in both directions than supported units.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi (20.7MPa) 38-day compressive-strength concrete and reinforcement. Refer to architectural and structural for additional requirements.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.12 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.13 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs. Refer to Division 7.

B. Seal floor, shower, and mop sink drains watertight to adjacent materials.

3.14 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating. Install per manufacturer's instructions to comply with appropriate listing.

D. Fire Rated Surface:

1. Seal openings as follows:
   a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
   b. Size sleeve allowing minimum of 1-inch (25 mm) void between sleeve and building element.
   c. Pack void with backing material.
   d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

E. Non-Rated Surfaces:
   1. Seal openings, where required by code, through non-fire rated openings as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
      b. Size sleeve allowing minimum of 1-inch (25 mm) void between sleeve and building element.
      c. Install type of firestopping material recommended by manufacturer.
   2. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
   3. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and pipe.

F. Inspect installed firestopping for compliance with specifications and submitted schedule.

G. Clean adjacent surfaces of firestopping materials.

3.15 INSTALLATION OF ACCESS DOORS

A. Provide access doors in construction wherever access is required for valves, dampers, equipment, etc.

B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.16 INSTALLATION OF DRIP PANS

A. Locate drip pans under piping passing within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection and run to nearest plumbing drain or elsewhere as indicated.

3.17 CLEANING

A. Refer to Division 1 for general requirements for final cleaning.

B. Contractor shall clean work area of all construction dirt and debris at the end of each workday.

3.18 WARRANTIES

A. Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties as specified into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. This Contractor shall warrant all material and equipment installed by him for a period of one year after completion of the project.

END OF SECTION 22 05 00

SECTION 22 05 16
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Flexible pipe connectors.
   2. Expansion joints.
   3. Expansion compensators.
   4. Pipe alignment guides.
   5. Pipe anchors.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME B31.9 - Building Services Piping.
   2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.

1.03 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:
   1. Installation Temperature: 50 degrees F.
   2. Domestic Hot Water: 140 degrees F.
   3. Safety Factor: 30 percent.

1.04 SUBMITTALS

A. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints.

B. Product Data:
   1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

C. Design Data: Indicate criteria and show calculations.

1.05 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

B. Operation and Maintenance Data: Submit adjustment instructions.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience approved by manufacturer.

1.08 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

B. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

A. Furnish five-year manufacturer warranty for leak free performance of packed expansion joints.

1.11 EXTRA MATERIALS

A. Supply two 12-ounce (340 g) containers of packing lubricant and cartridge style grease gun.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS

A. Steel Piping:

1. Inner Hose: Carbon Steel.
2. Exterior Sleeve: Double braided stainless steel.
3. Pressure Rating: 125 psig (862 kPa) WOG at 70 degrees F (21 degrees C).
4. Joint: As specified for pipe joints.
5. Maximum offset: 3/4 inch (20 mm) on each side of installed center line.

B. Copper Piping:

1. Inner Hose: Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 125 psig (862 kPa) WOG at 70 degrees F (21 degrees C).
4. Joint: As specified for pipe joints.
5. Maximum offset: 3/4 inch (20 mm) on each side of installed center line.

2.02 EXPANSION JOINTS

A. Stainless Steel Bellows Type:

1. Pressure Rating: 125 psig (862 kPa) WOG at 70 degrees F (21 degrees C).
2. Maximum Compression: 1-3/4 inch (45 mm).
3. Maximum Extension: 1/4 inch (6 mm).
4. Joint: Flanged.
5. Application: Steel piping 3 inch (75 mm) and smaller.

B. External Ring Controlled Stainless Steel Bellows Type:

1. Pressure Rating: 125 psig (862 kPa) WOG at 70 degrees F (21 degrees C).
2. Maximum Compression: 15/16 inch (24 mm).
3. Maximum Extension: 5/16 inch (8 mm).
4. Maximum Offset: 1/8 inch (3 mm).
5. Joint: Flanged.

6. Accessories: Internal flow liner.
7. Application: Steel piping 3 inch (75 mm) and larger.

C. Two-ply Bronze Bellows Type:
1. Construction: Bronze with anti-torque device, limit stops, internal guides.
2. Pressure Rating: 125 psig (862 kPa) WOG at 70 degrees F (21 degrees C).
3. Maximum Compression: 1-3/4 inch (45 mm).
4. Maximum Extension: 1/4 inch (6 mm).
5. Joint: As specified for pipe joints.
6. Application: Copper piping.

D. Low Pressure Compensators with two-ply Bronze Bellows:
1. Working Pressure: 75 psig (510 kPa).
2. Maximum Temperatures: 250 degrees F (121 degrees C).
3. Maximum Compression: 1/2 inch (12.7 mm).
4. Maximum Extension: 5/32 inch (4.0 mm).
5. Joint: Soldered.
6. Application: Copper or steel piping 2 inch (50 mm) and smaller.

E. Copper with Packed Sliding Sleeve:
1. Maximum Temperature: 250 degrees F (121 degrees C).
2. Joint: As specified for pipe joints.
3. Copper or steel piping 2 inches (50 mm) and larger.
4. Application: Copper or steel piping 2 inch (50 mm) and larger.

2.03 ACCESSORIES

A. Pipe Alignment Guides: Two-piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1-inch (25 mm) thick insulation, minimum 3-inch (75 mm) travel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install Work in accordance with ASME B31.9.

B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.

E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints as indicated on Drawings.

F. Provide grooved piping systems with minimum one joint per inch (25 mm) pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.

G. Provide expansion loops as indicated on Drawings.

3.02 MANUFACTURER'S FIELD SERVICES

A. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 220516

SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Bronze angle valves.
2. Brass ball valves.
3. Bronze ball valves.
4. Iron, single-flange butterfly valves.
5. Iron, grooved-end butterfly valves.
6. Brass, grooved-end butterfly valves.
7. Bronze swing check valves.
8. Iron swing check valves.
9. Iron swing check valves with closure control.
10. Iron, grooved-end swing check valves.
11. Bronze gate valves.
12. Iron gate valves.
13. Bronze globe valves.
14. Iron globe valves.
15. Chainwheels.

B. Related Documents:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of valve used in the project.

1.04 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.
C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooved ends, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

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

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

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 6 (DN 150) and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 4 (DN 100) and smaller.
   4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Grooved: With grooves according to AWWA C606.
   3. Solder Joint: With sockets according to ASME B16.18.
   4. Threaded: With threads according to ASME B1.20.1.

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

2.02 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hammond Valve.
      b. Milwaukee Valve Company.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded.
   e. Stem and Disc: Bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150, Bronze Angle Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co., Crane Valve Group; Stockham Division.
      b. Kitz Corporation.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 300 psig (2070 kPa).
      c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      d. Ends: Threaded.
      e. Stem and Disc: Bronze.
      f. Packing: Asbestos free.
      g. Handwheel: Malleable iron, bronze, or aluminum.

2.03 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Hammond Valve.
      d. Kitz Corporation.
      e. Legend Valve.
      f. Milwaukee Valve Company.
      g. NIBCO INC
      h. Red-White Valve Corporation.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig (1035 kPa).
      c. CWP Rating: 600 psig (4140 kPa).
      d. Body Design: Two piece.
      e. Body Material: Forged brass.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Brass.
      i. Ball: Chrome-plated brass.
      j. Port: Full.

2.04 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.; Apollo Valves
   b. Hammond Valve
   c. Legend Valve.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Red-White Valve Corporation.
   g. Viega
   h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig (1035 kPa).
   c. CWP Rating: 600 psig (4140 kPa).
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded or press fit.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze, blowout proof.
   i. Handle: Metal with powder coating.
   j. Ball: Chrome-plated brass.
   k. Port: Full.

B. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.; Apollo Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division
   c. Hammond Valve.
   d. Jomar Valve.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Viega
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig (1035 kPa).
   c. CWP Rating: 600 psig (4140 kPa).
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded or press fit.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze, blowout proof.
   i. Handle: Metal with powder coating.

j. Ball: Chrome-plated brass.

k. Port: Regular.

2.05 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.; Apollo Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group, Stockham Division
   d. DeZurik Water Controls.
   e. Hammond Valve.
   f. Jomar Valve.
   g. Kitz Corporation.
   h. Legend Valve.
   i. Milwaukee Valve Company.
   j. NIBCO INC.
   k. Red-White Valve Corporation.
   l. Spence Strainers International; a division of CIRCOR International, Inc.
   m. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum bronze or stainless steel.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.; Apollo Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group, Stockham Division
   d. DeZurik Water Controls.
   e. Hammond Valve.
   f. Jomar Valve.
   g. Kitz Corporation.
   h. Legend Valve.
   i. Milwaukee Valve Company.
   j. NIBCO INC.
   k. Red-White Valve Corporation.
   l. Spence Strainers International; a division of CIRCOR International, Inc.
   m. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
    a. Standard: MSS SP-67, Type I.
    b. CWP Rating: 200 psig (1380 kPa).
    c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
    e. Seat: NBR.
    f. Stem: One- or two-piece stainless steel.
    g. Disc: Aluminum bronze or stainless steel.

2.06 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Kennedy Valve: a division of McWane, Inc.
    b. Tyco Fire Products LP; Grinnell Mechanical Products.
    c. Victaulic Company
2. Description:
    a. Standard: MSS SP-67, Type I.
    b. CWP Rating: 175 psig (1200 kPa).
    c. Body Material: Coated, ductile iron.
    d. Stem: Two-piece stainless steel.
    e. Disc: Aluminum-bronze.
    f. Seat: Pressure-responsive EPDM.

2.07 BRASS, GROOVED-END BUTTERFLY VALVES

A. 300 CWP, Brass, Grooved-End Butterfly Valves:
1. Manufacturer:
    a. Victaulic Company.
    b. Kennedy
    c. Tyco
    d. Or approved substitution
2. Description:
    a. CWP Rating: 300 psig (2065 kPa).
    b. Body Material: Cast brass to UNS C87850.
    c. Stem: Stainless steel, offset from the disc centerline to provide complete 360-degree circumferential seating.
    d. Disc: Aluminum-bronze.
    e. Seat: Fluoroelastomer.

2.08 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Crane Co., Crane Valve Group; Crane Valves.
    b. Crane Co., Crane Valve Group; Jenkins Valves.
    c. Crane Co., Crane Valve Group; Stockham Division.
    d. Hammond Valve.

e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.09 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.

i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Stockham Division.
2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Composition.
g. Seat Ring: Bronze.
h. Disc Holder: Bronze.
i. Disc: PTFE or TFE.
j. Gasket: Asbestos free.

2.10 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO, INC.
2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Jenkins Valves.

b. Crane Co., Crane Valve Group; Stockham Division.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and weight.

2.11 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. Tyco Fire Products LP; Grinnell Mechanical Products.
c. Victaulic Company.

2. Description:
a. CWP Rating: 300 psig (2070 kPa).
b. Body Material: ASTM A 536, ductile iron.
c. Seal: EPDM.
d. Disc: Spring-operated, ductile iron or stainless steel.

2.12 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.

e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron**,** bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Jomar Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.13 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig (1380 kPa).

c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Jomar Valve.
f. Kitz Corporation.
g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell Valves.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.14 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Stockham Division.
c. Hammond Valve.
d. Kitz Corporation.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Powell Valves.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, Bronze Globe Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Stockham Division.
c. NIBCO INC.
d. Red-White Valve Corporation.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.15 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

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

D. Examine grooved ends for form and cleanliness. Ends shall be clean and free from indentations and projections in the area from valve, fitting, or pipe end to (and including) the groove.

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

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

3.02 VALVE INSTALLATION

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

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

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

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly, gate, and globe valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

F. 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 and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.03 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.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly or gate valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Globe or angle, ball, or butterfly valves.
4. Pump-Discharge Check Valves:
   a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
   b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
   c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded or solder end.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded end.

3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded ends.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:
1. Bronze Angle Valves: Class 125, bronze disc.
2. Ball Valves: Two piece, full port, brass or bronze with brass or bronze trim.
3. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.
4. Bronze Globe Valves: Class 125, bronze or nonmetallic disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:
1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM or NBR seat, aluminum-bronze disc.
2. Iron, Grooved-End Butterfly Valves: 175 CWP.
3. Iron Swing Check Valves: Class 125, metal or nonmetallic-to-metal seats.
4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring or weight.
5. Iron, Grooved-End Swing Check Valves: 300 CWP.
6. Iron Globe Valves: Class 125.

END OF SECTION 22 05 23

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Building attachments.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.
11. Miscellaneous equipment.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

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

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment where required.

1.04 SUBMITTALS

A. Product Data: For each type of product used in the project.

1.05 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

2.01 METAL PIPE HANGERS AND SUPPORTS

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

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

2.02 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.

2.03 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers
1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous thread rod, washer, and nuts made of stainless steel.

2.04 METAL FRAMING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit.
2. Cooper B-Line, Inc.
3. Unistrut Corporation; Tyco International, Ltd.

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

C. Standard: MFMA-4.

D. Channels: Continuous slotted steel channel with inturned lips.

E. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

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

G. Metallic Coating: Hot-dipped galvanized.

H. Paint Coating: Epoxy.

I. Plastic Coating: Polyurethane.

2.05 FIBERGLASS STRUT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit
2. Champion Fiberglass, Inc.

3. Cooper B-Line, Inc.
4. SEASAFE, INC.; a Gibraltar Industries Company.

B. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
1. Channels: Continuous slotted fiberglass channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.06 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) or ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength.

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

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

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.07 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory- fabricated building attachments comply with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Attachment materials to building structure shall be approved by the Structural Engineer.

B. Where concrete structure occurs hang piping using 1/2" diameter Phillips red head wedge anchors or equal by Hilti.
1. Concrete Inserts: MSS Type 18.
2. Top Beam C-Clamps: MSS Type 19.
3. Side Beam or Channel Clamps: MSS Type 20.
4. Center Beam Clamps: MSS Type 21.
5. Welded Beam Attachments: MSS Type 22.
6. C-Clamps: MSS Type 23.
7. Top Beam Clamps: MSS Type 25.
8. Side Beam Clamps: MSS Type 27.
9. Steel Beam Clamps with Eye Nut: MSS Type 28.

10. Linked Steel Clamps with Eye Nut: MSS Type 29.
11. Malleable Beam Clamps: MSS Type 30.
12. Steel Brackets: One of the following for indicated loading:
    a. Light Duty: MSS Type 31.
    b. Medium Duty: MSS Type 32.
    c. Heavy Duty: MSS Type 33.
13. Side Beam Brackets: MSS Type 34.
14. Plate Lugs: MSS Type 57.
15. Horizontal Travelers: MSS Type 58.

2.08 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic or stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.09 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.

2.10 EQUIPMENT SUPPORTS

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

2.11 MISCELLANEOUS MATERIALS

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

PART 3 EXECUTION

3.01 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 supporting 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. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

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

G. Installation of Building Attachments:

1. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.
2. Use power driven anchors or expansion anchors at concrete structure.
3. Install supplementary steel angles, fastened or welded to building structure as required to support pipe and accessories. Use 3” x 3” x 1/4” steel angle with long leg vertical, or heavier if required.

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Sections for how system interfaces with roofing system.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

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

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

L. 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.

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

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

O. 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.

P. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (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.
5. Pipes NPS 8 (DN 200) and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 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.

3.03 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.

3.04 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).

3.05 PAINTING

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

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

3.06 INSTALLATION - PIPE HANGER AND SUPPORT

A. Install in accordance with ASME B31.9, MSS SP 58, MSS SP69, and MSS SP 89.

B. Support horizontal and vertical piping as scheduled.

C. Install hangers with minimum 1/2-inch (13 mm) space between finished covering and adjacent work.

D. Provide clearance in hangers and from structure and other equipment for installation of insulation.

E. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.

F. Design hangers for pipe movement without disengagement of supported pipe

G. Comply with MSS SP-69 for pipe-hanger selections and applications that are not otherwise specified.

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

I. Use stainless-steel pipe hangers, fiberglass pipe hangers, fiberglass strut systems and stainless-steel or corrosion-resistant attachments for outdoors and/or hostile environment applications.

J. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing. Use vinyl-coated hangers and attachments for PEX, PVC, and CPVC piping. Use stainless steel hangers and stainless-steel attachments on stainless steel pipes.

K. Use padded hangers for piping that is subject to scratching, including plastic pressure piping and all glass piping.

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

M. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified elsewhere, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

N. Vertical-Piping Clamps: Unless otherwise indicated and except as specified elsewhere, 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.

O. Hanger-Rod Attachments: Unless otherwise indicated and except as specified elsewhere, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

P. Building Attachments: Unless otherwise indicated and except as specified elsewhere, 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 (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.

Q. Saddles and Shields: Unless otherwise indicated and except as specified elsewhere, 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.

R. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not otherwise specified.

S. Comply with MFMA-103 for metal framing system selections and applications that are not otherwise specified.

T. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

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

3.07 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.08 SCHEDULES

HORIZONTAL PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet (m)	HANGER ROD DIAMETER Inches (mm)
ABS thru 3 inches (75)	4 (1.2)	1/2 (13)
ABS 4 to 12 inch (300)	4 (1.2)	7/8 (22)
Cast Iron to 5 inch	5 (1.5)	5/8 (15)
Cast Iron 6 to 12 inch	5 (1.5)	7/8 (22)
Cast Iron with 10-foot (3 m) length of pipe to 5 inch	10 (3)	5/8 (15)
Cast Iron with 10-foot (3m) length of pipe 6 to 12 inch	10 (3)	7/8 (22)
CPVC, 1 inch (25 mm) and smaller	3 (0.9)	1/2 (13)
CPVC, 1-1/4 inch (32 mm) to 3 inch (75)	4 (1.2)	1/2 (13)
CPVC, 4 inch (100) to 8 inch (200)	4 (1.2)	7/8 (22)
Copper Tube, 1-1/4 inch (32 mm) and smaller	5 (1.5)	3/8 (10)
Copper Tube, 1-1/2 inch (38 mm) to 5 inches (DN125)	8 (2.4)	1/2 (13)
Copper Tube 6 inch (DN150)	10 (3)	5/8 (16)
Copper Tube 8 inch (DN200)	10 (3)	3/4 (19)
Fiberglass up to 4 inch (100 mm)	10 (3)	5/8 (16)
Glass up to 4 inch (100mm)	5 (1.5)	5/8 (16)
PEX 1 inch (25 mm) and smaller	2.5 (.75)	3/8 (9)
Polybutylene	2.67 (0.8)	3/8 (9)
Polypropylene 3 inches (75 mm) and smaller	3 (.9)	1/2 (13)
Polypropylene 4 inches (100 mm) to 8 inches (200 mm)	4 (1.2)	7/8 (22)
PVC 3 inches (75 mm) and smaller	4 (1.2)	1/2 (13)
PVC 4 inches (100 mm) to 8 inch (100 mm)	4 (1.2)	7/8 (22)
PVDF up to 3 inch (75 mm)	2.5 (.75)	1/2 (13)
PVDF 4 inch (100mm) to 6 inch (150 mm)	4 (12)	3/4 (19)
Stainless Steel or Steel, 3 inches (75 mm) and smaller	12 (3.7)	1/2 (13)
Stainless Steel or Steel, 4 inches (100 mm) to 6 inch (150 mm)	12 (3.7)	3/4 (19)
Stainless Steel or Steel, 8 inches (200 mm) and larger	12 (3.7)	7/8 (22)

NOTE: 1. Where code requirements for hangers are more stringent than above, code requirements shall apply.
2. Place hangers within 12 inches (300 mm) of each horizontal elbow, fitting, valve and coupling.
3. Support horizontal cast iron pipe adjacent to each hub.
4. Rod diameters may be reduced one size for double-rod hangers, with 3/8 inch (10mm) minimum rods.

VERTICAL PIPE SUPPORT SPACING	
PIPE MATERIAL	MAXIMUM SUPPORT SPACING Feet (m)
ABS	4 (1.2)
Cast Iron	15 (4.5)
CPVC 1 inch (25 mm) and smaller	5 (1.5)
CPVC 1-1/4 inch (32mm) and larger	6 (1.8)
Copper Tube	10 (3)
Fiberglass	12 (3.7)
Glass	8 (24)
PEX	4 (1.2)
Polypropylene	5 (1.5)
PVC	4 (1.2)
PVDF	4 (1.2)
Steel or Stainless Steel	15 (4.5)

NOTE: 1. Where not otherwise indicated, support vertical piping at each floor.
2. Support cast iron at hubs.
3. Support riser piping independently of connected horizontal piping.

END OF SECTION 22 05 29

SECTION 22 05 48
VIBRATION AND SEISMIC CONTROLS FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Seismic snubbers.
2. Restraining braces and cables.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Restraint

1. Unless otherwise specified, all mechanical, electrical, medical gas and plumbing equipment, pipe, and duct shall be restrained to resist seismic forces. Restraints shall maintain equipment, piping, and duct work in a captive position. Restraint devices shall be designed and selected to meet the seismic requirements as defined in the adopted issue of the IBC.
2. This building is a Seismic Design Category C and all mechanical, plumbing, and medical gas systems shall be treated as having an importance factor (Ip) of 1.5. Refer also to structural drawings for additional information.
3. Seismic restraint shall not be required for the following:
   a. High deformability piping (steel, copper, aluminum with welded, brazed, ground, or screwed connections) designated as having a nominal pipe size of 1 inch (25 mm) or less where provisions are made to protect the piping from impact or to avoid the impact of larger piping or other plumbing equipment. Note, any combination of piping supported on a trapeze where the total weight exceeds 10 lb/ft. shall be braced.
   b. PVC or other plastic or fiberglass vent piping.
   c. Equipment items installed in-line with the duct system (e.g. fans, heat exchangers, and humidifiers) with an operating weight less than 76 pounds (334 N). Equipment must be rigidly attached to duct at inlet and outlet.
   d. All equipment with an Importance Factor of 1.0.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:

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 seismic-restraint component used.
   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.

B. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

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

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation and seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
2. 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, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Seismic -Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the Building Code unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 PRODUCTS

2.01 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Cooper B-Line, Inc.; a division of Cooper Industries.
   3. Hilti, Inc.
   4. Kinetics Noise Control.
   5. Mason Industries.
   6. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
   2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. 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.

G. 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.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. 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. Minimum length of eight times diameter.

J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl 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.

2.02 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
   1. Powder coating on springs and housings.
   2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
   3. Baked enamel or powder coat for metal components on isolators for interior use.
   4. Color-code or otherwise mark vibration isolation and seismic and wind control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings 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 will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
   3. Brace a change of direction longer than 12 feet (3.7 m).

B. Install cables so they do not bend across edges of adjacent equipment or building structure.

C. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

D. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

E. 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.

F. 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.

G. 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 structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed 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.

3.04 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Install flexible connections in piping where they cross building joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.05 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.06 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.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 220548

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Warning signs and labels.
   2. Pipe labels.
   3. Valve tags.
   4. Warning tags.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 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.

1.03 COORDINATION

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

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

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

PART 2 PRODUCTS

2.01 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

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

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

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

2.02 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. For insulated pipes, also include pipe size on the label.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or 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 and an arrow indicating flow direction. For insulated pipes, also include pipe size on the label.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.03 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Multilayer, multicolored plastic, 0.0625 inch (1.6mm); Brass, 0.032-inch (0.8-mm); Stainless steel, 0.025-inch (0.64-mm); Aluminum, 0.032-inch (0.8-mm); or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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.

2.04 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches (100 by 178 mm).
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 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.

3.02 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; mechanical rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings.
   8. There shall be a minimum of one label for each system per room.

3.03 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; 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.

3.04 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53

SECTION 22 07 00
PLUMBING INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Plumbing piping insulation, jackets and accessories.
   2. Plumbing equipment insulation, jackets and accessories.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 REFERENCES

A. ASTM International:
   1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   3. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
   4. ASTM C450 - Standard Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments.
   5. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   6. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
   7. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
   8. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
   9. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   10. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   11. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   12. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. National Fire Protection Association:
   1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories Inc.:
   1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

B. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255. Any items exposed in return air plenums shall not exceed 25/50 for flame and smoke.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Perform work in accordance with applicable local and state codes.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years' experience.

1.06 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

B. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
   1. CertainTeed LLC; Saint-Gobain North America.
   2. Knauf Insulation.
   3. John Manville.
   4. Owens-Corning.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
   1. Aeroflex, USA.
   2. Armacell, LLC.
   3. K-flex.

C. Manufacturer for Fire Barrier Plenum Wrap Products:
   1. 3M Building and Commercial Services Division.
   2. Morgan Advanced Materials (Firemaster Plenumwrap).

D. Manufacturer for Glass Fiber for Plenum Installation:
   1. Johns Manville Micro-Lok HP or HP Ultra.
   2. Other manufacturers whose products have been listed and labeled as an assembly for use with PVC or Polypropylene pipe in accordance with ASTM E-84 or UL-723.

2.02 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.23 at 75 degrees F (0.034 at 24 degrees C).
2. Operating Temperature Range: 0 to 850 degrees F (minus 18 to 454 degrees C).
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).

B. TYPE P-2: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.245 at 75 degrees F (0.0353 at 25 degrees C).
2. Operating Temperature Range: Range: Minus 70 to 220 degrees F (minus 57 to 104 degrees C).

C. TYPE P-3: Fire Barrier Plenum Wrap. high temperature fiber blanket thermal insulation encapsulated in a fiberglass-reinforced aluminized foil. For use in plenum spaces, to provide a flexible, non-combustible enclosure for PVC, CPVC, PB, PE, PP, PVDF and ABS piping.

D. TYPE P-4: ASTM C547, molded glass fiber pipe insulation.
1. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints or polypropylene-coated factory applied vapor-barrier jacket with self-sealing adhesive joints.
2. For use in plenum spaces. Insulation must be listed and labeled as an assembly for use with PVC or Polypropylene pipe in accordance with ASTM E-84 or UL-723.

2.03 PIPE INSULATION JACKETS

A. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1784, One piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 30 mil (51 mm).
3. Connections: Brush on welding adhesive or tacks.

B. Aluminum Pipe Jacket:
1. ASTM B209.
2. Thickness: 0.032 inch (0.80 mm) thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2-inch (50 mm) laps.
5. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.020 inch (0.50 mm) thick stainless steel.

2.04 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches (40 mm) diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Minimum 6 inches (150 mm) long.

D. Piping 2 inches (50 mm) diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches (150 mm) long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum or stainless-steel jacket single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Adhesives: Compatible with insulation.

2.05 ADHESIVES:

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

B. Flexible Elastomeric and Polyolefin Adhesive:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.
      b. Armacell LCC.
      c. Foster Products Corporation, H.B. Fuller Company.
      d. K-Flex USA, LLC.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify piping has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Division 07 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
   1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
   2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
   3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
   1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with stud, pins, clips, adhesive, wires, or bands.
   2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
   3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Hot Piping Systems at or less than 140 degrees F (60 degrees C):
   1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
   3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

F. Hot Piping Systems greater than 140 degrees F (60 degrees C):
   1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

G. Inserts and Shields:
1. Piping 1-1/2 inches (40 mm) Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches (50 mm) Diameter and Larger: Install insert between support shield and piping and under finish jacket:
a. Insert Configuration: Minimum 6 inches (150 mm) long, of thickness and contour matching adjoining insulation; may be factory fabricated.
b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

H. Fire Barrier Plenum Wrap: Installation shall be in strict accordance with manufacturer's written instructions, as shown on the approved shop drawings.

I. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with PVC jacket and fitting covers or aluminum jacket.

K. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like materials, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

L. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

M. Prepare pipe insulation for finish painting. Refer to Division 09.

3.03 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches (mm)
Domestic Hot Water Supply and Recirculation	P-1, P-2	1-1/4 inches (35 mm) and smaller 1-1/2 inches (40 mm) and larger	1.0 (25) 1.5 (40)
Domestic Cold Water	P-1, P-2	All Sizes	1.0 (25)

END OF SECTION 22 07 00

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Flexible connectors.

B. Related Documents:

1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

1.03 SUBMITTALS

A. Product Data: For the following products:

1. Piping.
2. Piping fittings.
3. Flexible connectors.

B. Coordination Drawings.

C. System purging and disinfecting activities report.

D. Field quality-control reports.

1.04 QUALITY ASSURANCE

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

B. Comply with NSF 61 for potable domestic water piping and components.

C. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.05 PROJECT CONDITIONS

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

1. Notify Architect no fewer than two days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Architect's written permission.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 COPPER TUBE AND FITTINGS

A. Hard (Drawn Temper) Copper Tube: ASTM B 88, Type L or K (ASTM B 88M, Type A or B) water tube, drawn temper.

B. Soft (Annealed Temper) Copper Tube: ASTM B 88, type L or K (ASTM B 88M, type A or B).

C. Fittings:
   1. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   3. 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.
   4. Wrought Copper Unions: ASME B16.22.
   5. Copper or Bronze Pressure-Seal-Joint Fittings: ASME B16.18 or ASME B16.23.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Merit Brass (CopperPress)
         2) Mueller Streamline (PRS)
         3) Viega LLC(ProPress)
      b. Source Limitations: Obtain pressure seal joint fittings from a single manufacturer.
      c. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      d. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      e. Tools: Manufacturer's special tools.
      f. Minimum 200 psig (1370 kPa) working pressure rating at 250 deg F (121 deg C).
      g. Integral leak detection feature to help identify unpressed connections prior to putting the system in operation.
   6. Rolled Grooved-Joint Copper-Tube Appurtenances:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Victaulic Company
         2) ASC Gruvlok.
      b. Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
      c. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting, EDPM rubber gasket, UL classified per NSF 61 and NSF 372 and rated for minimum 180 deg F (80 deg C) for use with ferrous housing and steel bolts and nuts; 300 psig (2060 kPa) minimum CWP pressure rating.

2.03 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110/A21.10, ductile or gray iron.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile or gray iron glands, rubber gaskets and steel bolts.
   2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153/A21.51, ductile iron.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.04 STAINLESS STEEL PIPE AND FITTINGS

A. Stainless Steel Pipe: ASTM A312/A312M seamless, stainless steel Type 304, schedule 10.

B. Stainless Steel Pipe Fittings: ASTM A815/A815M.

C. Appurtenances for Grooved-End, Stainless Steel Pipe: stainless steel casting with dimensions matching stainless steel pipe.
   1. Manufacturers - Subject to compliance with requirements, provide products by one of the following:
      a. ASC (Gruvlok)
      b. Victaulic
   2. Source Limitations: Obtain appurtenance for grooved-end, stainless steel pipe from single manufacturer.
   3. Mechanical Couplings for Grooved-End Stainless Steel Pipe shall have stainless steel housing sections, bolts and nuts, and EPDM rubber gaskets suitable for hot and cold water.

D. Stainless Steel Pressure-Seal-Joint Fittings:
   1. Manufacturers - Subject to compliance with requirements, provide products by one of the following:
      a. Merit Brass (Stainless Press)
      b. Viega, LLC(MegaPress)
      c. Victaulic
   2. Source Limitations: Obtain stainless steel piping, pressure-seal-joint fittings from a single manufacturer.
   3. NPS 2 (DN50) and Smaller: Type 316 stainless steel fitting with EPDM-rubber O-ring seal in each end.
   4. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type 316 stainless steel fitting with EPDM-rubber O-ring seal in each end.

2.05 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony lead-free alloys. Include water-flushable flux according to ASTM B 813.

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

2.06 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction

loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook." Install tubing without joints if possible. If joints are required, they shall be brazed.

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

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

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

F. Install seismic restraints on piping as required. Comply with requirements for seismic restraint devices elsewhere in Division 22.

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

H. 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.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space. Provide space to permit insulation applications, with 1 inch clearance outside the insulation.

J. Install piping adjacent to equipment and specialties to allow service and maintenance.

K. Install piping to permit valve servicing.

L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating.

M. Install piping free of sags and bends.

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

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

P. Install pressure gages on suction and discharge piping from each plumbing pump.

Q. Install thermometers on inlet and outlet piping from each water heater.

3.02 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

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

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

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

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer. Leave insertion marks on pipe after assembly.

G. Joint Construction for Grooved-End Copper Tubing: Make joints in accordance with AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

H. Joint Construction for Grooved-End Steel Piping: Make joints in accordance with AWWA C606. Roll groove ends of pipe. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

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

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

3.03 VALVE INSTALLATION

A. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 (DN 50) and smaller. Use butterfly valves or ball valves for piping NPS 2-1/2 (DN 65) and larger.

B. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

C. Install calibrated balancing valves in each hot-water circulation return branch of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow.

3.04 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.05 DIELECTRIC FITTING INSTALLATION

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

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

E. Install bronze-hose flexible connectors in copper domestic water tubing.

F. Install stainless-steel-hose flexible connectors in stainless steel domestic water piping.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

B. Support piping and tubing not otherwise listed according to MSS SP-69, plumbing code, and manufacturer's written instructions.

C. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

3.07 CONNECTIONS

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

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

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

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code.
2. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.08 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors. See Division 22 Section "Common Results for Plumbing" for materials and installation of escutcheons.

3.09 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

C. See Division 22 Section "Common Work Results for Plumbing" for materials and installation of sleeves and fire barrier (firestopping).

3.10 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entry into building. See Division 22 Section "Common Work Results for Plumbing" for materials and installation of sleeve seals.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification of materials and installation.

B. Where multiple system pressures exist, label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. 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:
    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. 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.
3. 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.
4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow standing for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

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

E. Prepare test and inspection reports.

3.13 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust calibrated balancing valves in hot-water-circulation return piping to provide adequate flow or to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.14 CLEANING

A. Clean and disinfect 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 (50 mg/L) of chlorine. Isolate with valves and allow standing for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow standing for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.15 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. Use the minimum number of joints possible in below floor piping.

DOMESTIC WATER PIPING SERVICE DESCRIPTION	PIPING	FITTINGS
Above Ground NPS 2 (DN 50) and smaller	Hard Copper Tube Type L (Type B)	Wrought Copper and Soldered Joints
		Copper Pressure-Seal Joint Fittings, and Pressure Sealed Joints
Above Ground NPS 2-1/2 to NPS 6 (DN 65 to DN 150)	Hard Copper Tube Type L (Type B)	Wrought Copper and Soldered Joints
		Copper Pressure-Seal Joint Fittings and Pressure-Sealed Joints
		Grooved Joints
	Stainless Steel Type 304, Schedule 10 (Where allowed by code.)	Grooved Mechanical
		Stainless Steel Pressure-Seal Joint Fittings and Pressure Sealed Joints

3.16 VALVE SCHEDULE

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

1. Shutoff Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use butterfly valves with flanged ends or ball valves for piping NPS 2-1/2 (DN 65) and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 22 11 16

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated water mixing valves.
5. Strainers.
6. Outlet boxes.
7. Drain valves.
8. Water hammer arresters.
9. Trap-seal primer valves.

B. Related Documents:

1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.03 SUBMITTALS

A. Product Data: For each type of product used in the project.

1.04 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities have jurisdiction, and NSF 61 and NFS 372 or to be certified to be in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third party certification body that the weighted average lead content at wetting surfaces is less than or equal to 0.25 percent.

PART 2 PRODUCTS

2.01 VACUUM BREAKERS

A. Pipe applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; a division of Aalberts IPS.
   b. Ames, A WATTS Brand.
   c. Cash Acme.
   d. FEBCO; A WATTS Brand.
   e. WATTS Water Technologies, Inc.
   f. Zurn Industries, LLC.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze or chrome plate.
7. Operation: Anti-siphon, anti-spill, not for operation under continuous pressure.

B. Low Hazard Hose-Connection Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; a division of Aalberts IPS.
   b. Cash Acme.
   c. Jay R. Smith Manufacturing.
   d. MIFAB, Inc.
   e. WATTS Water Technologies, Inc.
   f. Woodford Manufacturing Company.
   g. Zurn Industries, LLC.
2. Standard: ASSE 1011.
3. Body: Bronze, non-removable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Match faucet or hydrant finish.

C. Pressure Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; a division of Aalberts IPS.
   b. FEBCO, A WATTS Brand.
   c. WATTS Water Technologies, Inc.
   d. Zurn Industries, LLC.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Accessories:
   a. Valves: Ball type, on inlet and outlet.
6. Use freeze-resistant type for outside installations.

D. Spill-Resistant Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves, a division of Aalberts IPS.
   b. WATTS Water Technologies, Inc.
   c. Zurn Industries, LLC.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories:
   a. Valves: Ball type, on inlet and outlet.

E. BACKFLOW PREVENTERS

F. Reduced-Pressure-Principle Backflow Preventers (RPZ):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Fire & Waterworks: A WATTS Brand.
      b. FEBCO; A WATTS Brand.
      c. WATTS Water Technologies Inc.
      d. Zurn Industries, LLC.
   2. Standard: ASSE 1013.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.
   5. Body: Bronze or stainless steel for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
   6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
   7. Configuration: Designed for horizontal, straight through flow or as indicated on the drawings.
   8. Accessories:
      a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
      b. Strainer on inlet.
      c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

G. Double-Check Backflow-Prevention Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Fire & Waterworks; A WATTS Brand.
      b. Apollo Valves; a part of Aalberts IPS.
      c. FEBCO; A WATTS Brand.
      d. WATTS Water Technologies Inc.
      e. Zurn Industries, LLC.
   2. Standard: ASSE 1015.
   3. Operation: Continuous-pressure applications, unless otherwise indicated.
   4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
   5. Body: Bronze or stainless steel for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
   6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
   7. Configuration: Designed for horizontal, straight through flow, or as indicated on drawings.
   8. Accessories:
      a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

H. Beverage-Dispensing-Equipment Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a division of Aalberts IPS.
      b. WATTS Water Technologies, Inc.
      c. Zurn Industries, LLC.
   2. Standard: ASSE 1022.
   3. Operation: Continuous-pressure applications.
   4. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10).
   5. Body: Stainless steel or non-metallic.
   6. End Connections: Threaded.

I. Dual-Check-Valve Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a division of Aalberts IPS.
      b. Cash Acme.
      c. McDonald, A. Y. Mfg. Co.
      d. WATTS Water Technologies, Inc.
      e. Zurn Industries, LLC.
   2. Standard: ASSE 1024.
   3. Operation: Continuous-pressure applications.
   4. Body: Bronze with union inlet.

J. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      a. WATTS Water Technologies, Inc..
   2. Standard: ASSE 1032.
   3. Operation: Continuous-pressure applications.
   4. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10).
   5. Body: Stainless steel.
   6. End Connections: Threaded.

K. High Hazard Hose Hose-Connection Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a division of Aalberts IPS.
      b. WATTS Water Technologies, Inc.
      c. Woodford Manufacturing Company.
   2. Standard: ASSE 1052.
   3. Operation: Up to 10-foot head of water (30-kPa) back pressure.
   4. Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
   5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
   6. Capacity: At least 3-gpm (0.19-L/s) flow.

2.02 CALIBRATED BALANCE VALVES (MANUAL BALANCE VALVES)

A. Manufacturer: Subject to compliance with requirements, provide calibrated balance valves by one of the following:

1. Armstrong Model CBV-S.CBV-T (1/2” through 3/4”).
2. Bell & Gossett Model CB-LF (1/2” through 3”).
3. Jomar Valve TGG (1/2” through 2”).
4. Viega ProPress Zero Lead 2980ZL (1/2” through 2”).

B. General: Provide as indicated, calibrated balance valves equipped with readout test ports to facilitate connecting of a differential pressure meter to balance valves. Equip each readout test port with integral check valve designed to minimize system fluid loss during balancing process. Provide calibrated nameplate to indicate degree of closure of precision machined orifice with tamper resistant memory step. Valves shall be capable of positive shut-off with no leakage. Valve size shall be same size as connected piping, but not larger than 2” (DN 50).

C. Features: Balancing Valves shall be of bronze or brass body construction with solder, pressure seal, or NPT connections to match piping systems. Construct each valve for a minimum of 125 psig working pressure at a temperature of 250 F.

1. Provide each valve with an engraved valve tag attached permanently to valve with brass chain or wire link manufactured specifically for that purpose. A valve schedule suitable for framing shall be provided referencing each valve by sequenced number and indicating a minimum of valve size, model, manufacturer, and piping system served if applicable. A copy of the valve schedule shall be provided with balancing valve shop drawings submittals and included in the Operation and Maintenance Manual.

2.03 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Controls; Morris Group International.
   b. Apollo Valves; a division of Aalberts IPS.
   c. Bradley Corporation.
   d. Cash Acme.
   e. Leonard Valve Company.
   f. POWERS; a WATTS Industries Co.
   g. Symmons Industries, Inc.
   h. WATTS Water Technologies.
   i. Zurn Industries, LLC.
2. Standard: ASSE 1070, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
4. Type: Thermostatically controlled water mixing valve.
5. Body: Bronze body with corrosion-resistant interior components.
6. Temperature Control: Adjustable.
7. Inlets and Outlet: Threaded or soldered; checkstops on inlet.
8. Finish: Chrome-plated or rough bronze.

2.04 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.

5. Perforation Size:
   a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
   b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
   c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).
6. Drain: Factory-installed, hose-end drain valve.

2.05 OUTLET BOXES

A. Icemaker Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Guy Gray; IPS Corp.
   b. Oatey.
   c. Sioux Chief Mfg. Co.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel, epoxy-painted-steel, stainless steel, or plastic box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
5. Accessories: Water hammer arrester.
6. In fire-rated assemblies, the installation shall be listed to maintain the fire rating.

2.06 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 (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 (DN 20) threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:
1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig (1380-kPa) minimum CWP or Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 (DN 6) side outlet with cap.

2.07 WATER HAMMER ARRESTERS

A. Water Hammer Arresters (WHA-X*):

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. Precision Plumbing Products.
   e. Sioux Chief Manufacturing Company, Inc.
   f. WATTS.
   g. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.
5. Water hammer arresters shown in inaccessible locations shall be approved for that application.

* P.D.I. Size.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers where indicated on plans. Comply with authorities having jurisdiction:

1. Locate backflow preventers in same room as connected equipment or system, unless indicated otherwise on drawings.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain, or as shown. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install unprotected bypass piping around backflow preventers.
4. Install backflow preventers in the orientation (vertical up, vertical down, horizontal, etc.) for which it is approved.

C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

E. Balancing valves shall be installed with flow in the direction of the arrow on the valve body and installed at least five pipe diameters downstream of any fitting, and at least ten pipe diameters downstream of any pump. Do not install fittings less than two pipe diameters downstream of the balancing valve. Install balancing valves in locations where they can easily be adjusted and measured.

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

1. Install thermometers and water regulators as specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

H. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs.

I. Install water hammer arresters in water piping according to PDI-WH 201 and as shown on the plans.

J. Install vacuum breakers per manufacturer's instructions observe critical level of vacuum breaker above outlet of water or source of possible contamination.

3.02 CONNECTIONS

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

3.03 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate valve tag or nameplate on or near each of the following:

1. Vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Double-check backflow-prevention assemblies.
4. Dual-check-valve backflow preventers.
5. Water pressure-reducing valves.
6. Calibrated balancing valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each vacuum breaker and backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.05 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

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

END OF SECTION 22 11 19

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

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

B. LLDPE: Linear, low-density polyethylene plastic.

C. NBR: Acrylonitrile-butadiene rubber.

D. PE: Polyethylene plastic.

E. PVC: Polyvinyl chloride plastic.

F. TPE: Thermoplastic elastomer.

1.03 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.04 SUBMITTALS

A. Product Data: For each type of product used in project.

B. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.05 QUALITY ASSURANCE

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

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-SEWER" for plastic sewer piping.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Architect's written permission.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Charlotte Pipe
   c. Dallas Specialty & Mfg. Co.
   d. Fernco Inc.
   e. Matco-Norca, Inc.
   f. MIFAB, Inc.
   g. Mission Rubber Company; a division of MCP Industries, Inc.
   h. Ideal Tridon.
   i. Tyler Pipe.
2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Charlotte Pipe
   c. Clamp-All Corp.
   d. Dallas Specialty & Mfg. Co.
   e. MIFAB, Inc.
   f. Mission Rubber Company; a division of MCP Industries, Inc.
   g. Ideal Tridon.
   h. Tyler Pipe.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MG Piping Products Company.
   b. Other manufacturer by prior approval only.

2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Steel Pipe Pressure Fittings:

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

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

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

D. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International; a subsidiary of Mueller Water Products, Inc.
   b. Grinnell Mechanical Products.
   c. Shurjoint Piping Products.
   d. Victaulic Company.
2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.05 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.

2. Ductile-Iron-Pipe Appurtenances:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Anvil International.
      2) Shurjoint Piping Products.
      3) Star Pipe Products.
      4) Victaulic Company.
   b. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
   c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.06 COPPER TUBE AND FITTINGS

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

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

C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.07 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

D. Solvent Cement: ASTM D 2564.

2.08 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Shielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cascade Waterworks Mfg. Co.
         2) Mission Rubber Company; a division of MCP Industries, Inc.
      b. Standard: ASTM C 1460.
      c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   4. Pressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cascade Waterworks Mfg. Co.

2) Dresser, Inc.
3) EBAA Iron, Inc.
4) JCM Industries, Inc.
5) Romac Industries, Inc.
6) Smith-Blair, Inc.; a Sensus company.
7) The Ford Meter Box Company, Inc.
8) Viking Johnson.

b. Standard: AWWA C219.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Manufacturer's standard.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:
1. General Requirements: Assembly of copper alloy and ferrous materials with separating non-conductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Flanges:
a. Description:
1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
3. Dielectric-Flange Insulating Kits:
a. Description:
1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig (1035 kPa).
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.
4. Dielectric Nipples:
a. Description:
1) Electroplated steel nipple complying with ASTM F 1545.
2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
3) End Connections: Male threaded or grooved.
4) Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.
B. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.
C. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.
D. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PIPING INSTALLATION

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

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

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

1. Horizontal Sanitary Drain Piping: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Vent Piping: Shall slope down toward vertical fixture vent.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install steel piping according to applicable plumbing code.

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

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

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

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section “Common Work Results for Plumbing."

S. Install mechanical sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for mechanical sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

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

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

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

D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

E. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

G. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.
3. In Aboveground Pressure Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100: Use dielectric flanges or flange kits.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.05 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
2. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support piping and tubing not otherwise listed above according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

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

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in risers near floor and floor cleanouts with cover flush with floor.
5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.08 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.09 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 piping does not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

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

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point

of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test pressure piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or pressure main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

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

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

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

Soil & Waste Piping	Above Ground	4" (DN100) and smaller	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron soil pipe & fittings; CISPI hubless-piping couplings; & cast-iron, hubless-piping couplings.
			Copper DWV tube, copper drainage fittings, and soldered joints
			Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)
Soil & Waste Piping	Above Ground	5" (DN125) and larger	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron, soil pipe & fittings; CISPI hubless piping couplings; & cast-iron, hubless-piping couplings..

			Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)
Vent Piping	Above Ground	4" (DN100) and smaller	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron, soil pipe & fittings; CISPI hubless piping couplings; & coupled joints.
			Copper DWV tube, copper drainage fittings, & soldered joints
			Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)
Vent Piping	Above Ground	5" (DN125) and larger	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron, soil pipe & fittings; CISPI hubless piping couplings; & cast-iron, hubless-piping couplings.
			Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)

Notes: (a) This piping material is not to be installed in a return air plenum.

END OF SECTION 22 13 16

SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
   3. Floor sinks.
   4. Air-admittance valves.
   5. Miscellaneous sanitary drainage piping specialties.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Division, may contain requirements that relate to this section.

1.02 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

1.04 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.01 CLEANOUTS

A. Exposed Metal Cleanouts (CO):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts(CO):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: If required.
7. Outlet Connection: Inside calk or spigot.
8. Closure: Brass plug with straight threads and gasket, or brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round (standard) or square where located in tile floor.
12. Top Loading Classification: Heavy duty where vehicle traffic is possible. Medium duty in all other areas.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts(WCO):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. PVC Products are not to be utilized in return air plenums.

D. Plastic Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Oatey
      b. Plastic Oddities; a division of Diverse Corporate Technologies.
      c. Sioux Chief Manufacturing Company, Inc.
      d. Zurn Plumbing Products Group; Light Commercial Operation.
   2. Size: Same as connected branch.
   3. Type: Threaded, adjustable housing.
   4. Body: PVC.
   5. Closure Plug: PVC.
   6. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.
   7. Adjustable Housing Material: PVC with threaded brass inserts.
   8. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
   9. Frame and Cover Material Shape: Round (standard) or square where located in tile floor.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains (FD):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Sioux Chief Manufacturing Company, Inc.
      d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      e. Tyler Pipe; Wade Div.
      f. Watts Drainage Products Inc.
      g. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.6.3.
   3. Pattern: Floor drain.
   4. Body Material: Cast iron.
   5. Seepage Flange: Required.
   6. Anchor Flange: Required.
   7. Clamping Device: Required.
   8. Outlet: Bottom.
   9. Top or Strainer Material: Nickel bronze.
   10. Top of Body and Strainer Finish: Nickel bronze.
   11. Top Shape: Square in tile floors, round in other applications.
   12. Dimensions of Top or Strainer: 5” x 5” or 5”ø for 2” outlet, 6” x 6” or 6”ø for 3” outlet, 8” x 8” or 8”ø for 4” outlet.
   13. Top Loading Classification: Light Duty.
   14. Funnel: If indicated provide 4” ø x 4” high funnel.
   15. Trap Material: Cast iron.
   16. Trap Pattern: Deep-seal P-trap.
   17. Trap Features: Trap-seal primer valve drain connection if required.

2.03 FLOOR SINKS:

A. Cast-Iron Floor Sinks (FS):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Division
   f. Watts Drainage Products, Inc.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3
3. Pattern: Sanitary drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: As required to suit project conditions.
7. Clamping Device: As required to suit project conditions.
8. Outlet: Bottom.
9. Coating on Interior Surfaces: Acid-resistant porcelain enamel.
10. Sediment Bucket: Aluminum.
11. Top of Body Finish: Nickel bronze or acid-resistant porcelain enamel.
12. Top Shape: Square.
13. Grate: Half hinged grate, unless indicated otherwise on drawings..
14. Dimensions: 12” x 12” top, 9” x 9” x 8” minimum deep body.
15. Trap Material: Cast iron.
16. Trap Pattern: Deep-seal P-trap.

2.04 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains (Hub Drains):

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, in-creaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping.
3. Use these drains only where shown on drawings and subject to approval of local authorities.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
   a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
   b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. 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 (51 mm) 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 stacks piping.

E. 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.

F. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

G. Trap Seal:

1. Manufacturer: “Trap Guard” as manufactured by ProSet. Similar design by “Sure Seal” is acceptable.
2. Description: Manufactured smooth, soft, flexible elastomeric PVC material or EPDM construction.
3. Standard: ASSE 1072.
4. Design: Allows wastewater to open and adequately discharge through its interior. Closes and return to its original molded shape after wastewater discharge is complete to prevent sewer gasses from escaping.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

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 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 100 feet (30 m).
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout covers with top flush with finished floor.

D. For cleanouts in piping concealed in wall, install cleanout wall access covers, of types indicated, with cover flush with finished wall.

E. Install floor drains and floor sinks at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

3. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

G. Install through-penetration firestop assemblies in stacks at floor penetrations.

H. Assemble open drain fittings and install with top of hub 2 inches (51 mm) above floor.

I. Install deep-seal traps on floor drains and other waste outlets.

J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

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

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

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

O. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

P. Install trap seal in floor drains where indicated and where allowed by authorities having jurisdiction in lieu of trap primers to maintain floor drain traps.

3.02 CONNECTIONS

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

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

3.03 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 22 13 19

SECTION 22 14 16
STORM DRAINAGE PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water (30 kPa).

B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.03 SUBMITTALS

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

B. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.04 QUALITY ASSURANCE

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

1.05 PROJECT CONDITIONS

A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of storm-drainage service.
   2. Do not proceed with interruption of storm-drainage service without Architect's written permission.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service classes.

B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe
      c. Dallas Specialty & Mfg. Co.
      d. Fernco Inc.
      e. Matco-Norca, Inc.
      f. MIFAB, Inc.
      g. Mission Rubber Company; a division of MCP Industries, Inc.
      h. Stant.
      i. Tyler Pipe.
   2. Standards: ASTM C 1277 and CISPI 310.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe
      c. Clamp-All Corp.
      d. Dallas Specialty & Mfg. Co.
      e. MIFAB, Inc.
      f. Mission Rubber Company; a division of MCP Industries, Inc.
      g. Stant.
      h. Tyler Pipe.
   2. Standards: ASTM C 1277 and ASTM C 1540.
   3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MG Piping Products Company.
      b. Other manufacturer only by prior approval.
   2. Standard: ASTM C 1277.
   3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.

3. Shielded, Non-pressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cascade Waterworks Mfg. Co.
      2) Mission Rubber Company; a division of MCP Industries, Inc.
   b. Standard: ASTM C 1460.
   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Dielectric Fittings:
1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Flanges:
   a. Description:
      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 150 psig (1035 kPa).
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
3. Dielectric-Flange Insulating Kits:
   a. Description:
      1) Non-conducting materials for field assembly of companion flanges.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Gasket: Neoprene or phenolic.
      4) Bolt Sleeves: Phenolic or polyethylene.
      5) Washers: Phenolic with steel-backing washers.
4. Dielectric Nipples:
   a. Description:
      1) Electroplated steel nipple complying with ASTM F 1545.
      2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      3) End Connections: Male threaded or grooved.
      4) Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PIPING INSTALLATION

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

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow.
2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

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

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing."

P. Install mechanical sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for mechanical sleeve seals specified in Division 22Section "Common Work Results for Plumbing."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

3.03 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

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

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

D. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

E. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, non-pressure transition couplings.

B. Dielectric Fittings:
   1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
   2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
   3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges or flange kits.
   4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.05 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support piping and tubing not otherwise listed according to MSS SP-69 and manufacturer's written instructions.

3.06 CONNECTIONS

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

B. Connect storm drainage piping to storm drainage specialties.
   1. Install test tees (wall cleanouts) in rainleaders near floor, and floor cleanouts with cover flush with floor.

C. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

D. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.07 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.08 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If piping does not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.09 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

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

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

SERVICE DESCRIPTION	LOCATION	SIZE	PIPING AND FITTINGS
Storm Drainage Piping (Rainleaders)	Above Ground	6” and Smaller	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron soil pipe & fittings; CISPI hubless-piping couplings; or heavy duty hubless-piping couplings.
Storm Drainage Piping (Rainleaders)	Above Ground	8” and Larger	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron soil pipe & fittings; heavy duty hubless-piping couplings; & cast-iron, hubless-piping couplings.
Storm Drainage Piping (Rainleaders)	Above Ground	18” and Larger	Galvanized -steel pipe, drainage fittings and grooved joints.

END OF SECTION 22 14 16

SECTION 22 14 19
STORM DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Miscellaneous storm drainage piping specialties.
   2. Cleanouts.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 SUBMITTALS

A. Product Data: For each type of product used in the project.

1.03 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.01 CLEANOUTS

A. Exposed Metal Cleanouts (CO):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk or raised-head, brass plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Floor Cleanouts(CO):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      c. Tyler Pipe; Wade Div.
      d. Watts Drainage Products Inc.
      e. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
   3. Size: Same as connected branch.
   4. Type: Threaded, adjustable housing.

5. Body or Ferrule: Cast iron.
6. Clamping Device: If required.
7. Outlet Connection: Inside calk or spigot.
8. Closure: Brass plug with straight threads and gasket, or brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy duty where vehicle traffic is possible, medium duty in all other areas.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts(WCO):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 100 feet (30 m).
4. Locate cleanouts at base of each vertical rainleader.

B. For floor cleanouts for piping below floors, install cleanout covers with top flush with finished floor.

C. For cleanouts in piping concealed in walls, install cleanout wall access covers, of types indicated, with cover flush with finished wall.

D. Install test tees in vertical rainleaders and near floor.

E. Install wall cleanouts in vertical rainleaders. Install access door in wall if indicated.

F. Install sleeve flashing device with each rainleader passing through floors with waterproof membrane.

3.02 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 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 22 14 19

SECTION 22 43 00
HEALTHCARE PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following medical plumbing fixtures and related components:
   1. Faucets for lavatories, showers, and sinks.
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   6. Bedpan washers.
   7. Water closets.
   8. Lavatories.
   9. Individual showers.
   10. Sinks.
   11. Mop basins.
   12. Clinical sinks.
   13. Outlet boxes.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

A. Accessible Medical Plumbing Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the medical plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

1.03 SUBMITTALS

A. Product Data: For each type of medical plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain medical plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer:
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

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

F. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for medical plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Plastic Bathtubs: ANSI Z124.1.
   3. Plastic Shower Enclosures: ANSI Z124.2.
   4. Slip-Resistant Bathing Surfaces: ASTM F 462.
   5. Vitreous-China Fixtures: ASME A112.19.2M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   2. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
   3. Faucets: ASME A112.18.1.
   4. Hose-Connection Vacuum Breakers: ASSE 1011.
   5. Hose-Coupling Threads: ASME B1.20.7.
   6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
   7. NSF Materials: NSF 61.
   8. Pipe Threads: ASME B1.20.1.
   9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   10. Supply Fittings: ASME A112.18.1.
   11. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:
   1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
   2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
   3. Faucets: ASME A112.18.1.
   4. Hand-Held Showers: ASSE 1014.
   5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
   6. Hose-Coupling Threads: ASME B1.20.7.
   7. Manual-Control Antiscald Faucets: ASTM F 444.
   8. Pipe Threads: ASME B1.20.1.
   9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
   10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   1. Atmospheric Vacuum Breakers: ASSE 1001.
   2. Brass and Copper Supplies: ASME A112.18.1.
   3. Flexible Water Connectors: ASME A112.18.6.

4. Manual-Operation Flushometers: ASSE 1037.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
6. Brass Waste Fittings: ASME A112.18.2.

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

1. Grab Bars: ASTM F 446.
2. Hose-Coupling Threads: ASME B1.20.7.
3. Off-Floor Fixture Supports: ASME A112.6.1M.
4. Pipe Threads: ASME B1.20.1.
5. Plastic Toilet Seats: ANSI Z124.5.
6. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 PRODUCTS

2.01 REFERENCES

A. See “Plumbing Fixture List” in the plumbing drawings for more precise description, including “Basis of Design” product.

B. See “Plumbing Fixture Schedule” in the plumbing drawings for sizes of runouts and connections to water, waste and vent.

2.02 LAVATORY FAUCETS

A. Lavatory Faucets:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings, or a comparable product by one of the following:
   a. American Standard Companies, Inc.
   b. Bradley Corporation.
   c. Chicago Faucets.
   d. Delta Faucet Company.
   e. Eljer.
   f. Elkay Manufacturing Co.
   g. Just Manufacturing Company.
   h. Kohler Co.
   i. Sloan Valve Company.
   j. Speakman Company.
   k. Symmons Valve Company.
   l. T & S Brass and Bronze Works, Inc.
   m. Zurn Plumbing Products Group; Commercial Brass Operation.
2. Description: Faucet for lavatory-type medical plumbing fixture. Coordinate faucet inlets with supplies, connectors, and fixture holes; coordinate outlet with spout and fixture receptor.
   a. Maximum Flow Rate: 2.2 gpm (8.3 L/min.).
   b. Body Material: Solid brass.
   c. Finish: Polished chrome plate.
   d. Temperature Indicators: Color-coded for hot and cold water.
   e. Faucet outlet shall be laminar-flow.

2.03 SHOWER FAUCETS

A. Shower Faucets:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:

a. American Standard Companies, Inc.
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Eljer.
f. Kohler Co.
g. Leonard Valve Company.
h. Powers; a Watts Industries Co.
i. Speakman Company.
j. Symmons Industries, Inc.
k. T & S Brass and Bronze Works, Inc.
l. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Faucet for shower-type medical plumbing fixtures. Include hot- and cold-water indicators; check stops; and handheld showerhead, slide bar mounted. Coordinate faucet inlets with supplies.
   a. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
   b. Body Material: Solid brass.
   c. Finish: Polished chrome plate.
   d. Mounting: Concealed.
   e. Handle(s): Single lever.
   f. Temperature Indicators: Color-coded for hot and cold water.

2.04 SINK FAUCETS

A. Sink Faucets:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. American Standard Companies, Inc.
   b. Chicago Faucets.
   c. Delta Faucet Company.
   d. Eljer.
   e. Elkay Manufacturing Co.
   f. Fisher Manufacturing Co.
   g. Grohe America, Inc.
   h. Just Manufacturing Company.
   i. Kohler Co.
   j. Speakman Company.
   k. T & S Brass and Bronze Works, Inc.
   l. Zurn Plumbing Products Group; Commercial Brass Operation.
2. Description: Faucet for sink-type medical plumbing fixtures. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   a. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
   b. Body Material: Solid brass.
   c. Finish: Polished chrome plate.
   d. Temperature Indicators: Color-coded for hot water on left and cold water on right.
   e. Faucet outlet shall be laminar flow.

2.05 FLUSHOMETERS

A. Flushometers:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Coyne & Delany Co.
   b. Sloan Valve Company.
   c. Zurn Plumbing Products Group; Commercial Brass Operation.
2. Description: Flushometer for urinals, clinical-sink and water-closet-type medical plumbing fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts.
   a. Internal Design: Diaphragm operation.
   b. Style: Exposed.
   c. Inlet Size: NPS 1 (DN 25).
   d. Integral Bedpan Washer: Factory fabricated, attached to tailpiece, and with spray head, where indicated.

2.06 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Bemis Manufacturing Company.
   b. Centoco Manufacturing.
   c. Church Seats.
   d. Olsonite Corp.
   e. Sanderson Plumbing Products, Inc.; Beneke Div.
   f. Any approved water closet manufacturer.
2. Description: Plastic toilet seat for water-closet-type medical plumbing fixture.
   a. Material: Molded, solid plastic.
   b. Configuration: Open front without cover.
   c. Size: Elongated, unless otherwise indicated.
   d. Class: Commercial.
   e. Hinge Type: Stainless-steel SC, self-sustaining check.
   f. Color: White.

2.07 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Insul-Tect Products Co.
   b. McGuire Manufacturing Co., Inc.
   c. Plumberex Specialty Products Inc.
   d. TCI Plumbing Products, Inc.
   e. TRUEBRO, Inc.
   f. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic wraps for covering medical plumbing fixture water supply and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.08 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   1. Josam Company.
   2. MIFAB Manufacturing Inc.
   3. Smith, Jay R. Mfg. Co.
   4. Tyler Pipe; Wade Div.
   5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
   6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water-Closet Supports:
   1. Description: Combination carriers designed for accessible and standard mounting heights of wall-mounting, water-closet-type medical plumbing fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Lavatory Supports:
   1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type medical plumbing fixture. Include steel uprights with feet.
   2. Carrier must be able to fit within standard stud walls.

D. Sink Supports:
   1. Description: As required for sink-type medical plumbing fixture. Include steel uprights with feet.

2.09 BEDPAN WASHERS

A. Bedpan Washers:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. Acorn Engineering Company.
      b. American Standard Companies, Inc.
      c. Chicago Faucets.
      d. Delta Faucet Company.
      e. Kohler Co.
      f. Sloan Valve Company.
      g. T & S Brass and Bronze Works, Inc.
      h. Zurn Plumbing Products Group; Commercial Brass Operation.
   2. Description: Wall-mounting, hand-held, medical plumbing fixture.
      a. Hose: Rubber or vinyl hose with spray nozzle, wall bracket, and hook.
      b. Self-closing valve.
      c. Loose-key supply stop.
      d. Vacuum Breaker: Wall mounting, atmospheric.
      e. Finish: Polished, chrome-plated finish on metal parts exposed after installation.

2.10 WATER CLOSETS

A. Floor-Mounting Water Closets:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. American Standard Companies, Inc.

b. Crane Plumbing, L.L.C/Fiat Products.
c. Kohler Co.
d. Sloan Valve Company.
e. Toto.
f. Zurn Plumbing Products.

2. Description Accessible, floor and floor-mounting, floor-outlet, vitreous-china medical plumbing fixture designed for flushometer valve operation.
   a. Style: Flushometer valve.
      1) Bowl Type: Elongated with siphon-jet design and bedpan lugs or slots if indicated. Include bolt caps matching fixture.
      2) Height: Standard or Accessible.
      3) Design Consumption: 1.6 gal./flush (6 L/flush).
      4) Color: White.
      5) Bedpan Washer: Integral to Flush Valve as indicated.
   b. Flushometer: as indicated.
   c. Toilet Seat: Elongated open front.

2.11 LAVATORIES

A. Wall-Mounting Lavatories:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. American Standard Companies, Inc.
      b. Crane Plumbing, L.L.C./Fiat Products.
      c. Kohler Co.
      d. Sloan Valve Company.
      e. Toto.
      f. Zurn.
   2. Description: Accessible, wall-mounting, vitreous-china medical plumbing fixture.
      a. Color: White.
      b. Faucet: Lavatory as indicated.
      c. Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes with stops.
      d. Drain: Grid strainer with offset tailpiece as required.
      e. Drain Piping: Chrome plated cast brass ‘P’ trap, 0.045-inch (1.1 mm) thick tubular brass waste to wall; and wall escutcheon.
      f. Protective Shielding Guard(s): as indicated.
      g. Fixture Support: Concealed arm.

B. Counter-Mounting Lavatories:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. American Standard Companies, Inc.
      b. Crane Plumbing, L.L.C./Fiat Products.
      c. Kohler Co.
      d. Sloan Valve Company.
      e. Toto.
      f. Zurn Plumbing Products.

2. Description: Counter-mounting, vitreous-china, medical plumbing fixture.
   a. Type: Self-rimming.
   b. Faucet Hole Location: Top.
   c. Color: White.
   d. Faucet: Lavatory as indicated.
   e. Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes with stops.
   f. Drain: Grid strainer with offset tailpiece as required.
   g. Drain Piping: Chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
   h. Protective Shielding Guard(s): as indicated.

C. Lavatories:
   1. Description: Accessible countertop with integral bowl fixtures furnished and installed by others.
      a. Faucet(s): Lavatory with separate drain for each bowl.
      b. Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
      c. Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
      d. Protective Shielding Guards: For bowls as indicated.

2.12 INDIVIDUAL SHOWERS

A. Individual Showers:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. Aqua Bath Company, Inc.
      b. Aqua Glass Corporation.
      c. Crane Plumbing, L.L.C./Fiat Products.
      d. Fiberglass Systems, Inc. (Best Bath)
      e. Kohler Co.
      f. LASCO Bathware.
      g. Praxis Industries, Inc., Aquarius Products.
   2. Description: Accessible shower enclosure medical plumbing fixture with slip-resistant bathing surface complying with ASTM F 462. Comply with ADA requirements for use by people with disabilities:
      a. Surround: One piece.
      b. Color: White.
      c. Faucet: Shower.
      d. Drain: Grid, NPS 2 (DN 50).
      e. Accessories: If not furnished as integral components of specified fixture. Accessories are specified in Division 10 Section "Toilet, Bath, and Laundry Accessories":
         1) Grab bar(s).
         2) Heavy-duty shower-curtain rod.
         3) Vinyl shower curtain.
         4) Shower-curtain hooks.
         5) Folding seat.

2.13 SINKS

A. Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Elkay Manufacturing Co.
   b. Just Manufacturing Company.
   c. Kohler Co.
2. Description: Residential, counter-mounting, stainless-steel kitchen sink.
   a. Metal Thickness: 0.050 inch (1.3 mm).
   b. Faucet: Sink.
   c. Supplies: NPS 1/2 (DN 15) chrome-plated copper with stops.
   d. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; continuous waste; and wall escutcheon(s).

B. Bar Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Elkay Manufacturing Co.
   b. Just Manufacturing Company.
   c. Kohler Co.
2. Description: Single-bowl, counter-mounting, stainless-steel bar sink.
   a. Faucet: Faucet.
   b. Supplies: Chrome-plated copper with stops.
   c. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.

2.14 MOP BASINS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Acorn Engineering Company.
2. Crane Plumbing, L.L.C./Fiat Products.
3. Florestone Products Co., Inc.
4. Stern-Williams Co., Inc.
5. Mustee, E. L. & Sons, Inc.
6. Swan Corporation (The).
7. Zurn Plumbing Products Group; Light Commercial Operation.

B. Description: Flush-to-wall, floor-mounting, fixture with rim guard.

1. Rim Guard: On all top surfaces.
2. Faucet: Sink.
3. Drain: Grid with NPS 3 (DN 80) outlet.

2.15 CLINICAL SINKS

A. Floor-Mounting Clinical Sinks:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Kohler Co.

d. Zurn Industries, LLC.

2. Description: Floor-mounting, bottom-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture. Include bolt caps.
   a. Color: White.
   b. Rim Guards: Stainless steel on front and sides.
   c. Sink Base: Set on sink base by General Contractor.
   d. Faucet: Sink as indicated.
   e. Flushometer: as indicated.
   f. Bedpan Washer: as indicated.

2.16 OUTLET BOXES

A. Dialysis Equipment Outlet Boxes:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. Acorn Engineering Company.
      b. Bradley Corporation.
      c. Metcraft Industries Inc.
      d. Whitehall Manufacturing; a division of Acorn Manufacturing Company.
   2. Description: Recessed-mounting outlet box with water supply and drain connections.
      a. Box and Faceplate: Stainless steel.
      b. Drain: NPS 2 (DN 50) standpipe, P-trap, and direct waste connection to drainage piping.
   3. Reinforcement: 2-by-4-inch (50-by-100-mm) fire-retardant-treated-wood blocking between studs. Fire-retardant-treated wood blocking is specified in Division 06.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for medical plumbing fixtures to verify actual locations of piping connections before fixture installation.

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

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

3.02 INSTALLATION

A. Assemble medical plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation:
   1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture.

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install shower flow-control fittings with specified maximum flow rates in shower arms.

N. Install traps on fixture outlets:

1. Exception: Omit trap on fixtures with integral traps.

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

P. Set showers in leveling bed of cement grout.

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

3.03 CONNECTIONS

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

B. Connect water supplies from domestic water piping to medical plumbing fixtures.

C. Connect drain piping from medical plumbing fixtures to sanitary waste and vent piping.

D. Ground equipment according to Division 26.

E. Connect wiring according to Division 26.

3.04 FIELD QUALITY CONTROL

A. Verify that installed medical plumbing fixtures are categories and types specified for locations where installed.

B. Check that medical plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed medical plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.05 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning medical plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets, shower valves and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.06 CLEANING

A. Clean medical plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.07 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

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

END OF SECTION 22 43 00

SECTION 22 45 00
EMERGENCY PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Eyewash equipment.
   2. Eye/face wash equipment.
   3. Supplemental equipment.
   4. Water-tempering equipment.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

D. Tepid: Moderately warm.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 PRODUCTS

2.01 EYEWASH EQUIPMENT

A. Standard, Freestanding, Plumbed Eyewash Units:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. Acorn Safety; a division of Acorn Engineering Company.
      b. Bradley Corporation.
      c. Encon Safety Products.
      d. Guardian Equipment Co.
      e. Haws Corporation.
      f. Speakman Company.
   2. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.

3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Paddle.
5. Mounting: Pedestal.

B. Accessible, Freestanding, Plumbed Eyewash Units:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
2. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Paddle.
5. Mounting: Offset pedestal.
6. Special Construction: Comply with ICC/ANSI A117.1.

C. Standard, Wall-Mounted, Plumbed Eyewash Units:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. Speakman Company.
2. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Paddle.
5. Mounting: Wall bracket.

D. Accessible, Wall-Mounted, Plumbed Eyewash Units:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. Speakman Company.
2. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Paddle.
5. Mounting: Wall bracket.

6. Special Construction: Comply with ICC/ANSI A117.1.

E. Sink, Swivel-Type, Plumbed Eyewash Unit:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. Speakman Company.
2. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
5. Mounting: Deck next to sink or wall behind sink.

2.02 EYE/FACE WASH EQUIPMENT

A. Standard, Freestanding, Plumbed, Eye/Face Wash Units:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. Speakman Company.
2. Capacity: Not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Mounting: Pedestal.

B. Accessible, Freestanding, Plumbed, Eye/Face Wash Units:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
2. Capacity: Not less than 3 gpm (11.4 L/min.) for at least 15 minutes.
3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Mounting: Offset pedestal.
5. Special Construction: Comply with ICC/ANSI A117.1.

C. Standard, Wall-Mounted, Plumbed, Eye/Face Wash Units:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. Acorn Safety; a division of Acorn Engineering Company.
      b. Bradley Corporation.
      c. Encon Safety Products.
      d. Guardian Equipment Co.
      e. Haws Corporation.
      f. Speakman Company.
   2. Capacity: Not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
   3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   4. Mounting: Wall bracket.

D. Accessible, Wall-Mounted, Plumbed, Eye/Face Wash Units:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. Bradley Corporation.
      b. Encon Safety Products.
      c. Guardian Equipment Co.
      d. Haws Corporation.
   2. Capacity: Not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
   3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   4. Mounting: Wall bracket.
   5. Special Construction: Comply with ICC/ANSI A117.1.

2.03 SUPPLEMENTAL EQUIPMENT

A. Wall-Mounted, Plumbed Drench Hoses:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. Acorn Safety; a division of Acorn Engineering Company.
      b. Bradley Corporation.
      c. Encon Safety Products.
      d. Guardian Equipment Co.
      e. Haws Corporation.
      f. Speakman Company.
   2. Capacity: Not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
   3. Supply Fitting: NPS 1/2 (DN 15) brass with flow regulator.
   4. Mounting: Wall bracket.

2.04 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
      a. Acorn Safety; a division of Acorn Engineering Company.
      b. Armstrong International, Inc.
      c. Bradley Corporation.

d. Encon Safety Products.
e. Guardian Equipment Co.
f. Haws Corporation.
g. Lawler Manufacturing Co., Inc.
h. Leonard Valve Company.
i. Powers; a division of Watts Water Technologies, Inc.
j. Speakman Company.

2. Description: Factory-fabricated equipment with thermostatic mixing valve.
   a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
   b. Supply Connections: For hot and cold water.

B. Electric Water-Tempering Equipment:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Chronomite Laboratories, Inc.; a division of Acorn Engineering Company.
2. Description: Factory-fabricated equipment with electric heating.
   a. Heating System: Electric, designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, heating coils, high-temperature-limit device, metal piping, and corrosion-resistant enclosure.

2.05 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
B. Install fixtures level and plumb.
C. Fasten fixtures to substrate.
D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation.
   1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals.
F. Install thermometers in outlet piping connections to water-tempering equipment.
G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system.

H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system.

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations.

3.03 CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment.

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

C. Connect cold water and electrical power to electric heating water-tempering equipment.

D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping.

E. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

F. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.04 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment.

3.05 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.06 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 22 45 00

SECTION 22 47 00
DRINKING FOUNTAINS AND WATER COOLERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following drinking fountains and water coolers and related components:
   1. Drinking fountains.
   2. Pressure water coolers.
   3. Fixture supports.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

A. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.

G. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.03 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 PRODUCTS

2.01 DRINKING FOUNTAINS

A. Drinking Fountains:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Elkay Manufacturing Co.
   b. Filtrine Manufacturing Company; Drinking Water Division.
   c. Halsey Taylor.
   d. Haws Corporation.
   e. Murdock, Inc.
   f. Oasis Corporation.
2. Description: Accessible, Style W, wall-mounting drinking fountain.
   a. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
   b. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
   c. Support: Type I, water cooler carrier. Refer to "Fixture Supports" Article.
   d. Cabinet Finish: Stainless steel unless indicated otherwise on drawings.

2.02 PRESSURE WATER COOLERS

A. Water Coolers:

1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Elkay Manufacturing Co.
   b. Halsey Taylor.
   c. Haws Corporation.
   d. Murdock Manufacturing.
   e. Oasis Corporation.
2. Description: ARI 1010, Type PB, pressure with bubbler water cooler.
   a. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
   b. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
   c. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
      1) Capacity: 8 gph (0.0084 L/s of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
      2) Electrical Characteristics: 120-V ac; single phase; 60 Hz.
   d. Cabinet Finish: Stainless steel unless indicated otherwise on drawings.

2.03 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:

1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.

6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

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

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

3.02 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.03 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation.

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

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

3.04 CONNECTIONS

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

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26.

D. Connect wiring according to Division 26.

3.05 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.06 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.07 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 22 47 00

SECTION 22 62 13
VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 20 inches mercury (510 mm mercury or 67.7 kPa vacuum).

B. Related Documents:

1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

A. D.I.S.S.: Diameter-index safety system.

B. HVE: High-volume (oral) evacuation.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. WAGD: Waste anesthetic gas disposal.

1.03 SUBMITTALS

A. Product Data: For the following:

1. Vacuum pipes, tubes and fittings.
2. Vacuum valves and valve boxes.
3. Medical vacuum service connections and vacuum-bottle brackets.

B. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.

C. Qualification Data: For Installer and testing agency.

1.04 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Source Limitations: Obtain vacuum terminal connections of same type and from same manufacture as outlets provided for in other Division 22 sections.

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

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.

G. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

1.05 PROJECT CONDITIONS

A. Interruption of Existing Laboratory and Medical Vacuum Service(s): Do not interrupt laboratory or medical vacuum service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of laboratory and medical vacuum service(s).
2. Do not proceed with interruption of laboratory and medical vacuum service(s) without Owner's written permission.

1.06 COORDINATION

A. Coordinate medical vacuum service terminals with other service outlets. Medical compressed-air outlets and medical gas outlets are specified in other Division 22 sections.

PART 2 PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Type L or K, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

B. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.

1. Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
3. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
4. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.02 JOINING MATERIALS

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

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

C. Threaded-Joint Tape: PTFE.

D. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, full-face type.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.03 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.

B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.

c. Ohio Medical Co.

2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device where indicated.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Bronze Check Valves: In-line pattern.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.
   c. Ohio Medical Co.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.
   c. Ohio Medical Co.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
8. Vacuum Gage: Manufacturer installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.
   c. Ohio Medical Co.
2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Aluminum or extruded-anodized aluminum, satin-chrome finish steel, or stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.
4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.

G. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate.

2.04 MEDICAL VACUUM SERVICE INLET TERMINALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amico Corporation.
   2. BeaconMedaes.
   3. Ohio Medical Co.

B. Inlet Terminals: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   1. Roughing-in Assembly:
      a. Steel outlet box for recessed mounting and concealed piping.
      b. Brass-body inlet block.
      c. Seals that will prevent vacuum leakage.
      d. ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   2. Finishing Assembly:
      a. Brass housing with primary check valve.
      b. Seals that will prevent vacuum leakage.
      c. Cover plate with gas-service label.
   3. Quick-Coupler Service Inlet Terminals: Suction inlets for medical vacuum and WAGD evacuation inlet terminals with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
   4. D.I.S.S. Service Inlet Terminals: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      a. Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.
      b. WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.
   5. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
   6. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish, metal, with chrome-plated finish, or anodized aluminum and permanent, color-coded, identifying label matching corresponding service.

2.05 MEDICAL VACUUM PIPING ALARM SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amico Corporation.
   2. BeaconMedaes.
   3. Ohio Medical Co.

B. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.

C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

D. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Vacuum Operating Range: 0- to 30-in. Hg (0- to 101-kPa vacuum).

E. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.

F. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   1. Include alarm signals when the following condition exists:
      a. Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).

2.06 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical vacuum piping system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

2.07 FLEXIBLE PIPE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Hyspan Precision Products, Inc.
   4. Mercer Rubber Co.
   5. Metraflex, Inc.
   6. Proco Products, Inc.
   7. Unaflex.
   8. Universal Metal Hose; a Hyspan Co.

B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: 200 psig (1380 kPa) minimum.
   2. End Connections: Threaded copper pipe or plain-end copper tube.

2.08 NITROGEN

A. Description: Comply with USP 28 – NF 23 for oil-free dry nitrogen.

PART 3 EXECUTION

3.01 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or certified installer perform the following procedures:
   1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
   2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb (0.453 kg) of chemical to 3 gal. (11.3 L) of water.
      a. Scrub to ensure complete cleaning.
      b. Rinse with clean, hot water to remove cleaning solution.

3.02 PIPING APPLICATIONS

A. Medical Vacuum Piping: Use the following piping materials for each size range:

1. NPS 4 (DN 100) and Smaller: Type L or K, copper medical gas tube; wrought-copper fittings; and brazed joints.
2. NPS 5 to NPS 8 (DN 125 to DN 200): Type L or K, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.03 PIPING INSTALLATION

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

B. Comply with ASSE Standard #6010 for installation of vacuum piping.

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

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

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

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install vacuum and drain piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.

I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator.

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

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

O. Install medical vacuum piping to medical vacuum service inlet terminal specified in this Section and to equipment specified in other Sections requiring medical vacuum service.

P. Install seismic restraints on vacuum piping as indicated or required.

Q. Install medical vacuum service inlet terminals recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

R. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet where indicated.

S. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

T. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

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

V. Install sleeve seals for piping penetrations of concrete walls and slabs.

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

3.04 VALVE APPLICATIONS

A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

3.05 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from vacuum equipment and specialties.

B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

3.06 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

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

D. Threaded Joints: Apply appropriate tape to external pipe threads.

E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

F. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

G. Flanged Joints:

1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
2. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

3.07 MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION

A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.

B. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.

C. Install medical vacuum piping system area alarm panels where indicated.

3.08 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in other Division 22 sections for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.

8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
9. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
10. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
11. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
12. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
13. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
14. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

I. Install supports for vertical copper tubing every 10 feet (3 m).

3.09 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties.

B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Medical Vacuum: Black letters on white background.

3.10 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

A. Perform tests and inspections of vacuum piping in nonmedical laboratory facilities.

B. Tests and Inspections:

1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
   a. Test Pressure for Copper Tubing: 100 psig (690 kPa).
2. Repair leaks and retest until no leaks exist.
3. Inspect filters for proper operation.

C. Prepare test reports.

3.11 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.

B. Tests and Inspections:

1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
2. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
   a. Initial blow down.
   b. Initial pressure test.
   c. Cross-connection test.
   d. Piping purge test.
   e. Standing pressure test for vacuum systems.
   f. Repair leaks and retest until no leaks exist.
3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
   a. Standing pressure test.
   b. Individual-pressurization or pressure-differential cross-connection test.
   c. Valve test.
   d. Master and area alarm tests.

e. Piping purge test.
f. Final tie-in test.
g. Operational vacuum test.
h. Verify correct labeling of equipment and components.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.12 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 01.

END OF SECTION 22 62 13

SECTION 22 63 13
GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig (345 to 380 kPa).

B. Owner-Furnished Material:
   1. Patient Service Consoles.
   2. Ceiling columns.
   3. Bulk gas storage tanks.
   4. Owner will furnish gases for medical gas concentration testing specified in this Section.

C. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. D.I.S.S.: Diameter-index safety system.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide and medical oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.

E. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Gas manifolds and piping shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 as required.
   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."

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Tubes and fittings.
   2. Valves and valve boxes.
   3. Medical gas outlets.
   4. Medical gas alarm system components.

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

C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer and testing agency.

E. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds, accessories, and components will withstand seismic forces defined in other Division 22 Sections. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

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

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. NFPA Compliance:

1. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.

F. UL Compliance:

1. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Specialty and Medical Gas Service(s): Do not interrupt specialty or medical gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of specialty and medical gas service(s).

2. Do not proceed with interruption of specialty and medical gas service(s) without Owner's written permission.

1.07 COORDINATION

A. Coordinate medical gas outlets with other outlets and inlet terminals, which are specified in other Division 22 sections.

PART 2 PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, types K and L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.

3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.02 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.03 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.
   c. Ohio Medical Co.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device where indicated
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Check Valves: In-line pattern, bronze.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a.
   b. Amico Corporation.
   c. BeaconMedaes.
   d. Ohio Medical Co.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.
   c. Ohio Medical Co.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
8. Pressure Gage: Manufacturer-installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.
   c. Ohio Medical Co.
2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Aluminum or extruded-anodized aluminum, satin-chrome finish steel or Stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.
4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

2.04 MEDICAL GAS OUTLETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amico Corporation.
   2. BeaconMedaes.
   3. Ohio Medical Co.

B. General Requirements for Medical Gas Outlets,: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   1. Roughing-in Assembly:
      a. Steel outlet box for recessed mounting and concealed piping.
      b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
      c. Double seals that will prevent gas leakage.
      d. ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   2. Finishing Assembly:
      a. Brass housing with primary check valve.
      b. Double seals that will prevent gas leakage.
      c. Cover plate with gas-service label.
   3. Quick-Coupler Outlets: Pressure outlets for carbon dioxide, nitrous oxide and oxygen with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
   4. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      a. Medical Oxygen Outlets: D.I.S.S. No. 1240.
   5. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish, metal, with chrome-plated finish or anodized aluminum and permanent, color-coded, identifying label matching corresponding service.

2.05 MEDICAL GAS PIPING ALARM SYSTEMS

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

2. BeaconMedaes.
3. Ohio Medical Co.

B. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.

C. Components: Designed for continuous service and to operate on power supplied from 120V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
1. Low-Pressure Operating Range: 0- to 100-psig (0- to 690-kPa).
2. High-Pressure Operating Range: Up to 250-psig (1725-kPa).

E. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
1. Mounting: Recessed installation.
2. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.
a. Medical Oxygen: Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
b. Medical Oxygen: Pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.

F. Area Alarm Panels: Separate trouble alarm signals; pressure gages; and indicators for medical gas piping systems.
1. Include alarm signals when the following conditions exist:
a. Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

2.06 NITROGEN

A. Description: Comply with USP 28 – NF 23 for oil-free dry nitrogen.

PART 3 EXECUTION

3.01 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or certified installer perform the following procedures:
1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb (0.453 kg) of chemical to 3 gal. (11.3 L) of water.
a. Scrub to ensure complete cleaning.
b. Rinse with clean, hot water to remove cleaning solution.

3.02 PIPING APPLICATIONS

A. Medical Gas Piping for systems operating at less than 185 psig: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

B. Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.

3.03 PIPING INSTALLATION

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

B. Comply with ASSE Standard #6010 for installation of medical gas piping.

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

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

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

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

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

K. Install medical gas piping to medical gas outlets specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.

L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.

M. Install seismic restraints on gas piping as indicated or required.

N. Install medical gas outlets recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

O. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

P. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

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

R. Install sleeve seals for piping penetrations of concrete walls and slabs.

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

3.04 VALVE INSTALLATION

A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on gas piping where reduced pressure is required.

3.05 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

B. Threaded Joints: Apply appropriate tape to external pipe threads.

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

3.06 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

A. Install medical gas alarm system components in locations required by and according to NFPA 99.

B. Install medical gas area alarm panels where indicated.

3.07 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in other Division 22 Sections for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
9. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
10. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
11. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
12. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
13. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
14. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

I. Install supports for vertical copper tubing every 10 feet (3 m).

3.08 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties.

B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Oxygen: White letters on green background or green letters on white background.

3.09 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.

B. Tests and Inspections:

1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
   a. Initial blow down.
   b. Initial pressure test.
   c. Cross-connection test.
   d. Piping purge test.
   e. Standing pressure test for positive pressure medical gas piping.
   f. Standing pressure test for vacuum systems.
   g. Repair leaks and retest until no leaks exist.
3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
   a. Standing pressure test.
   b. Individual-pressurization or pressure-differential cross-connection test.
   c. Valve test.
   d. Master and area alarm tests.
   e. Piping purge test.
   f. Piping particulate test.
   g. Piping purity test.
   h. Final tie-in test.
   i. Operational pressure test.
   j. Medical gas concentration test.
   k. Medical air purity test.
   l. Verify correct labeling of equipment and components.
   m. Verify the following source equipment:
      1) Medical gas supply sources.
4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain medical gas alarm system. Refer to Division 01 Section.

END OF SECTION 22 63 13

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following items which apply to all Division 23 sections:
   1. Submittals.
   2. Coordination drawings.
   3. Record documents.
   4. Maintenance manuals.
   5. Piping materials and installation instructions common to most piping systems.
   6. Transition fittings.
   7. Dielectric fittings.
   8. Mechanical sleeve seals.
   9. Sleeves.
   10. Escutcheons.
   11. Grout.
   12. Flashing.
   13. Through penetration firestop assemblies.
   14. HVAC demolition.
   15. Equipment installation requirements common to equipment sections.
   16. Painting and finishing.
   17. Supports and anchorages.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.

4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

H. Firestopping (Through-Penetration Protection System): Sealing of stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.03 SUBMITTALS

A. Product Data for each kind of product indicated.

B. Firestopping Schedules: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

C. Submittal of shop drawings, product data, and samples will be accepted only when signed and submitted by this Contractor and the General Contractor. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.

D. Shop drawings submitted without this Contractor's signature or approval and verification will not be approved. Quantities will not be checked or verified. It is the Contractor's responsibility to provide the proper quantities required to complete the job.

E. Portions of the work requiring a shop drawing submittal shall not begin until the shop drawing has been approved by the Engineer.

F. Submit wiring diagrams for all equipment requiring field wiring clearly showing all required connections. This Contractor will send one copy of Engineer approved shop drawings to the Electrical Contractor with a transmittal letter. Forward one copy of the transmittal letter to the Engineer's office.

G. Where catalog cuts are used, mark them to indicate equipment, capacities, controls, fittings, valves, sizes, etc.

H. Reference each item to applicable specification paragraph number and plan sheet number. Reference items not appearing in base specification to applicable alternate numbers, change order numbers, letters of authorization, etc.

I. Engineers acceptance of Compliance Submittals will not relieve Contractor from his responsibility for any deviations from the requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation at the time of submission and Engineer has given written approval to the specific deviation, nor shall any acceptance by Engineer relieve Contractor from responsibility for errors or omissions in Compliance Submittals.

1.04 GENERAL WORK REQUIREMENTS

A. Permits:
   1. Obtain and pay for all licenses and permits, fees, inspection and certificates required for the execution of this work.
   2. Pay fees and charges for connection to outside services and use of property.
   3. Deliver permits and certificates to the Architect to be transmitted to the Owner.

1.05 RESPONSIBILITY

A. This Contractor will be held responsible for any and all damage to any part of the building or to the work of other contractors, as may be caused through his operation.

B. This contractor shall make all provisions for entry of equipment, installed under this contract, to the installed location. This contractor shall provide openings in existing construction if necessary. This contractor shall do all repair necessary to restore the building to the original condition. During the period of entry of equipment and removal of trash, no disruption of the Owner's normal business shall occur.

C. This Contractor shall fully coordinate equipment installation requirements with other trades. Any revisions or adjustments required to be made by other trades due to deviations from the basis of design equipment shall be the financial responsibility of this Contractor.

1.06 QUALITY ASSURANCE

A. Execute work in compliance with all applicable Federal. State and Municipal laws, codes, ordinances, and local customs regarding the trade to perform the work. The Contractor is required to verify that all installations comply with applicable codes. The codes applicable to this specific project may be listed on the Architect's code compliance sheet. If not, it is the Contractor's responsibility to determine which codes apply to the installations. Where code requirements conflict with those shown on the drawings and specifications, the code requirements shall take precedence. The Contractor shall notify the Architect immediately of any discrepancies between the applicable code requirements and the documents. Changes made to comply with the applicable requirements shall not justify an additional cost.

B. Inspect the existing site and conditions and check the drawings and specifications to be fully informed of the requirements for completion of the work. Lack of such information shall not justify an extra to the contract price.

C. The HVAC Work shall include labor, materials, and equipment to install systems and place in proper working order, as shown on plans and hereinafter specified. The installation shall include all labor, materials, tools, transportation, equipment, services and facilities, required for the complete, proper and substantial installation of all mechanical work shown on the plans, and/or outlined in these specifications. The installation shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the drawings but which are necessary to make a complete working installation of all mechanical systems.

D. Material and equipment shall be new, of best quality and design and free from defects. A manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating manufacturer's name, address and catalog number.

E. Furnish testing equipment and test all piping systems under methods and conditions as specified.

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

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

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

H. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

I. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 and ASTM E814 with 0.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
    a. Floor Penetrations within Wall Cavities: T-Rating is not required.

J. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.

1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.

2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

K. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

L. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

M. Surface Burning Characteristics: 25/50 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.07 DELIVERY, STORAGE, AND HANDLING

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

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

1.08 WORKMANSHIP AND COORDINATION

A. Make installation substantially as shown on plans.

B. Pipe and duct routing and equipment location shown on the drawings are schematic in nature. Make alterations in location of apparatus or piping as may be required to conform to building construction without extra charge.

C. Equipment service clearances, per equipment manufacturer's specifications, shall be maintained from general construction. No pipe shall be installed within these clearances. No piping shall be installed above electrical panels, starters or switchgear, or in elevator equipment rooms.

D. Cooperate with other contractors in their installation of work.

E. The ductwork shall take precedence over all pipe work except where it is necessary to maintain an even grade on the piping.

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

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

H. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

I. Use only experienced mechanics.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Do not apply sealants, caulking, or mastic materials outside the range of the manufacturer's installation instructions.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

1.10 ELECTRONIC DOCUMENT REQUESTS

A. The Contractor may request the use of the bidding documents in electronic format (CAD, BIM, PDF etc.) for use in preparation of shop drawings and coordination drawings.

B. Professional Engineering Consultants, P.A. (PEC) reserves the right to refuse requests for electronic files at its sole discretion. The format of the files will be at PEC's sole discretion.

C. All electronic documents provided are provided on an as-is basis, and are utilized by the Contractor at his own risk. All files provided by the Engineer are subject to PEC's standard "CADD/Electronic File Disclaimer". This disclaimer can be provided upon request.

D. At PEC's sole discretion, per sheet fee of up to $50 may be required to cover the costs of preparing the electronic files for transmission.

E. By obtaining the bid document CAD or BIM files, the Contractor is not relieved from his duty to create construction, shop and coordination drawings.

1.11 HVAC COORDINATION DRAWINGS

A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of HVAC equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of piping, equipment, hangers, and materials. Include the following:
   a. Clearances for installing and maintaining insulation.
   b. Clearances for servicing and maintain equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
   c. Equipment connections and support details.
   d. Exterior wall and foundation penetrations.
   e. Fire-rated wall and floor penetrations.
   f. Underground piping.
   g. Sizes and locations of required concrete pads and bases.
   h. Numbered valve location diagrams.
   i. Valve stem movement.
   j. Pipe expansion loops.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Submit drawing to Architect to review for completeness. These drawings will be reviewed and returned with comments. They will not be approved as a shop drawing.

1.12 RECORD DOCUMENTS

A. Prepare record documents in accordance with Division 1. These drawings shall reflect the actual "As-Built" condition including any change orders, of the mechanical systems and installation. In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Identification Section. Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, contract modifications, and actual equipment and materials installed.

1.13 MAINTENANCE MANUALS

A. Prepare Maintenance Manuals in accordance with Division 1 Sections. In addition to the requirements specified in Division 1, include the following information for equipment items:

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

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control stopping, shutdown, and emergency instructions.
3. Maintenance procedures for routing preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Approved shop drawing submittals.
5. Servicing instructions and lubrication charts and schedules.
6. Copy of valve tag chart.

1.14 FINAL ELECTRONIC SUBMITTAL

A. In addition to the hard-copy record documents above, provide a set of electronic documents in PDF formats on an USB drive. The electronic shall include the following:
1. Floor plans, O&M manuals, approved shop drawings, and valve tag schedules.
2. The floor plans shall contain labels and links for each piece of equipment specified in this Division. The equipment links shall open the O&M manual for the respective piece of equipment with a single mouse click. Valve tag links shall open the appropriate portion of the valve tag schedule.
3. It is anticipated that there will be separate PDF floor plan documents for each class of equipment, and separate PDF valve tag floor plan(s) for each unique system. The exact format and quantity of PDF documents shall be submitted to the Owner for approval prior to creation of the comprehensive final submittal.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified or pre-approved equals.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

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

2.03 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials.

2.04 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

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

C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

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

2.05 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.06 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

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

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

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

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

F. PVC Pipe: ASTM D 1785, Schedule 40.

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

2.07 ESCUTCHEONS

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

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

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed set screw or spring clips, and chrome-plated finish.

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

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

2.08 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.09 FLASHING

A. Metal Flashing: 26 gage (0.5 mm) thick galvanized steel.

B. Metal Counterflashing: 22 gage (0.8 mm) thick galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb./sq. ft (24.5 kg/sq m) sheet lead.
2. Soundproofing: 1 lb./sq. ft (5 kg/sq m) sheet lead.

D. Flexible Flashing: 47 mil (1.2 mm) thick sheet of material compatible with roofing. Coordinate with Architectural roofing specifications.

E. Caps: Steel, 22 gage (0.8 mm) minimum; 16 gage (1.5 mm) at fire resistant elements.

2.10 FIRESTOPPING

A. Manufacturers:

1. Hilti Corp.
2. 3M fire Protection Products
3. Specified Technologies, Inc.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Single or multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single or multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

D. Coordinate the above requirements with Division 7.

2.11 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

C. General:

1. Furnish UL listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

D. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

2.12 ACCESS DOORS

A. If specified in Division 7 that section shall apply. Where not specified in Division 7 provide access doors as follows.

B. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

C. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

D. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks individually keyed; provide 2 keys.

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

1. Bar-Co., Inc.
2. J.L. Industries.
3. Karp Associates, Inc.
4. Milcor Div. Inryco, Inc.
5. Nystrom, Inc.

2.13 DRIP PANS

A. Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drainline connections. Reference Installation of Drip Pans section below for location requirements.

PART 3 EXECUTION

3.01 HVAC DEMOLITION REQUIREMENTS

A. The existing areas surrounding the remodel area are fully occupied and shall remain operational throughout the duration of this project.

B. This contractor shall closely coordinate with the Owner and/or his representative the timing and schedule for any temporary cutoffs of any mechanical systems. The valve location and scheduled shutdown shall be closely coordinated with the Owner. It is recognized that temporary shutdown of systems will be required. These shall be scheduled in advance with Owner's representatives and restored to full service at the end of the work period.

C. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

D. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

E. Contractor shall provide protective plastic drop cloths to protect the existing occupied areas and equipment from dust and debris during the construction work, and shall clean the areas of all construction dirt daily, and upon completion of the work.

F. Connection to existing piping for HVAC, medical gas, fire sprinkler or domestic water will require temporary shutdown of those mains to accomplish the new tie-ins. Closely coordinate and schedule this work with the Owner. Perform such work on weekends or nights as required by Owner's use and schedule.

G. All drained piping risers and mains shall be refilled with fluid and properly vented by this Contractor.

H. Coordinate with General Contractor the removal and replacement of all existing ceilings, walls, etc. as required for mechanical demolition work.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

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

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

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

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type or stamped steel with polished chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw.

g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.

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

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.

b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.

d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.

e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.

f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.

g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

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

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

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

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

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

3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).

b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

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

1) Seal space outside of sleeve fittings with grout.

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

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

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

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

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.03 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. The Contractor shall field verify all existing conditions and dimensions. The Contractor shall make field adjustments as required to accommodate the new work.

B. Verify final equipment locations for roughing-in.

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

3.04 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

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

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

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

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

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

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

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

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

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

4. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 using manufacturer certified mechanics and tools.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.05 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric nipples and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.06 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

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

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

D. Install equipment to allow right of way for piping installed at required slope.

3.07 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
   1. Coordinate mechanical systems, equipment, and materials installation with other building components, including the structure, fire sprinklers, and the electrical lights and equipment.
   2. Verify all dimensions by field measurements.
   3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
   4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
   5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
   6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
   7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
   8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
   9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
   10. Install access panel or doors where units are concealed behind finished surfaces.

11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope, or systems requiring a fixed access clearance.
12. The Mechanical Contractor shall locate and mark the location of all holes and openings which require blocking out, cutting or core drilling.
13. All square openings through precast concrete shall be blocked out by precast manufacturer. All openings 6" dia. or larger shall be blocked out by precast manufacturer. All holes less than 6" dia. may be core drilled.
14. Contractor shall review with Owner location, accessibility, and method of operating all HVAC shut-off valves located in plumbing chases, ceiling cavity and mechanical rooms.
15. This Contractor shall assist with and provide supervised start-up of the steam, condensate return, hot water and chilled water systems, involving air venting, drainage, etc. Monitor the air venting until all air has been eliminated from the building system and the lines within the buildings are completely filled with fluid, or steam as applicable.
16. The ceiling cavity space is limited. Therefore the ductwork and piping locations shall be closely coordinated with each other as well as the lights, ceiling height, electrical conduit and fire sprinkler piping.
17. It is the intent, where possible, to locate the domestic water piping, medical gas piping, fire sprinkler piping, and HVAC piping above the ductwork and tight to the existing steel and concrete structure. The steam condensate return piping shall, in most cases, be located to run below the ductwork.
18. Selected pipe and duct elevations are shown on the plans as an aid to the contractor in their installation. Where necessary, due to conflicts, these items may be changed as long as conflict with other items does not occur.
19. Ductwork and piping shall rise into the joist or beam space and run between joists or beams where shown on the drawings and as may be required, whether specifically shown or not, to avoid conflict with other trades.
20. This Contractor shall be responsible for coordination with the fire sprinkler subcontractor, plumbing contractor, and the Electrical Contractor as required to avoid and or resolve conflicts. Conflicts between piping, ducts, electrical, sprinklers, etc. shall be resolved with no additional cost or change to the contract amount.
21. Where new work conflicts with existing ductwork or piping (plumbing, HVAC, fire protection, medical gas etc.) this contractor shall relocate those items as required to make way for new work without additional charges.

3.08 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1. In addition to the requirements specified in Division 1, the following requirements apply:
   1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
   1. Uncover work to provide for installation of ill-timed work.
   2. Remove and replace defective work.
   3. Remove and replace work not conforming to requirements of the Contract Documents.
   4. Remove samples of installed work as specified for testing.
   5. Install equipment and materials in existing structures.
   6. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.

3.09 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in other divisions.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.12 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.13 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs. Refer to Division 7.

3.14 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating. Install per manufacturer's instructions to comply with appropriate listing.

D. Fire Rated Surface:

1. Seal openings as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
    b. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.
    c. Pack void with backing material.
    d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

E. Non-Rated Surfaces:

1. Seal openings, where required by code, through non-fire rated openings as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.

b. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.

c. Install type of firestopping material recommended by manufacturer.

2. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.

3. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and pipe.

F. Inspect installed firestopping for compliance with specifications and submitted schedule.

G. Clean adjacent surfaces of firestopping materials.

3.15 INSTALLATION OF ACCESS DOORS

A. Provide access doors in construction wherever access is required for valves, dampers, equipment, etc.

B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.16 INSTALLATION OF DRIP PANS

A. Locate drip pans under piping passing within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection, and run to nearest drain or elsewhere as indicated.

3.17 CLEANING

A. Refer to Division 1 for general requirements for final cleaning.

B. Contractor shall clean work area of all construction dirt and debris at the end of each work day.

3.18 WARRANTIES

A. Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties as specified into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. This Contractor shall warrant all material and equipment installed by him for a period of one year after completion of the project.

END OF SECTION 230500

SECTION 23 05 16
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 SUMMARY

A. Section Includes:

1. Flexible, ball-joint packed expansion joints.
2. Slip-joint, packed expansion joints.
3. Metal, compensator packless expansion joints.
4. Rubber union connector packless expansion joints.
5. Flexible-hose packless expansion joints.
6. Metal-bellows packless expansion joints.
7. Externally pressurized metal-bellows packless expansion joints.
8. Rubber packless expansion joints.
9. Grooved-joint expansion joints.
10. Alignment guides and anchors.
11. Pipe loops and swing connections.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 DELEGATED DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.02 PACKED EXPANSION JOINTS

A. Flexible, Ball-Joint Packed Expansion Joints:

1. Manufacturers:
    a. Advanced thermal Systems
    b. Hyspan Precision Products
    c. Mason Industries
2. Standards: ASME Boiler and Pressure Vessel Code: Section II, "Materials"; ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.

3. Material: Carbon-steel assembly with asbestos-free composition packing.
4. Design: Provide 360-degree rotation and angular deflection.
5. Minimum Pressure Rating: 250 psig at 400 deg F (1725 kPa at 204 deg C).
6. Angular Deflection for NPS 6 (DN 150) and Smaller: 30 degree minimum.
7. Angular Deflection for NPS 8 (DN 200) and Larger: 15 degree minimum.
8. Seal Type: Two carbon steel and graphite seals suitable for continuous operation at temperature up to 650 deg F (343 deg C).
9. Internal Ball: Plated with minimum 1-mil chrome cover.
10. Ball Socket: One- or two-piece design with integral socket/retainer.
    a. Stuffing Box: Incorporates containment seals and compression seals for containment of injectable packing.
    b. Packing Cylinders: Provides packing under full line pressure with check valves to prevent blowback.
11. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
12. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

B. Slip-Joint Packed Expansion Joints:
    1. Manufacturers:
        a. Adsco Manufacturing, LLC
        b. Advanced Thermal Systems
        c. Hyspan Precision Products
        d. Mason Industries
    2. Standard: ASTM F 1007.
    3. Material: Carbon steel with asbestos-free PTFE packing.
    4. Design: With internal guide and injection ports for repacking under full system pressure. Housing shall be furnished with drain ports and lifting ring. Include drip connection if used for steam piping.
    5. Configuration: Single joint class(es), unless otherwise indicated.
    6. Slip Tube for sizes NPS 1-1/2 (DN 40) through NPS 16 (DN 400): Schedule 80.
    7. Slip Tube for sizes NPS 18 (DN 450) through NPS 24 (DN 600): Schedule 60.
    8. Sliding Surface: 2 mil thick chrome finish.
    9. End Connections: Flanged or welded ends to match piping system.

2.03 PACKLESS EXPANSION JOINTS

A. Metal, Compensator Packless Expansion Joints:
    1. Manufacturers:
        a. Hyspan Precision Products
        b. Mason Industries, Inc.
        c. Metraflex Company
    2. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
    3. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid flow by an internal pipe sleeve and external housing.
    4. Joint Axial Movement: 2 inches (50 mm) of compression and 1/2 inch (12 mm) of extension.
    5. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.
        a. End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
        b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded.

6. Configuration for Steel Piping: Multi-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
    a. End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
    b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged.

B. Rubber Union Connector Expansion Joints:
    1. Manufacturers:
        a. Amber/Booth Company
        b. General Rubber Corporaiton
        c. Mason Industries, Inc.
    2. Material: Twin reinforced-rubber spheres with external restraining cables.
    3. Minimum Pressure Rating: 150 psig at 170 deg F (1035 kPa at 77 deg C), unless otherwise indicated.
    4. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

C. Flexible-Hose Packless Expansion Joints:
    1. Manufacturers:
        a. Flex-Hose Co., Inc.
        b. Mason Industries, Inc.
        c. Metraflex Company
    2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
    3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
    4. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.
        a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
    5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.
        a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.
    6. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon-steel fittings with threaded end connections.
        a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.
    7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon-steel fittings with flanged end connections.
        a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.
    8. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Carbon-steel fittings with flanged end connections.
        a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F (860 kPa at 21 deg C) and 90 psig at 600 deg F (625 kPa at 315 deg C) ratings.
    9. Expansion Joints for Steel Piping NPS 14 (DN 350) and Larger: Carbon-steel fittings with flanged end connections.
        a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

D. Metal-Bellows Packless Expansion Joints:

1. Manufacturers:
    a. Hyspan Precision Products
    b. Mason Industries, Inc.
    c. Metraflex Company
2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
5. Configuration: **Single joint** class(es), unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single- or multi- ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
    a. End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint.
    b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Solder joint.
    c. End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.
7. Expansion Joints for Steel Piping: Single-or multi- ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
    a. End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
    b. End Connections for Steel Pipe NPS 2-1/2 (DN 65) and Larger: Flanged.

E. Externally Pressurized Metal-Bellows Packless Expansion Joints EPEJ-XX:
1. Manufacturers:
    a. Hyspan Precision Products
    b. Mason Industries, Inc.
    c. Metraflex Company
2. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
3. Description:
    a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
    b. Carbon-steel housing.
    c. Drain plugs and lifting lug for the NPS 3 (DN 80) and larger.
    d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
    e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
    f. Joint Axial Movement: 4 inches (100 mm).
4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

F. Rubber Packless Expansion Joints:
1. Manufacturers:
    a. General Rubber Corporation
    b. Mason Industries, Inc.
    c. Metraflex Company
2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

3. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
4. Arch Type: **Single or multiple** arches with external control rods.
5. Minimum Pressure Rating for NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 150 psig (1035 kPa) at 220 deg F (104 deg C).
6. Minimum Pressure Rating for NPS 5 and NPS 6 (DN 125 and DN 150): 140 psig (966 kPa) at 200 deg F (93 deg C).
7. Minimum Pressure Rating for NPS 8 to NPS 12 (DN 200 to DN 300): 140 psig (966 kPa) at 180 deg F (82 deg C).
8. Material for Water: Butyl rubber.
9. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.04 GROOVED-JOINT EXPANSION JOINTS

A. Manufacturers:
1. Anvil International
2. Shurjoint Piping Products
3. Victaulic Company

B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

C. Standard: AWWA C606, for grooved joints.

D. Nipples: ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

E. Couplings: Five flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water, and bolts and nuts.

2.05 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

B. Manufacturers:
1. Hyspan Precision Products
2. Anvil International
3. Metraflex Company
4. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

C. Anchor Materials:
1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated steel.
   c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
   a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
   c. Washer and Nut: Zinc-coated steel.

PART 3 EXECUTION

3.01 EXPANSION JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install packed-type expansion joints with packing suitable for fluid service.

C. Install metal-bellows expansion joints according to manufacturer’s recommendations.

D. Install rubber packless expansion joints according to manufacturer’s recommendations.

E. Install grooved-joint expansion joints to grooved-end steel piping.

3.02 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

3.03 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install guide(s) on each side of pipe expansion fittings and loops. Install guides per expansion joint manufacturer installation instruction.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Iron ball valves.
3. Iron butterfly valves.
4. Iron, grooved-end butterfly valves.
5. Brass, grooved-end butterfly valves.
6. High-performance butterfly valves.
7. Bronze lift check valves.
8. Bronze swing check valves.
9. Iron swing check valves.
10. Iron swing check valves with closure control.
11. Iron, grooved-end spring-assisted check valves.
12. Bronze gate valves.
13. Iron gate valves.
14. Bronze globe valves.
15. Iron globe valves.
16. Lubricated plug valves.

B. Related Sections:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.03 SUBMITTALS

A. Product Data: For each type of valve used in the project.

1.04 QUALITY ASSURANCE

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

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooved ends, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

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

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

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
   4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
   5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions to match specified insulation thickness and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Threaded: With threads according to ASME B1.20.1.
   3. Grooved: With grooved ends according (or similar) to AWWA C606.

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

2.02 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Valves.
      b. Crane Co.; Crane Valve Group; Crane Valves.

c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
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 or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

B. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.

2. Description:
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 or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Regular.

2.03 IRON BALL VALVES

A. Class 150, Iron Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Kitz Corporation.
d. Sure Flow Equipment Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-72.

b. CWP Rating: 200 psig.
c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.04 IRON, BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Cooper Cameron Valves; a division of Cooper Cameron Corp.
c. Crane Co.; Crane Valve Group.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Cooper Cameron Valves; a division of Cooper Cameron Corp.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

2.05 IRON, GROOVED-END BUTTERFLY VALVES

A. 150 CWP, Iron, Grooved-End Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Victaulic Company
   b. Kennedy Valve; a division of McWane, Inc.
   c. Tyco Fire Products LP; Grinnell Mechanical Products
   d. Or approved substitution.
2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 150 psig (1032 kPa).
   c. Body Material: Coated, ductile iron.
   d. Stem: Two-piece stainless steel, offset from the disc centerline to provide complete 360-degree circumferential seating.
   e. Disc: Aluminum-bronze.
   f. Seat: EPDM, pressure responsive in sizes through NPS 12.

2.06 BRASS, GROOVED-END BUTTERFLY VALVES

A. 150 CWP, Brass, Grooved-End Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following
   a. Victaulic Company
   b. Kennedy Valve; a division of McWane, Inc.
   c. Tyco Fire Products LP; Grinnell Mechanical Products
   d. Or approved substitution.
2. Description:
   a. CWP Rating: 150 psig (1032 kPa).
   b. Body Material: Cast brass to UNS C87850.
   c. Stem: Stainless steel, offset from the disc centerline to provide complete 360-degree circumferential seating.
   d. Disc: Aluminum-bronze.
   e. Seat: Fluoroelastomer.

2.07 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by Zwick, no substitutions permitted.
2. Description:
   a. Standard: ANSI B16.10.
   b. CWP Rating: 720 psig at 100 deg F.
   c. Body Design: Flange type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: Carbon steel.
   e. Seat: Reinforced stainless steel.
   f. Stem: One piece stainless steel; offset from seat plane.
   g. Disc: Carbon steel.

h. Service: Bidirectional.

i. Packing: Graphite.

2.08 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.
   b. Jenkins Valves.
   c. Stockham.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Design: Vertical flow.
   d. Body Material: ASTM B 61 or ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.09 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group.
   c. Jenkins Valves.
   d. Stockham.
   e. Kitz Corporation.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Red-White Valve Corporation.
2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 300 psig.
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.10 IRON SWING CHECK VALVES

A. Class 250, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Jenkins Valves.
   c. Stockham.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. NIBCO INC.

g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
   c. NPS 14 to NPS 24, CWP Rating: 300 psig.
   d. Body Design: Clear or full waterway.
   e. Body Material: ASTM A 126, gray iron with bolted bonnet.
   f. Ends: Flanged.
   g. Trim: Bronze.
   h. Gasket: Asbestos free.

2.11 IRON, GROOVED-END SPRING-ASSISTED CHECK VALVES

A. Ductile Iron Spring-Assisted Check Valve for Vertical or Horizontal Installation.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Victaulic Company.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Tyco Fire Products LP; Grinnell Mechanical Products
   d. Or approved substitution.
2. Description:
   a. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
   b. NPS 14 to NPS 24, CWP Rating: 230 psig.
   c. Body Material: ASTM A 536, ductile iron.
   d. Ends: Grooved.
   e. Trim: Stainless steel.
   f. Disc / Seat / Seal:
      1) Stainless steel disc with elastomer seat.
      2) Elastomer coated ductile iron disc with welded-in nickel seat.
   g. Installation: Vertical or horizontal.

2.12 BRONZE GATE VALVES

A. Class 150, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Stockham.
   c. Hammond Valve.
   d. Kitz Corporation.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Powell Valves.
   h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 300 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
   d. Ends: Threaded.

e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.13 IRON GATE VALVES

A. Class 300, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Stockham Division.
c. NIBCO INC.
d. Vogt
2. Description:
a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig at 300 degrees F.
c. NPS 14 to NPS 24, CWP Rating: 300 psig at 300 degrees F.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free, graphite.

B. Class 300, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Powell Valves.
g. Vogt.
2. Description:
a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig at 300 degrees F.
c. NPS 14 to NPS 24, CWP Rating: 300 psig at 300 degrees F.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free, graphite.

C. Class 800, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
a. Milwaukee

b. Vogt

2. Description:
   a. Standard: MSS SP-70, Type 1.
   b. CWP Rating: 1745 PSIG at 300 degrees F.
   c. Body Material: ASTM A 105 carbon steel with bolted bonnet.
   d. Ends: Threaded or flanged.
   e. Disc: Solid wedge.
   f. Seat: Hard faced.
   g. Packing and Gasket: Asbestos free, spiral wound gasket, graphite packing.

2.14 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Stockham Division.
      c. Hammond Valve.
      d. Kitz Corporation.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Powell Valves.
      h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 200 psig.
      c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      d. Ends: Threaded or solder joint.
      e. Stem and Disc: Bronze.
      f. Packing: Asbestos free.
      g. Handwheel: Malleable iron.

2.15 IRON GLOBE VALVES

A. Class 300, Iron Globe Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Jenkins Valves.
      c. Stockham Division.
      d. Hammond Valve.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Vogt.
   2. Description:
      a. Standard: MSS SP-85, Type I.
      b. CWP Rating: 500 psig at 300 degrees F.
      c. Body Material: ASTM A 126, gray iron with bolted bonnet.

d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free, graphite.

B. Class 800, Iron Globe Valve:
1. Manufacturers: Subject to compliance with the requirements, provide products of one of the following:
a. Milwaukee.
b. Vogt.
2. Description:
a. Standard: MSS SP-70, Type 1.
b. CWP Rating: 1745 psig at 300 degrees F.
c. Body material: ASTM A 105 carbon steel with bolted bonnet.
d. Ends: Threaded or flanged.
e. Disc: Solid wedge.
f. Seat: Hard faced.
g. Packing and Gasket: Asbestos free, spiral wound gaskets, graphite packing.

2.16 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nordstrom Valves, Inc.
2. Description:
a. Standard: MSS SP-78, Type II.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
e. Pattern: Venturi.
f. Plug: Cast iron or bronze with sealant groove.

B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nordstrom Valves, Inc.
2. Description:
a. Standard: MSS SP-78, Type II.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
e. Pattern: Venturi.
f. Plug: Cast iron or bronze with sealant groove.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

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

D. Examine grooved ends for form and cleanliness. Ends shall be clean and free from indentations and projections in the area from valve end to (and including) the groove.

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

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

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

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

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

D. Install valves in position to allow full stem movement.

E. Install gear operators on all non-quarter turn valves over 6” size.

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

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.03 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.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.
2. Throttling Service except Steam: Globe valves.
3. Pump-Discharge Check Valves:
   a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
   b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. Grooved end valves may be used in lieu of flanged valves on applicable piping systems.

3.05 CHILLED-WATER AND HEATING WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, regular port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Gate Valves: Class 150, NRS, bronze.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, stainless-steel disc.
2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, stainless-steel disc.
3. Iron, Grooved-End Butterfly Valves, NPS 2 to NPS 24: 150 psi CWP, EPDM seat / seal.
4. High-Performance Butterfly Valves: Class 150, single flange.
5. Iron Swing Check Valves: Class 125, metal seats.
6. Grooved-End, Spring-Assisted Iron Check Valves: 150-psi CWP.
7. Iron Gate Valves: Class 125, NRS.
8. Iron Globe Valves: Class 125.
9. Lubricated Plug Valves: Class 125, regular gland, flanged.

END OF SECTION 230523

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Building attachments.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.
11. Miscellaneous equipment.

B. Related Documents:

1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 DEFINITIONS

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

1.03 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. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment where required.

1.04 SUBMITTALS

A. Product Data: For each type of product used in project.

1.05 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

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

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

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

2.02 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.

2.03 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers
1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous thread rod, washer, and nuts made of stainless steel.

2.04 METAL FRAMING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit.
2. Cooper B-Line, Inc.
3. Unistrut Corporation; Tyco International, Ltd.

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

C. Standard: MFMA-4.

D. Channels: Continuous slotted steel channel with inturned lips.

E. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

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

G. Metallic Coating: Hot-dipped galvanized.

H. Paint Coating: Epoxy.

I. Plastic Coating: Polyurethane.

2.05 FIBERGLASS STRUT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit

2. Champion Fiberglass, Inc.
3. Cooper B-Line, Inc.
4. SEASAFE, INC.; a Gibraltar Industries Company.

B. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
1. Channels: Continuous slotted fiberglass channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.06 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) or ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength.

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

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

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.07 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory- fabricated building attachments comply with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Attachment materials to building structure shall be approved by the Structural Engineer.

B. Where concrete structure occurs hang piping using 1/2" diameter Phillips red head wedge anchors or equal by Hilti.
1. Concrete Inserts: MSS Type 18.
2. Top Beam C-Clamps: MSS Type 19.
3. Side Beam or Channel Clamps: MSS Type 20.
4. Center Beam Clamps: MSS Type 21.
5. Welded Beam Attachments: MSS Type 22.
6. C-Clamps: MSS Type 23.
7. Top Beam Clamps: MSS Type 25.

8. Side Beam Clamps: MSS Type 27.
9. Steel Beam Clamps with Eye Nut: MSS Type 28.
10. Linked Steel Clamps with Eye Nut: MSS Type 29.
11. Malleable Beam Clamps: MSS Type 30.
12. Steel Brackets: One of the following for indicated loading:
    a. Light Duty: MSS Type 31.
    b. Medium Duty: MSS Type 32.
    c. Heavy Duty: MSS Type 33.
13. Side Beam Brackets: MSS Type 34.
14. Plate Lugs: MSS Type 57.
15. Horizontal Travelers: MSS Type 58.

2.08 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic or stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.09 PIPE POSITIONING SYSTEMS

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

2.10 EQUIPMENT SUPPORTS

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

2.11 MISCELLANEOUS MATERIALS

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

PART 3 EXECUTION

3.01 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 supporting 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. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

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

G. Installation of Building Attachments:

1. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.
2. Use power driven anchors or expansion anchors at concrete structure.
3. Install supplementary steel angles, fastened or welded to building structure as required to support pipe and accessories. Use 3” x 3” x 1/4” steel angle with long leg vertical, or heavier if required.

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Sections for how system interfaces with roofing system.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each HVAC fixture. See Division 23 HVAC fixture Sections for requirements for pipe positioning systems for HVAC fixtures.

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

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

L. 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.

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

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

O. 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.

P. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (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.
5. Pipes NPS 8 (DN 200) and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 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.

3.03 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.

3.04 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).

3.05 PAINTING

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

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

3.06 INSTALLATION - PIPE HANGER AND SUPPORT

A. Install in accordance with ASME B31.9, MSS SP 58, MSS SP69, and MSS SP 89.

B. Support horizontal and vertical piping as scheduled.

C. Install hangers with minimum 1/2 inch (13 mm) space between finished covering and adjacent work.

D. Provide clearance in hangers and from structure and other equipment for installation of insulation.

E. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.

F. Design hangers for pipe movement without disengagement of supported pipe

G. Comply with MSS SP-69 for pipe-hanger selections and applications that are not otherwise specified.

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

I. Use stainless-steel pipe hangers, fiberglass pipe hangers, fiberglass strut systems and stainless-steel or corrosion-resistant attachments for outdoors and/or hostile environment applications.

J. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing. Use vinyl-coated hangers and attachments for PEX, PVC, and CPVC piping. Use stainless steel hangers and stainless steel attachments on stainless steel pipes.

K. Use padded hangers for piping that is subject to scratching, including plastic pressure piping and all glass piping.

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

M. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified elsewhere, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

N. Vertical-Piping Clamps: Unless otherwise indicated and except as specified elsewhere, 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.

O. Hanger-Rod Attachments: Unless otherwise indicated and except as specified elsewhere, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

P. Building Attachments: Unless otherwise indicated and except as specified elsewhere, 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 (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.

Q. Saddles and Shields: Unless otherwise indicated and except as specified elsewhere, 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.

R. 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 (32 mm).
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.

S. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not otherwise specified.

T. Comply with MFMA-103 for metal framing system selections and applications that are not otherwise specified.

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

3.07 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.08 SCHEDULES

HORIZONTAL PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet (m)	HANGER ROD DIAMETER Inches (mm)
CPVC, 1 inch (25 mm) and smaller	3 (0.9)	1/2 (13)
CPVC, 1-1/4 inch (32 mm) to 3 inch (75)	4 (1.2)	1/2 (13)
CPVC, 4 inch (100) to 8 inch (200)	4 (1.2)	7/8 (22)
Copper Tube, 1-1/4 inch (32 mm) and smaller	5 (1.5)	3/8 (10)
Copper Tube, 1-1/2 inch (38 mm) to 5 inches (DN125)	8 (2.4)	1/2 (13)
Copper Tube 6 inch (DN150)	10 (3)	5/8 (16)
Copper Tube 8 inch (DN200)	10 (3)	3/4 (19)
Fiberglass up to 4 inch (100 mm)	10 (3)	5/8 (16)
Polypropylene/Polyethylene 3 inches (75 mm) and smaller	3 (.9)	1/2 (13)
Polypropylene/Polyethylene 4 inches (100 mm) to 8 inches (200 mm)	4 (1.2)	7/8 (22)
PVC 3 inches (75 mm) and smaller	4 (1.2)	1/2 (13)

PVC 4 inches (100 mm) to 8 inch (100 mm)	4 (1.2)	7/8 (22)
Stainless Steel or Steel, 3 inches (75 mm) and smaller	12 (3.7)	1/2 (13)
Stainless Steel or Steel, 4 inches (100 mm) to 6 inch (150 mm)	12 (3.7)	3/4 (19)
Stainless Steel or Steel, 8 inches (200 mm) and larger	12 (3.7)	7/8 (22)

NOTE: 1. Where code requirements for hangers are more stringent than above, code requirements shall apply.
2. Place hangers within 12 inches (300 mm) of each horizontal elbow, fitting, valve and coupling.
3. Support horizontal cast iron pipe adjacent to each hub.
4. Rod diameters may be reduced one size for double-rod hangers, with 3/8 inch (10mm) minimum rods.

VERTICAL PIPE SUPPORT SPACING	
PIPE MATERIAL	MAXIMUM SUPPORT SPACING Feet (m)
CPVC 1 inch (25 mm) and smaller	5 (1.5)
CPVC 1-1/4 inch (32mm) and larger	6 (1.8)
Copper Tube	10 (3)
Fiberglass	12 (3.7)
Polypropylene/Polyethylene	5 (1.5)
PVC	4 (1.2)
Steel or Stainless Steel	15 (4.5)

NOTE: 1. Where not otherwise indicated, support vertical piping at each floor.
2. Support cast iron at hubs.
3. Support riser piping independently of connected horizontal piping.

END OF SECTION 230529

SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Elastomeric hangers.
   2. Spring hangers.
   3. Spring hangers with vertical-limit stops.
   4. Pipe riser resilient supports.
   5. Resilient pipe guides.
   6. Seismic snubbers.
   7. Restraining braces and cables.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Restraint
   1. Unless otherwise specified, all mechanical, electrical, medical gas and plumbing equipment, pipe, and duct shall be restrained to resist seismic forces. Restraints shall maintain equipment, piping, and duct work in a captive position. Restraint devices shall be designed and selected to meet the seismic requirements as defined in the adopted issue of the IBC.
   2. This building is a Seismic Design Category C and all mechanical, plumbing, and medical gas systems shall be treated as having an importance factor (Ip) of 1.5. Refer also to structural drawings for additional information.
   3. Seismic restraint shall not be required for the following:
      a. High deformability piping (steel, copper, aluminum with welded, brazed, ground, or screwed connections) designated as having a nominal pipe size of 1 inch (25 mm) or less where provisions are made to protect the piping from impact or to avoid the impact of larger piping or other mechanical equipment. Note, any combination of piping supported on a trapeze where the total weight exceeds 10 lb/ft. shall be braced.
      b. PVC or other plastic or fiberglass vent piping.
      c. HVAC ducts suspended from hangers that are 12 inches (305 mm) or less in length from the top of the duct to the supporting structure and the hangers are detailed to avoid significant bending of the hangers and their connections. Duct must be positively attached to hanger with minimum #10 screws with 2' from the top of the duct.
      d. HVAC ducts that have a cross-section area less than 4 square feet.
      e. Equipment items installed in-line with the duct system (e.g. fans, heat exchangers, and humidifiers) with an operating weight less than 76 pounds (334 N). Equipment must be rigidly attached to duct at inlet and outlet.
      f. All equipment with an Importance Factor of 1.0.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:
   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 seismic-restraint component used.

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.

B. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

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

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation and seismic forces required to select vibration isolators and seismic restraints.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

2. 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, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Seismic Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For professional engineer and testing agency.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the Building Code unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

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

1. Kinetics Noise Control.
2. Mason Industries.
3. Vibration Mountings & Controls, Inc.

B. Elastomeric Hangers (Type 2): Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

C. Spring Hangers (Type 3): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
   1. 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.
   2. Outside 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. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

D. Spring Hangers with Vertical-Limit Stop (Type 3): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
   1. 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.
   2. Outside 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. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

E. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.

F. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.02 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Cooper B-Line, Inc.; a division of Cooper Industries.

3. Hilti, Inc.
4. Kinetics Noise Control.
5. Mason Industries.
6. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
   2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. 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.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

H. 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. Minimum length of eight times diameter.

I. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl 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.

2.03 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
   1. Powder coating on springs and housings.
   2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
   3. Baked enamel or powder coat for metal components on isolators for interior use.
   4. Color-code or otherwise mark vibration isolation and seismic and wind control devices to indicate capacity range.

PART 3 EXECUTION

3.01 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.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings 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 will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
3. Brace a change of direction longer than 12 feet (3.7 m).

B. Install cables so they do not bend across edges of adjacent equipment or building structure.

C. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

D. 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.

E. 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.

F. 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 structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed 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.

3.04 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Install flexible connections in piping and ductwork where they cross building joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.05 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.06 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 48

SECTION 23 05 53
DENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Valve tags.
   6. Warning tags.
   7. Plastic underground pipe markers.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 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.

1.03 COORDINATION

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

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

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

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch (0.8-mm); Stainless steel, 0.025-inch (0.64-mm); Aluminum, 0.032-inch (0.8-mm); or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   4. Fasteners: Stainless-steel rivets or self-tapping screws.
   5. 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, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
   2. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths 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.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

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

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

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

2.03 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. For insulated pipes, also include pipe size on the label.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or 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 and an arrow indicating flow direction. For insulated pipes, also include pipe size on the label.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.04 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and

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

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

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

G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.05 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Multilayer, multicolored plastic, 0.0625 inch (1.6mm); Brass, 0.032-inch (0.8-mm); Stainless steel, 0.025-inch (0.64-mm); Aluminum, 0.032-inch (0.8-mm); or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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.

2.06 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches (100 by 178 mm).
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 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.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten plastic or metal labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; mechanical rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings.
8. There shall be a minimum of one label for each system per room.

3.04 DUCT LABEL INSTALLATION

A. Install plastic-laminated 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.
   4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

3.05 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; 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.

3.06 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

SECTION 23 05 9
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Variable-flow hydronic systems.
   3. Testing, Adjusting, and Balancing Equipment:
      a. Heat exchangers.
      b. Motors.
   4. Testing, adjusting, and balancing existing systems and equipment.
   5. Duct leakage tests.
   6. Control system verification.

1.03 DEFINITIONS

A. BAS: Building automation systems.
B. NEBB: National Environmental Balancing Bureau.
C. TAB: Testing, adjusting, and balancing.
D. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
E. TDH: Total dynamic head.

1.04 PREINSTALLATION MEETINGS

A. Pre-TAB Meeting: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 10 days' advance notice of scheduled meeting time and location.
   1. Minimum Attendance:
      a. Controls Contractor.
      b. Mechanical Contractor.
      c. Electrical Contractor.
      d. General Contractor.
      e. Mechanical Engineer.
      f. Architect.
   2. Minimum Agenda:
      a. Contract document examination report.
      b. System readiness checklist.
      c. TAB plan.
      d. Duct Air Leakage Test (DALT).
      e. Control software requirements.
      f. Equipment software requirements.
      g. TAB schedule development. TAB contractor shall assist general contractor in identifying and scheduling TAB activities, taking into account project phasing, installation of furniture, owner occupancy and overall project schedule.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 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 "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. TAB Plan: Prior to Pre-TAB meeting and beginning work, submit TAB strategies and step-by-step procedures as specified in "TAB Plan" Article.

D. System Readiness Checklists: Prior to beginning work, submit system readiness checklists as specified in "Preparation" Article.

E. Construction Document Examination Report: Prior to beginning work submit a report of the examination review required in "Examination" Article.

F. Installation Examination Report: During construction phases submit a report of the installation examination review required in “Examination” Article.

G. Certified TAB reports: After work is complete, submit TAB report as described in “Final Report” Article.

H. Sample report forms.

I. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of calibration.

J. Controls Verification Report: Submit a report of the controls verification Article.

1.06 QUALITY ASSURANCE

A. The Mechanical Contractor shall procure the services of or an engineer pre-approved independent test and balance agency to test water and air moving equipment and air distribution and exhaust systems and to supervise the balance and adjustment of these systems.

B. TAB Specialists Qualifications: Certified by NEBB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB as a 3. TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

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

1.07 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.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 EXAMINATION

A. Construction Document Examination: Report: 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:

1. Identify systems that contain diversity.
2. Verify floor plans and details that contain all balance devices necessary to execute entire specification.
3. Identify measurements that cannot be made or may not be accurate due to pipe or duct geometry.
4. Review equipment schedules and specifications as well as electrical connections to verify. Require speed control devices have been specified.
5. Identify balance devices that are difficult to reach during or after construction and make recommendations to overcome issue.
6. Bring any unmarked air inlet or outlets to the attention of the engineer immediately.
7. Review how TAB scope affects existing air and hydronic systems.

B. Installation Examination Report: Examine installed systems for deficiencies, which may reflect TAB activities. Prepare report bi-weekly and submit to engineer for review:

1. Examine systems for balancing devices such as test ports, gage locks, thermowells, flow-control devices, balancing valves and fittings and manual volume dampers.Verify that locations of these balance devices are applicable for intended purpose and are accessible.
2. Examine ceiling plenums and underfloor air plenum used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire stopped if required.
3. Examine system and equipment installation and verify that field quality-control testing such as factory startups or pump alignment have occurred. Verify equipment and systems are clean and are being protected from construction process and verify that adjusting specified in individual sections have been performed.
4. Examine test reports specified in individual systems and equipment sections.
5. Examine HVAC equipment and verify that bearings are greased, bolts are aligned, and functioning controls is ready for operation.
6. Examine terminal units, such as variable-air-volume boxes and verify that they are accessible, and their controls are connected and functioning.
7. Examine a sample of strainers to verify they are clean. A minimum of two strainers per system shall be inspected. Verify startup strainers have been removed. Provide photo documentation of findings.
8. Examine control valves for proper orientation, that operator(s) are securely attached.
9. Examine heat-transfer coils for correct piping connections and for clean straight fins. All piping connects are counterflow.
10. Examining system pumps to verify gage ports are installed as detailed.
11. Examine expansion tank to determine if system is filled correctly and that air side is charged properly. Report water and air-filled pressures as well as corresponding system temperatures and fluid composition.
12. Examine fan interlocks to fire alarm, hoods, dampers, temperature control systems wall switches or other fans.
13. Examine the system for the presence of air.

C. Examine the approved submittals for HVAC systems and equipment to verify accessories required for compliance with TAB specifications are being provided.

3.02 PREPARATION

A. TAB 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. System Readiness Checklist: Prepare and execute system-readiness checks of HVAC systems and equipment 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. Automatic temperature-control systems are operational.
      f. Ceilings are installed.
      g. Windows and doors are installed.
      h. 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. Variable-frequency controllers' startup is complete, and safeties are verified.
      i. Suitable access to balancing devices and equipment is provided.
   3. Controls:
      a. Verify controllers are communicating to user interface.
      b. Verify software and cable requirements to communicate with control system.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

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, 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 230700 “HVAC INSULATION."

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

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

3.04 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. Report discrepancies to Engineer and discuss/recommend procedures for testing with diversity.

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

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

G. Check for airflow blockages.

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

I. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

J. Verify fire dampers are open.

3.05 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select 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.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor for maximum airflow.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor for minimum airflow. If no minimum calibration is available, note any deviation from design airflow.
    f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer:
    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.

c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.

d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

f. Plot static pressure, fan RPM and brake HP on fan curve.

g. Total flow (fan) measurement must include duct leakage outlet or inlet flow may only be reported if traverse measurements are not possible.

6. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or in the first segment of duct.

b. Measure static pressure directly at the fan inlet or in the first segment of duct.

c. Measure static pressure across each component that makes up the air-handling system.

d. Report condition of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow:

a. Calibrate outside airflow stations by comparison to airflow traverse of outside path, subtraction of return from supply path, and by slowing unit to produce 100 percent outside air and traversing supply path only. Record both airflow traverse data and airflow monitor station output. Document area and setup perimeters used for calibration. Balance the return-air ducts and inlets the same as described for constant-volume air systems.

b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.

9. Verify final system conditions as follows:

a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.

b. Re-measure and confirm that total airflow is within design.

c. Re-measure final fan operating data, rpms, volts, amps, and static profile.

d. Mark final settings.

e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.

f. Verify tracking between supply and return fans.

g. Set max fan speed and amps in variance frequency drives.

3.06 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

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

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check system pressure at expansion tank location and verify pressure exceeds the height of the system plus five psig.
2. Check flow-control valves for proper position.
3. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
4. Check that air has been purged from the system.
5. Check pump strainer to verify it is clean.

3.07 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

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

B. Adjust the variable-flow hydronic system as follows:
   1. Verify that the differential-pressure sensor is located as indicated.
   2. Determine whether there is diversity in the system. If diversity exists, discuss balance procedure with designer in order to obtain intended balance.

C. For systems with no diversity:
   1. Adjust pumps to deliver total design gpm.
      a. Measure total water flow.
         1) Position valves for full flow through coils.
         2) Measure flow by main flow meter, if installed.
         3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
      b. Measure pump TDH as follows:
         1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
         2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
         3) Convert pressure to head and correct for differences in gage heights.
         4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
         5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved, plus 15% flow.
      c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
   2. Adjust flow-measuring devices installed in mains and branches (if available) to design water flows.
      a. Measure flow in main and branch pipes.
      b. Adjust main and branch balance valves for design flow.
      c. Re-measure each main and branch after all have been adjusted.
   3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
      a. Measure flow at terminals.
      b. Adjust each terminal to design flow.
      c. Re-measure each terminal after it is adjusted.
      d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
      e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:
    a. Measure differential pressure and verify that it is within manufacturer's specified range.
    b. Record differential pressure measurement. “Pass” and “Fail” records are not acceptable.
    c. Perform temperature tests after flows have been verified.
5. Prior to verifying final system conditions, determine the system differential-pressure set point.
6. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions. If pump speeds are less than 50 Hz, return pump discharge valve to initial position in order to allow adequate control range.
7. Mark final settings and verify that all memory stops have been set.
8. Verify final system conditions as follows:
    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, and amps.
    c. Mark final settings.
    d. Record BAS differential pressure setpoint. Paint with permanent paint or marker.
    e. Plot RPM, head pressure and brake hp on pump curve.
9. Verify that memory stops have been set.

3.08 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.
B. Balance the secondary circuits after the primary circuits are complete.
C. Adjust pumps to deliver total design gpm:
    1. Measure total water flow:
        a. Position valves for full flow through coils.
        b. Measure flow by main flow meter, if installed.
        c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
    2. Measure pump TDH as follows:
        a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        c. Convert pressure to head and correct for differences in gage heights.
        d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
    3. Monitor motor performance during procedures and do not operate motor in an over-loaded condition.
D. Adjust flow-measuring devices installed in mains and branches to design water flows:
    1. Measure flow in main and branch pipes.
    2. Adjust main and branch balance valves for design flow.

3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows:
   1. Measure flow at terminals.
   2. Adjust each terminal to design flow.
   3. Re-measure each terminal after it is adjusted.
   4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
   5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:
   1. Measure differential pressure and verify that it is within manufacturer's specified range.
   2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:
   1. Measure and balance coils by either coil pressure drop or temperature method.
   2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:
   1. Re-measure and confirm that total water flow is within design.
   2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   3. Mark final settings.
   4. Plot RPM, head and brake horsepower on pump curve.

I. Verify that memory stops have been set.

3.09 PROCEDURES FOR HEAT EXCHANGERS

A. Adjust water flow to within specified tolerances.

B. Measure inlet and outlet water temperatures.

C. Measure water pressure in and out of heat exchanger.

3.10 PROCEDURES FOR MOTORS

A. Record:
   1. Manufacturer's name, model number, and serial number.
   2. Motor horsepower rating.
   3. Motor rpm.
   4. Phase and hertz.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.
   1. .

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for coils over 2,000 CFM:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Make, model and setting of balance device.
   4. Coil pressure drop.
   5. Dry bulb temperature of entering and leaving air.
   6. Web bulb temperature of entering and leaving air for cooling coils.

7. Temperature measurements may be deferred to opposite season with approval of Engineer.

B. Measure, adjust, and record the following data for coils under 2,000 CFM:
   1. Water flow rate.
   2. Make, model and setting of balance device.

3.12 DUCT AIR LEAKAGE TESTS (DALT)

A. DALT Test Preparation:
   1. Coordinate sheet metal requirements with Mechanical Contractor:
      a. Branch duct tops installed, and runouts capped.
      b. Duct sealed per metal duct specifications.
      c. Obtain fabrication drawings from Sheetmetal Contractor for calculation of areas and leakage rates.
   2. Pre-Test Report:
      a. Colored diagram identifying and labeling each duct segment.
      b. Segment, sub-segment dimensions, area, allowable leakage rate.
      c. Require test procedure:
         1) For medium and high velocity ducts, use 3” w.c.
         2) For low velocity ducts, use 1” w.c.
         3) Refer to metal duct specification for seal and pressure requirements.

B. DALT Testing:
   1. Notify Engineer/Architect one (1) week in advance of testing.
   2. Instruments:
      a. Airflow from 5 CFM to 400 CFM with accuracy of +/- 2% of reading.
      b. Pressure from 0” to 6” w.c.
   3. Test all ducts under positive pressure.
   4. Include a minimum of (2) tests per duct segment.

C. Final Report:
   1. Include all data contained in Pre-Test Report.
   2. Actual leakage rate and test pressures for preliminary and final measurements.
   3. Report sheet metal deficiencies and duct construction that does not match design drawings.
   4. Final DALT must be submitted and approved prior to balance activities.

3.13 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:
   1. Measure water flow rate at all flow monitor locations. Report both measurement and coincident control system readings.
   2. For variable volume air systems, measure and record duct static pressure and coincident control system reading at duct pressure transmitter location at design airflow. Assist controls contractor in determining max static setpoint.
   3. Measure and record airflow and coincident control system reading airflow stations.
   4. Measure and record alarm threshold static pressure safety shutdown switches. Calibrate setting to Engineers requirements.
   5. Measure and record alarm threshold static pressure at dirty filter pressure switch. Calibrate setting to Engineer’s requirement.
   6. For terminal units, record duct area settings and flow coefficients.

7. Measure and record differential and coincident control system room pressure monitor reading.

B. Controls Verification Report: Also see Article “Final Report”:

1. Include summary of measurements performed, remaining deficiencies, and verifications from indicated conditions.
2. Include graphic or schematic showing location of duct static transmitters, air flow stations and water flow meters.
3. Measurement records shall include coincident value in control system.

3.14 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused:

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check the condition of coils.
5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Fans are clean.
4. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work:

1. Balance inlets, outlets and equipment identified in construction documents to capacities identified in the construction documents.
2. 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.
3. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
4. If calculations increase or decrease the airflow 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.
5. Balance each air outlet.

3.15 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:
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above. Obtain approval from Engineer prior to deviating from design values.

3.16 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 with annotated data.
2. Fan curves with annotated data.
3. Field startup reports prepared by system and equipment installers.
4. 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. Summary of TAB procedures.
    b. Summary of all rooms indicating design air changes vs. actual air changes and any required pressure relationships.
    c. Complete list of issues encountered, including status, when issue was encountered and resolved.
    d. Conditions under which measurements were taken.
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 turns from maximum pitch diameter.
    f. Inlet VFD settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.
16. Each page must include unique page number corresponding to table of contents.

D. System Diagrams: Include annotated floor plans of air and hydronic distribution systems. Present each system include the following:
1. Quantities of supply, return, and exhaust airflows for each inlet or outlet.

2. Location of airflow traverse.
3. Position of balancing devices If different than drawings).

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Sheave make, size in inches, and bore.
g. Number, make, and size of belts.
h. Number, type, and size of filters.
2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Outdoor airflow in cfm.
f. Return airflow in cfm.
g. Outdoor-air damper position.
h. Return-air damper position.
i. Graphic or schematic representation of unit showing static pressure in each compartment.

F. Apparatus-Coil Test Reports:
1. Coil Data:
a. System identification.
2. Test Data (Indicated and Actual Values):
a. Entering-air, wet- and dry-bulb temperatures in deg F.
b. Leaving-air, wet- and dry-bulb temperatures in deg F.
c. Water flow rate in gpm.
d. Water pressure differential in feet of head or psig.
e. Entering-water temperature in deg F.
f. Leaving-water temperature in deg F.
g. Make, model and setting of balance device.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.

c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.

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

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

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

1. Report Data:
a. System and air-handling-unit number.
b. Graphic representation showing location of traversed.
c. Duct static pressure in inches wg.
d. Duct size in inches.
e. Duct area in sq. ft.
f. Indicated airflow rate in cfm.
g. Indicated velocity in fpm.
h. Actual airflow rate in cfm.
i. Actual average velocity in fpm.

I. Air-Terminal-Device Reports:

1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Inlet diameter.

2. Test Data (Indicated and Actual Values):
a. Design airflow rates in cfm.
b. Flow coefficients in cfm.

c. Minimum cooling flow rate in cfm.
d. Maximum cooling flow rate in cfm.
e. Minimum heating flow rate in cfm.
f. Maximum heating flow rate in cfm.
g. Final airflow rate in cfm.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
2. Test Data (Indicated and Actual Values):
a. Airflow and actual water flow rates in cfm.
b. Make, model and setting of balance device. For pressure independent control values or auto flow values include pressure drop.
c. Entering-water temperature in deg F (if applicable).
d. Leaving-water temperature in deg F (if applicable).
e. Water pressure drop in feet of head or psig (if applicable).
f. Entering-air temperature in deg F (if applicable).
g. Leaving-air temperature in deg F (if applicable).

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Pump rpm.
i. Impeller diameter in inches.
j. Motor make and frame size.
k. Motor horsepower and rpm.
l. Voltage at each connection.
m. Amperage for each phase.
n. Full-load amperage and service factor.
2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig
g. Final suction pressure in feet of head or psig.

h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

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

M. Controls Verification Report:
1. Test Data:
a. Actual and control system values for each control input.
b. Air flow stations. Actual and system values, configuration settings.
c. Water flow meters. Actual and system values.
d. Safety high static shutdown switches setting.
e. Dirty filter pressure switches setting.
f. Room pressure monitors. Actual and system values.
g. Record flow coefficients for all terminal equipment.

N. Duct Air Pressure Test Report (DALT):
1. Assemble and report test findings as described in DALT Specification included in this specification.

O. Bi-weekly installation examination report.

3.17 VERIFICATION OF TAB REPORT

A. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

B. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

C. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

D. If TAB work fails, proceed as follows:
1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

3.18 ADDITIONAL TESTS

A. Seasonal Periods: With approval from the Engineer, certain measurements may be deferred until weather conditions are near-peak summer or winter conditions. Such request must be submitted in writing to the engineer for approval. Request must be accompanied with a plan to conduct the deferred work. TAB specialist shall return to the project site to conduct remaining work.

3.19 COMMISSIONING ASSISTANCE

1. Refer to Section 238000 “Systems Commissioning” for requirements of that section.

END OF SECTION 23 05 93

SECTION 23 07 00
HVAC INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. HVAC piping insulation, jackets, and accessories.
   2. HVAC equipment insulation, jackets, and accessories.
   3. HVAC ductwork insulation, jackets, and accessories.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Division, may contain requirements that relate to this section.

1.02 REFERENCES

A. Sheet Metal and Air Conditioning Contractors':
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

B. National Fire Protection Association:
   1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories Inc.:
   1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
   2. UL 1978 - Standard for Safety for Grease Ducts.

1.03 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

1.04 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255. All items exposed in return air plenums must not exceed 25/50 for flame and smoke.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Perform Work in accordance with applicable local and state codes.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years experience.

1.06 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

B. Maintain temperature before, during, and after installation for minimum period recommended by manufacturer.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
   1. CertainTeed.
   2. Knauf.
   3. Johns Manville.
   4. Owens-Corning.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
   1. Aeroflex. Aerocell.
   2. Armacell, LLC. Armaflex.
   3. Nomaco. K-flex.

C. Manufacturers for Polyisocyanurate Foam Insulation Products:
   1. Dow Chemical Company.

D. Manufacturers for Extruded Polystyrene Insulation Products:
   1. Dow Chemical Company.

2.02 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.23 at 75 degrees F (0.034 at 24 degrees C).
   2. Operating Temperature Range: 0 to 850 degrees F (minus 18 to 454 degrees C).
   3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.23 at 75 degrees F (0.034 at 24 degrees C).
   2. Operating Temperature Range: 0 to 850 degrees F (minus 18 to 454 degrees C).

C. TYPE P-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.040 at 24 degrees C).
   2. Operating Temperature Range: 0 to 650 degrees F (minus 18 to 343 degrees C).
   3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).

D. TYPE P-4: ASTM C612; semi-rigid, fibrous glass board noncombustible. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.040 at 24 degrees C).
   2. Operating Temperature Range: 0 to 650 degrees F (minus 18 to 343 degrees C).

E. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 25 degrees C).
   2. Operating Temperature Range: Range: Minus 70 to 180 degrees F (minus 57 to 82 degrees C).

F. TYPE P-6: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.30 at 75 degrees F (0.043 at 24 degrees C).
   2. Maximum Service Temperature: 300 degrees F (149 degrees C).
   3. Operating Temperature Range: Range: Minus 58 to 300 degrees F (minus 50 to 149 degrees C).

G. TYPE P-7: ASTM C534, Type I, flexible, nonhalogen, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
   2. Maximum Service Temperature: 250 degrees F (120 degrees C).
   3. Operating Temperature Range: Range: Minus 58 to 250 degrees F (minus 50 to 120 degrees C).

H. TYPE P-8: ASTM C547, Type I or II, mineral fiber preformed pipe insulation, noncombustible.
   1. Thermal Conductivity: 0.23 at 75 degrees F (0.034 at 24 degrees C).
   2. Maximum Service Temperature: 1200 degrees F (649 degrees C).
   3. Canvas Jacket: UL listed, 6 oz/sq yd (220 g/sq m), plain weave cotton fabric treated with fire retardant lagging adhesive.

I. TYPE P-9: ASTM C591, Type IV, polyisocyanurate foam insulation, formed into shapes for use as pipe insulation.
   1. Density: 2.0 pounds per cubic foot (32 kg per cubic meter).
   2. Thermal Conductivity: 180-day aged value of 0.19 at 75 degrees F (0.027 at 24 degrees C).
   3. Operating Temperature Range: Range: Minus 297 to 300 degrees F (minus 183 to 149 degrees C).
   4. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 mils (0.1 mm) thickness and water vapor permeance of 0.02 perms.

J. TYPE P-10: ASTM C578, Type XIII, extruded polystyrene insulation, formed into shapes for use as pipe insulation.
   1. Thermal Conductivity: 180-day aged value of 0.259 at 75 degrees F (0.037 at 24 degrees C).
   2. Operating Temperature Range: Range: Minus 297 to 165 degrees F (minus 183 to 74 degrees C).
   3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 mils (0.1 mm) thickness and water vapor permeance of 0.02 perms.

K. TYPE P-11: ASTM C533; Type I, hydrous calcium silicate pipe insulation, rigid molded white; asbestos free.
   1. Thermal Conductivity: 0.45 at 200 degrees F (0.0650 at 93 degrees C).
   2. Operating Temperature Range: 140 to 1200 degrees F (60 to 649 degrees C).

2.03 PIPE INSULATION JACKETS

A. PVC Plastic Pipe Jacket:
   1. Product Description: ASTM D1784, one piece molded type fitting covers and sheet material, off-white color.
   2. Thickness: 30 mil (0.76 mm).
   3. Connections: Brush on welding adhesive.

B. BS Plastic Pipe Jacket:
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.

2. Minimum service temperature: -40 degrees F (-40 degrees C).
3. Maximum service temperature of 180 degrees F (82 degrees C).
4. Moisture vapor transmission: ASTM E96; 0.012 perm-inches.
5. Thickness: 30 mil (0.76 mm).
6. Connections: Brush on welding adhesive.

C. Aluminum Pipe Jacket:
1. ASTM B209.
2. Thickness: 0.032 inch (0.80 mm) thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2-inch (50 mm) laps.
5. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.020 inch (0.50 mm) thick stainless steel.

2.04 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches (40 mm) diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches (50 mm) diameter and larger: Wood insulation saddle, hard maple. Insert length: not less than 6 inches (150 mm) long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048-inch (1.22 mm) stainless steel with twisted ends on maximum 12-inch (300 mm) centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.05 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied foil scrim craft jacket meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Maximum Operating Temperature: 250 degrees F (121 degrees C).
3. Density: 0.75 pound per cubic foot (12 kilogram per cubic meter).

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied paintable all service facing meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Density: 3.0 pounds per cubic foot (48 kilogram per cubic meter).

C. TYPE D-3: ASTM C612, Type IA or IB, rigid glass fiber, no facing.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Density: 3.0 pounds per cubic foot (48 kilogram per cubic meter).

D. TYPE D-4: ASTM C1071, Type I, flexible, glass fiber duct liner with coated air side.
1. Thermal Conductivity: 0.26 at 75 degrees F (0.038 at 24 degrees C).
2. Density: 2.0 pound per cubic foot (32 kilogram per cubic meter).
3. Maximum Operating Temperature: 250 degrees F (121 degrees C).
4. Maximum Air Velocity: 6,000 feet per minute (30.5 meter per second).

E. TYPE D-5: ASTM C1071, Type II, rigid, glass fiber duct liner with coated air side.
   1. Thermal Conductivity: 0.23 at 75 degrees F (0.033 at 24 degrees C).
   2. Density: 3.0 pounds per cubic foot (48 kilogram per cubic meter).
   3. Maximum Operating Temperature: 250 degrees F (121 degrees C).
   4. Maximum Air Velocity: 4,000 feet per minute (20.3 meters per second).

F. TYPE D-6: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
   2. Service Temperature Range: Range: Minus 58 to 180 degrees F (minus 50 to 82 degrees C).

G. TYPE D-7: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet laminated with white thermoplastic rubber membrane.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
   2. Service Temperature Range: Range: Minus 58 to 180 degrees F (minus 50 to 82 degrees C).

H. TYPE D-8: Inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978.
   1. Thermal Conductivity: 0.42 at 500 degrees F (0.060 at 260 degrees C).
   2. Weight: 1.4 pound per square foot (6.73 kilogram per square meter).
   3. Flame spread rating of 0 and smoke developed rating of 0 in accordance with ASTM E84.

2.06 DUCTWORK INSULATION JACKETS

A. Aluminum Duct Jacket:
   1. ASTM B209.
   2. Thickness: 0.032 inch (0.80 mm) thick sheet.
   3. Finish: Smooth.
   4. Joining: Longitudinal slip joints and 2-inch (50 mm) laps.
   5. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

B. Vapor Retarder Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture vapor transmission: ASTM E96; [0.02] [1.3] perm.
   3. Secure with pressure sensitive tape.

C. Canvas Duct Jacket: UL listed, 6 oz/sq yd (220 g/sq m), plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

D. Membrane Duct Jacket: ASTM D4637; Type I, EPDM; non-reinforced, 0.060 inch (1.5 mm) thick, 48 inch (1220 mm) wide roll; white color.

2.07 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber-based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Liner Fasteners: Galvanized steel, self-adhesive pad, impact applied, or welded with integral or press-on head.

E. Tie Wire: 0.048-inch (1.22 mm) stainless steel with twisted ends on maximum 12-inch (300 mm) centers.

F. Lagging Adhesive: Fire resistive to ASTM E84, NFPA 255, and UL 723.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.

I. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify piping, equipment and ductwork has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Division 07 for penetration of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:

1. Insulate the entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:

1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Polyisocyanurate Foam Insulation and Extruded Polystyrene Insulation:

1. Wrap elbows and fitting with vapor retarder tape.
2. Seal butt joints with vapor retarder tape.

F. Hot Piping Systems less than 140 degrees F (60 degrees C):

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

G. Hot Piping Systems greater than 140 degrees F (60 degrees C):

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

H. Inserts and Shields:
   1. Piping 1-1/2 inches (40 mm) Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
   2. Piping 2 inches (50 mm) Diameter and Larger: Install insert between support shield and piping and under finish jacket.
      a. Insert Configuration: Minimum 6 inches (150 mm) long, of thickness and contour matching adjoining insulation; may be factory fabricated.
      b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
   3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

I. Insulation Terminating Points:
   1. Coil Branch Piping 1 inch (25 mm) and Smaller: Terminate hot water piping at union upstream of the coil control valve. On VAV, CV, and FTU terminal units, insulate heating water piping and components up to coil connections.
   2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
   3. Cooling Coil Condensate Piping: Insulate entire piping system and components to prevent condensation.

J. Closed Cell Elastomeric Insulation:
   1. Push insulation on to piping.
   2. Miter joints at elbows.
   3. Seal seams and butt joints with manufacturer's recommended adhesive.
   4. When application requires multiple layers, apply with joints staggered.
   5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

K. High Temperature Pipe Insulation:
   1. Install in multiple layers to meet thickness scheduled.
   2. Attach each layer with bands. Secure first layer with bands before installing next layer.
   3. Stagger joints between layers.
   4. Finish with canvas jacket sized for finish painting.

****** [OR] ******

   5. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

L. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with PVC jacket and fitting covers.

M. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

N. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

O. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

P. Prepare pipe insulation for finish painting. Refer to Division 09.

3.03 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions. Increase duct dimension where internal duct liner is specified.

B. Insulated ductwork conveying air below ambient temperature:

1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:

1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. External Glass Fiber Duct Insulation:

1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

E. External Elastomeric Duct Insulation:

1. Adhere to clean oil-free surfaces with full coverage of adhesive.
2. Seal seams and butt joints with manufacturer's recommended adhesive.
3. When application requires multiple layers, apply with joints staggered.
4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
5. Lift ductwork off trapeze hangers and insert spacers.

3.04 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPES	PIPE SIZE	INSULATION THICKNESS inches (mm)
Chilled Water Supply and Return [40 to 60 degrees F]	P-1[b]	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) inch and larger	0.5 (13) 1.0 (25)
Chilled Water Supply and Return [less than 40 degrees F]	P-1[b]	3/4 inch (20 mm) and smaller 1 inch (25 mm) to 6 inches (150 mm) 8 inches (200 mm) and larger	0.5 (13) 1.0 (25) 1.5 (40)

Condensate Piping from Cooling Coils	P-5	All sizes	0.5 (13)

Notes:

a. Not all insulation types listed are allowed in return air plenums. Insulation in air plenums must have a flame and smoke rating of 25/50 or less per ASTM E84.
b. Insulation type P-5, P-9, or P-10 may be used for piping installed outdoors. Install longitudinal seams on the bottom of the pipe to allow moisture to drain.

B. Heating Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPES	PIPE SIZE	INSULATION THICKNESS inches (mm)
Heating Water Supply and Return [105 to 140 degrees F (40 to 60 degrees C)]	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.0 (13) 1.5 (25)
Heating Water Supply and Return [141 to 200 degrees F (61 to 93 degrees C)]	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.5 (25) 2.0 (40)
Heating Water Supply and Return [201 to 250 degrees F (94 to 121 degrees C)]	P-1	3 inches (76 mm) and smaller 4 inches (100 mm) and larger	2.5 (40) 3.0 (50)
Humidifier Supply Piping	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.5 (40) 2 (50)
Humidifier Drain Piping	P-1	All sizes	1 (25)

C. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE(S)[c,d]	INSULATION THICKNESS inches (mm)
Minimum R-Values to comply with the latest adopted year of ASHRAE/IESNA 90.1 based on Climate Zone and Duct Location. If not adopted, utilize 90.1-2016 values: Exterior Ducts: E-12, Fully Ducted Plenums: R-6, Un-ducted (Return Air Plenums: R-1.9		
All Supply Ducts in Hospital Applications (externally insulated)[f]	D-1[e]	1.5 (40)
Return Ducts in Hospital Applications (Note: Special situations have lower return air temperatures. Refer to the return insulation requirements for low temperature return below)	None	None

Return Ducts in Hospital Applications with Low Temperature Return Air (Spaces with an indoor cooling design temperature setpoint of 68 degrees or lower require insulation similar to that of supply ductwork. Some typical spaces that could fall into this requirement are operating rooms, compounding pharmacies, etc.)	D-1[e]	1.5 (40)
All Supply and Return Ducts Exposed to Outdoor Air[d] or Exterior to Building[b] in Hospital Applications	D- 1[e]	3.0 (76)
Exhaust Fan Discharge Ducts Between the Backdraft/Isolation Damper and the Exterior Opening	D-1[e]	1.5 (40)
Rectangular Exhaust Ducts for Last 15 Feet Before Fan In all Directions[a]	D-4	0.5 (13)
Exhaust Ducts Exposed to Outdoor Air[d] or Exterior to Building[b]	D-1[e]	2.0 (50)
Rectangular Transfer Air Ducts (internally insulated)[a]	D-4	1.0 (25)
Duct Coils and Heating Coils on VAV, CV and FTU Terminal Units (Entire coil must be insulated, including casing, header and return bends)	D-1	1.5 (40)

Notes:

a. Line exhaust ductwork only in clean air exhaust applications. In applications containing fumes, grease, dirt or water vapor, the internal liner shall be omitted.
b. For ductwork installed exterior to building, furnish and install weatherproof jacket.
c. Factory-insulated dual-wall ductwork is not required to be field insulated.
d. Examples of spaces exposed to outdoor air include ventilated attics, mechanical rooms with louvered openings directly to the outdoors, etc.
e. Where rectangular ducts are exposed to view (including mechanical rooms), substitute D-2 for D-1.
f. Internal duct liner is not allowed in the supply or return ductwork in hospital applications.

END OF SECTION 23 07 00

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. HVAC commissioning description.
   2. HVAC commissioning responsibilities.

B. Related Sections:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Division, may contain requirements that relate to this section.

1.02 REFERENCES

A. Associated Air Balance Council:
   1. AABC - AABC Commissioning Guideline.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE Guideline 1 - The HVAC Commissioning Process.

C. National Environmental Balancing Bureau:
   1. NEBB - Procedural Standards for Building Systems Commissioning.

1.03 COMMISSIONING DESCRIPTION

A. HVAC commissioning process includes the following tasks:
   1. Testing and startup of HVAC equipment and systems.
   2. Equipment and system verification checks.
   3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
   4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
   5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
   6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
   7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
   8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
   9. Provide training for systems specified in this Section with coordination by Commissioning Authority.

B. Equipment and Systems to Be Commissioned:
   1. Pumps.
   2. Piping systems.
   3. Ductwork.
   4. Variable frequency drives.
   5. Fan Coil Units.
   6. Hot water terminal heating equipment.

7. Unit heaters.
8. Heat exchangers.
9. Constant volume terminal units.
10. Variable volume terminal units.
11. Fire dampers.
12. Smoke dampers.
13. Indoor air quality.
14. Equipment sound control.
15. Equipment vibration control.
16. Egress pressurization.
17. Smoke evacuation system.
18. Automatic temperature control system.
19. Testing, Adjusting and Balancing work.

1.04 COMMISSIONING SUBMITTALS

A. Draft Forms: Submit draft of system verification form] [and] [functional performance test checklist.

B. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified.

C. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

1.05 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.

B. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with NEBB.

1.07 COMMISSIONING RESPONSIBILITIES

A. Equipment or System Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
4. Provide instructions and demonstrations for Owner's personnel.
5. Ensure subcontractors perform assigned commissioning responsibilities.
6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
7. Develop startup and initial checkout plan using manufacturer’s startup procedures and functional performance checklists for equipment and systems to be commissioned.
8. During verification check and startup process, execute HVAC related portions of checklists for equipment and systems to be commissioned.
9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
10. Provide manufacturer’s representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.

11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
15. Provide factory supervised startup services for equipment and systems specified in Section their respective sections. Coordinate work with manufacturer and Commissioning Authority.
16. Perform verification checks and startup on equipment and systems as specified.
17. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
18. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
19. Conduct HVAC system orientation and inspection.

B. Temperature Controls Installer Commissioning Responsibilities:
1. Attend commissioning meetings.
2. Review design for ability of systems to be controlled including the following:
   a. Confirm proper hardware requirements exists to perform functional performance testing.
   b. Confirm proper safeties and interlocks are included in design.
   c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
   d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
   e. Confirm sensors selected are within device ranges.
   f. Review sequences of operation and obtain clarification from Architect/Engineer.
   g. Indicate delineation of control between packaged controls and building automation system, listing BAS monitor points and BAS adjustable control points.
   h. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.
3. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.
4. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Commissioning Authority and Architect/Engineer.
5. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
6. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan.
7. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
8. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
9. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.

10. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

C. Testing, Adjusting, and Balancing Agency Commissioning Responsibilities:
1. Attend commissioning meetings.
2. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample of 10 percent of measurements contained in testing, adjusting, and balancing report as selected by Commissioning Authority.
3. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

1.08 COMMISSIONING MEETINGS

A. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.09 SCHEDULING

A. Prepare schedule indicating anticipated start dates for the following:
1. Piping system pressure testing.
2. Piping system flushing and cleaning.
3. Ductwork cleaning.
4. Ductwork pressure testing.
5. Equipment and system startups.
6. Automatic temperature control system checkout.
7. Testing, adjusting, and balancing.
8. HVAC system orientation and inspections.
9. Operation and maintenance manual submittals.
10. Training sessions.

B. Schedule seasonal tests of equipment and systems during peak weather conditions to observe full-load performance.

C. Schedule occupancy sensitive tests of equipment and systems during conditions of both minimum and maximum occupancy or use.

1.10 COORDINATION

A. Notify Commissioning Authority minimum of four weeks in advance of the following:
1. Scheduled equipment and system startups.
2. Scheduled automatic temperature control system checkout.
3. Scheduled start of testing, adjusting, and balancing work.

B. Coordinate programming of automatic temperature control system with construction and commissioning schedules.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required by commissioning plan.

B. Place HVAC systems and equipment into full operation and continue operation during each working day of commissioning.

C. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.

D. Install test holes in ductwork and plenums as requested by Commissioning Authority for taking air measurements.

E. Prior to start of functional performance test, install replacement filters in equipment.

3.02 COMMISSIONING

A. Seasonal Sensitive Functional Performance Tests:

1. Test heating equipment at winter design temperatures.
2. Test cooling equipment at summer design temperatures with fully occupied building.
3. Participate in testing delayed beyond Final Completion to test performance at peak seasonal conditions.

B. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.

C. Occupancy Sensitive Functional Performance Tests:

1. Test equipment and systems affected by occupancy variations at minimum and peak loads to observe system performance.
2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.

END OF SECTION 23 08 00

SECTION 23 09 00
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes control equipment and installation for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-furnished controls.

1.02 RELATED DOCUMENTS

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

1. Section 013300 – Submittal Requirements.
2. Section 230800 – Commissioning of HVAC.
3. Section 230500 – Common Work Results for HVAC.
4. Section 230593 – Testing, Adjusting, and Balancing for HVAC.
5. Section 260500 – Common Work Results for Electrical.
6. Section 260519 – Low Voltage Electrical Power Conductors and Cables.
7. Section 260533 – Raceway and Boxes for Electrical Systems.
8. Section 262923 – Motor Controllers.
9. Section 262900 – Motors.

1.03 DEFINITIONS

A. BACnet: An industry standard data communication protocol for Building Automation and Control Networks. Refer to AHSRAE standard 135-2010.

B. BIBB: BACnet Interoperability Building Blocks.

C. DDC: Direct digital controls.

D. IP: Internet Protocol.

E. I/O: Input/Output.

F. LAN: Local area network.

G. TCP: Transfer Control Protocol.

H. LonTalk: Communications based on the EIA-709.1.

I. SNVT: LonTalk standard network variable.

J. Scope Terminology.

1. Provide = Furnish equipment, engineer, program and install.
2. Furnish = Furnish equipment, engineer, and program.
3. Mount = securely fasten or pipe.
4. Install = mount and wire.
5. Wire = wire only.

1.04 SYSTEM DESCRIPTION

A. System Communications.

1. Each workstation, building controller, and equipment controller communication interface shall utilize the BACnet™ protocol with an Ethernet (IEEE 802.3, 802.11), RS485 (EIA-485), or Zigbee® (802.15.4) physical interface and an appropriate data link technology as defined in ANSI®/ASHRAE® Standard 135-2012. (e.g. BACnet over IP, BACnet over IPv6, BACnet over MS/TP, BACnet Zigbee).
2. All system controllers shall be BTL listed as a BACnet Building Controller (B-BC) as defined in ANSI®/ASHRAE® Standard 135-2012.

3. All documented status and control points, schedule, alarm, and data-log services or objects shall be available as standard object types as defined in ANSI®/ASHRAE® Standard 135-2012.
4. Each System Controller shall communicate with a network of Custom Application and Application Specific Controllers utilizing one or more of the interfaces documented within Field Bus Communications below.

B. Field Bus Communications
1. BACnet™.
a. All equipment and plant controllers shall be BTL listed as a BACnet Application Specific Controller (B-ASC) or a BACnet Advanced Application Controller (B-AAC) as defined in ANSI®/ASHRAE® Standard 135-2012.
b. All communication shall conform to ANSI®/ASHRAE® Standard 135-2012.
c. System Controller shall function as a BACnet router to each unit controller providing a globally unique BACnet Device ID for all BACnet controllers within the system.
d. BACnet over Zigbee®.
1) Communication between System Controller and equipment/plant controllers shall utilize BACnet over Zigbee as defined in ANSI®/ASHRAE® Standard 135-2012.
2) Each equipment controller wireless communication interface shall self-heal to maintain operation in the event of network communication failure.
3) Each zone sensor wireless communication interface shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications. Sensing options shall include temperature, relative humidity, C02, and occupancy.
e. BACnet over MS/TP.
1) Communication between System Controller and equipment/plant controllers shall utilize BACnet over MS/TP as defined in ANSI®/ASHRAE® Standard 135-2012.

C. Provide standalone controls called for on the drawings or sequences.

1.05 WORK INCLUDED

A. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer.

B. The Facility Management System is already existing and has the capacity for expansion to integrate new equipment and control systems. System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving. The Contractor shall provide products compatible with the existing control system:
1. Provide a submittal that meets the requirements below for approval.
2. Coordinate installation schedule with the mechanical contractor and general contractor.
3. Provide installation of all panels and devices unless otherwise stated.
4. Provide all low voltage (less than 50v) control wiring for the DDC system.
5. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
6. Participate in commissioning for all equipment that is integrated into the BAS (Refer to Commissioning sections of the equipment or systems in other parts of this specification.)
7. Provide testing, demonstration and training as specified below.

1.06 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 5 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 5 seconds.
3. Object Command: Reaction time of less than 5 seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within 5 seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 2 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Programmable controllers shall execute DDC PI control loops, and scan and update process values and outputs at least once per second.
7. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
   a. Water Temperature: Plus or minus 1 deg F.
   b. Water Flow: Plus or minus 5 percent of full scale.
   c. Water Pressure: Plus or minus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F.
   e. Ducted Air Temperature: Plus or minus 1 deg F.
   f. Outside Air Temperature: Plus or minus 2 deg F.
   g. Dew Point Temperature: Plus or minus 3 deg F.
   h. Temperature Differential: Plus or minus 0.25 deg F.
   i. Relative Humidity: Plus or minus 2 percent.
   j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
   k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
   l. Airflow (Terminal): Plus or minus 10 percent of full scale.
   m. Air Pressure (Space): Plus or minus 0.01-inch wg.
   n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
   o. Carbon Monoxide: Plus or minus 5 percent of reading.
   p. Carbon Dioxide : Plus or minus 50 ppm.
   q. Electrical: Plus or minus 5 percent of reading.

1.07 SUBMITTALS

A. Provide submittals for fast-track items that need to be approved and released to meet the schedule of the project. Provide submissions for the following items separately:
   1. Valve schedule and cut sheets including size, pipe size, pressure drop, close off pressure, Cv and voltage.
   2. Damper schedule and cut sheets and actuators including size, actuator torque, voltage, and flow characteristics.
   3. Thermostat locations.

B. Provide a complete submittal with all controls system information for approval prior to construction. Include the following:
   1. Schematic flow diagrams showing coils, dampers, valves, and control devices.
   2. Wiring Diagrams: Power, signal, and control wiring.
   3. Details of control panel, including arrangement of gutters, conduits, Panduit, power supplies, transformers, convenience receptacles, control hardware, instruments, and labeling.

4. If dampers are furnished by other, submit a damper actuator schedule coordinating actuator sizes, torque rating and voltage with the damper schedule. Schedule must include damper size and minimum actuator torque, and normal position.
5. Written description of the Sequence of Operations.
6. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses and/or device instance numbers. Show all routers, switches, hubs, and repeaters.
7. Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device. Refer to points summary shown on control details.
8. Points list containing alarm definitions including type, threshold limits, return to normal, delays, modes, and parent points. Refer to points summary shown on control details.
9. Points list containing trend definitions including type, number of samples, and intervals. Refer to points summary shown on control details.
10. Reduced size floor plan drawings showing locations of control panels, thermostats and any devices mounted in occupied space.
11. Factory mounting and wiring diagrams and cut sheets
12. Floor plan showing proposed communications cable routing.
13. Once control system has been started, submit completed point to point I/O report.
14. Submit training agenda as described in part 3 sections.

C. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated. Submit a write-up of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.

D. Wiring Diagrams: Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.

E. Variance letter: Submit a letter detailing each item in the submission that varies from the contract specification or sequence of operation in any way.

1.08 QUALITY ASSURANCE

A. Codes

1. Perform all wiring in accordance with Division 26, NEC, local codes, and Owner’s requirements.
2. International Building Code (IBC).
3. International Energy Code.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
5. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
6. Comply with ASHRAE 135-2010 BACNet: A Data Communication Protocol for Building Automation and Control Networks.
7. All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards, including UL 916 - PAZX Energy Management Systems.
8. Provide UL 864 – UUKL Smoke Control, where controllers and networks are used for that purpose.
   a. Provide written approvals and certifications after installation has been completed.

9. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

B. Qualifications.

1. Installer Qualifications: An experienced installer who is the authorized representative of the building automation system manufacturer for both installation and maintenance of controls required for this Project.
2. Engineering, drafting, programming, and graphics generation shall be performed by the local branch engineers and technicians directly employed by the Building Automation System Contractor.
3. Supervision, checkout, and commissioning of the system shall be by the local branch engineers and technicians directly employed by the Building Automation System Contractor. They shall perform commissioning and complete testing of the BAS system.

C. The BAS contractor shall maintain a service organization consisting of factory trained service personnel and provide a list of ten (10) projects, similar in size and scope to this project, completed within the last five years.

D. Final determination of compliance with these specifications shall rest solely with the Engineers and Owner who will require proof of prior satisfactory performance.

E. For any BAS system and equipment submitted for approval, the BAS contractor shall state what, if any, specific points of system operation differ from these specifications.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 COORDINATION

A. Coordinate location of thermostats, humidistats, panels, and other exposed control components with plans and room details before installation.

B. Coordinate equipment with Section 260000 "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate power for control units and operator workstation with electrical contractor.

D. Coordinate scheduling with the mechanical contractor and general contractor. Submit a schedule for approval based upon the installation schedule of the mechanical equipment.

E. Products Furnished but Not Installed Under This Section

1. Hydronic Piping:
   a. Control Valves.
   b. Temperature Sensor Wells and Sockets.
   c. Flow Switches.
   d. Flow Meters.
2. Sheetmetal accessories.
   a. Dampers.

F. Integrate to equipment as called for in the automation riser details and sequence of operations.

1.11 WARRANTY

A. Conform to the warranty requirement of the Contract Documents, General Requirements and this section or a minimum of 12 months from owner acceptance.

B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of three years from completion of system demonstration.

C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.

D. During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner's Representative.

E. This warranty shall apply equally to both hardware and software.

PART 2 PRODUCTS

2.01 ACCEPTABLE SYSTEMS

2.02 BAS NETWORK

A. All networked control products provided for this project shall be comprised of an industry standard open protocol internetwork. Communication over ethernet between web server, user workstation and building control units shall conform to ASHRAE 135-2010 BACnet standard. Communication between equipment controllers and building level controllers shall be BACnet or LonTalk protocol over TP/FT-10 channel type using transceivers that conform to the ISO/IEC 14908-2 Free-Topology Twisted Pair Channel Specification.

B. Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BAS network shall be totally transparent to the user when accessing data or developing control programs.

1. Software applications, features, and functionality, including administrative configurations, shall not be separated into several network control engines working together.

C. Any break in Ethernet communication from the PC to the controllers on the Primary Network shall result in a notification at the PC.

D. BACnet MSTP Setup rules:

1. Addressing for the MSTP devices shall start at 00 and continue sequentially for the number of devices on the subnetwork.
2. No gaps shall be allowed in the addresses.
3. Set the MaxMaster property to the highest address of the connected device.
4. MaxMaster property shall be adjusted when devices are added to the subnetwork.
5. For existing networks, addressing must be approved by owner's representative.

E. Application specific controllers for smaller single zone, supplemental or special systems can reside on the BACnet/IP network or on a subnetwork.

F. Floor level controllers, terminal units, auxiliary equipment, meters shall reside on one of the subnetworks above.

G. Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for the internetwork.

H. Use fiber optic cabling for all Ethernet runs longer than 300 ft and between buildings.

I. Controllers and software shall be BTL or LonMark listed at the time of installation.

J. The system shall meet peer-to-peer communication services such that the values in any one enterprise or AAC level controller can be read or changed from all other controllers with the need for intermediary devices. The software shall provide transparent transfer of all data, control programs, schedules, trends, and alarms from any one controller through the internetwork to any other controller, regardless of subnetwork routers.

K. Systems that use variations of BACnet using Point-to-Point (PTP) between controllers, gateways, bridges, or networks that are not peer-to-peer are not allowed.

L. Remote Communications: Provide a TCP/IP compatible communication port for connection to the Owner's network for remote communications. Remote communications must be capable of viewing entire system from a single IP address. Viewing via multiple connections is not acceptable. Provide coordination with the Owner for addressing and router configuration on both ends of the remote network.

M. Where a smoke control application is required, provide UUKL listed network switches, and NFPA approved cabling, enclosures, and installation methods.

N. The system shall be installed with a 30% spare capacity on each subnetwork for the addition of future controllers.

2.03 DISTRIBUTED CONTROL REQUIREMENTS

A. The loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.

B. The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.

C. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming, and trending function, or any function at any operator interface device.

D. VAV boxes subnetworks shall be connected to the AHU controller that feeds those boxes. If multiple subnetworks are needed, then the VAV shall be grouped into subnetworks in an orderly method, such as per floor, per wing, etc. No subnetworks may attach more than 30 devices.

E. Remote sensors shall be wired to the control panel of the equipment it is controlling, not across the network.

F. Signals to remote motor control centers shall be hard wired to the control panel, not across the network.

G. Terminal units shall each have their own controller. Only exceptions are:

1. Auxiliary heating coils.
2. Groups of exhaust fans.

2.04 ELECTRONIC DOCUMENTATION

A. Provide all controls cut sheets in PDF format. Make them available to any user accessing the system over the Internet.

B. Provide a text version of the sequence of operation. Make the written sequence available from the graphic that represents each system. The sequence shall pop up in a printable format such as HTML or PDF.

2.05 APPLICATION SPECIFIC CONTROLLERS

A. Each Application-Level Control Panel shall operate as a stand-alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each application specific controller shall be a microprocessor-based, multi-tasking, real-time digital control processor.

B. This controller shall have the LonMark or BTL listing.

C. The following types of equipment (if applicable):

1. Constant Air Volume (CAV) boxes
2. Variable Air Volume (VAV) boxes.
3. Other terminal equipment.

D. Each Application Specific Controller shall, at a minimum, be provided with:

1. Power supplies as required for all associated modules, sensors, actuators, etc.
2. Software as required for all sequences of operation, logic sequences and energy management routines.
3. A portable operator terminal connection port.
4. Each controller measuring air volume shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time.
5. Each controller measuring air volume shall include a differential pressure transducer.
6. Approvals and standards: UL916; CE; FCC.

E. Each Application Specific Controller shall continuously perform self-diagnostics on all hardware and secondary network communications. The Application Specific Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failure to establish communication to the system.

F. Provide each Application Specific Controller with sufficient memory to accommodate point databases, operating programs, local alarming, and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.

G. The Application Specific Controller shall be powered from a 24 VAC source provided by this contractor and shall function normally under an operating range of 18 to 28 VAC (-25% to +17%), allowing for power source fluctuations and voltage drops. Install plenum data line and sensor cable in accordance with local code and NEC. The controllers shall also function normally under ambient conditions of 32 to 122 F and 10% to 95%RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

2.06 ROUTERS

A. Provide a router for each subnetwork to connect the floor level network to the base building backbone level network. The router shall connect BACnet subnetworks to BACnet over Ethernet.

B. The router shall be capable of handling all of the BACnet objects, Layers and protocols that are listed for the controller that reside on the subnetwork.

C. ZigBee wireless communications operating at 2.4 GHz or 915 MHz complying with IEEE 802.15.4

2.07 GENERAL SPECIFICATIONS FOR DEVICES

A. Provide mounting hardware for all devices, including actuator linkages, wells, installation kits for insertion devices, wall boxes and fudge plates, brackets, etc.

B. If a special tool is required to mount a device, provide that tool.

2.08 SENSORS

A. Terminal Unit Space Thermostats.

1. Each controller performing space temperature control shall be provided with a matching room temperature and humidity sensor.

a. Plain Space Temperature Sensors – Wired: Where called for in the sequences or on the drawings, provide sensors with plain covers. Wireless sensors may be used if requested in writing and approved by owner and engineer.

b. The sensing element for the space temperature sensor shall be thermistor type providing the following.

1)	Element Accuracy:	+ /- 1.0°F.
2)	Operating Range:	55 to 95°F.
3)	Set Point Adjustment Range:	55 to 95°F.
4)	Calibration Adjustments:	None required.
5)	Installation:	Up to 100 ft. from controller.
6)	Auxiliary Communications Port:	as required.
7)	Local LCD Temperature Display:	as required.
8)	Setpoint Adjustment Dial	as required.
9)	Occupancy Override Switch	as required.

c. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator’s terminal.

2. Digital Display temperature sensor specifications – Wired: Wireless sensors may be used if requested in writing and approved by owner and engineer.
   a. As called for in the sequences of operations or on the drawings, provide temperature sensors with digital displays.
   b. The sensing element for the space temperature sensor must be IC-based and provide the following.
      1) Digitally communicating with the Application Specific Controller.
      2) Mountable to and fully covering a 2 x 4 electrical junction box without the need for an adapter wall plate.
      3) IC Element Accuracy: +/- 0.9°F.
      4) Operating Range: 55 to 95°F.
      5) Setpoint Adjustment Range: User limiting, selectable range between 55 and 95°F.
      6) Display of temperature setpoint with numerical temperature values.
      7) Display of temperature setpoint graphically, with a visual Hotter/Colder setpoint indication.
      8) Display of relative humidity with numerical values.
      9) Calibration: Single point, field adjustable at the space sensor to +/- 5°F.
      10) Installation: Up to 100 ft. from controller.
      11) Auxiliary Communications Port: included.
      12) Local OLED Temperature Display: included.
      13) Display of Temperature to one decimal place.
      14) Temperature Setpoint Adjustment included.
      15) Occupancy Override Function included.
   c. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal. Alternatively, room temperature sensor may have wireless connectivity to tool software in lieu of aux communication port.
3. Provide the following options as they are called for in the sequences or on the drawings:
   a. Setpoint Adjustment. The setpoint adjustment function shall allow for modification of the temperature by the building operators. Setpoint adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.
   b. Override Switch. An override button shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to two (2) hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.
   c. Space Combination Temperature and Humidity Sensors. Each controller performing space temperature control shall be provided with a matching room temperature sensor, which also includes the ability to measure humidity for either monitoring or control purposes. The combination temperature and humidity sensors shall have the same appearance as the space temperature sensors. Humidity elements shall measure relative humidity with a +/- 2% accuracy over the range of 10 to 90% relative humidity. Humidity

element shall be an IC (integrated circuit) sensing element. Humidity sensing elements shall be removable and field replaceable if needed.

B. Temperature Sensors.
   1. All temperature sensors shall meet the following specifications:
      a. Accuracy: Plus or minus 0.2 percent at calibration point.
      b. Vibration and corrosion resistant.
   2. Space temperature sensors shall meet the following specifications:
      a. 10k ohm or higher type 2 thermistors.
   3. Insertion Elements in Ducts shall meet the following specifications:
      a. Single point 10k or 100k ohm thermistor.
      b. Use where not affected by temperature stratification.
      c. The sensor shall reach more than 1/3 the distance from the duct wall.
      d. Junction box for wire splices.
   4. Averaging Elements in Ducts shall meet the following specifications:
      a. 72 inches long.
      b. Flexible.
      c. Use where prone to temperature stratification, in front of coils, or where ducts are larger than 9 sq. ft.
      d. Junction box for wire splices.
   5. Insertion Elements for Liquids shall meet the following specifications:
      a. Platinum RTD with 4-20mA transmitter.
      b. Threaded mounting with matching well.
      c. Brass well with minimum insertion length of 2-1/2 inches for pipes up to 4” diameter.
      d. Brass well with insertion length of 6 inches for pipes up to 10” diameter.
      e. Junction box for wire splices.
   6. Outside-Air Sensors Platinum RTD with 4-20mA transmitter:
      a. Watertight enclosure, shielded from direct sunlight.
      b. Circulation fan.
      c. Watertight conduit fitting.

C. Where called for in the sequences of operations, provide the following feature on space sensors and thermostats:
   1. Security Sensors: Stainless-steel cover plate with insulated back and security screws
   2. Space sensors with setpoint adjust: Plain white plastic cover with slide potentiometer to signal a setpoint adjustment to the DDC.
   3. Space Sensors with LCD display:
      a. Operator buttons for adjusting setpoints, setting fans speeds and overriding unit to on/off.
      b. Graphical LCD icons for signaling heating/cooling mode, fans speed, schedule mode, actual temperature and current setpoint.

D. Humidity Sensors shall meet the following specifications:
   1. Bulk polymer sensor element.
   2. Accuracy: 2 percent full range with linear output.
   3. Room Sensors: With locking cover matching room thermostats, span of 0 to 100 percent relative humidity.
   4. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Air Static Pressure Transmitter shall meet the following specifications:
   1. Non-directional sensor with suitable range for expected input, and temperature compensated.
   2. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   3. Output: 4 to 20 mA.
   4. Building Static-Pressure Range: 0 to 0.25 inches wg.
   5. Duct Static-Pressure Range: 0 to 5 inches wg.
   6. Pre-Filter Range: 0 to 2 inches.
   7. Final Filter Range: 0 to 2 inches.

F. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

G. Electronic Valve/Damper Position indication: Visual scale indicating percent of travel. Feedback is required where multiple actuators share the same control signal.

H. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vapor proof type.

I. Air Differential Pressure Switches: Diaphragm type air differential pressure switches with die cast aluminum housing, adjustable setpoint, minimum 5-amp switch rating at 120VAC, SPDT switches, and the switch pressure range shall be suited for the application. Provide Dwyer or equal. These switches shall be utilized for filter status.

J. Leak detectors: Provide spot leak detectors that can be secured to the floor or secured to a drain pan. The detection shall use a microchip controlled energized probes. The detector shall operate on 24Vor less. Provide a way to adjust the height of the leak probes. The SPDT contacts shall be inside a watertight enclosure.

K. Current switches: Adjustable trip point. Detection of belt loss and motor failure and LED status. Dry contract output. Sizing according to motor load.

L. Turbine Flow Meter: ONICON MODEL F-1210 Dual Turbine. The flow meter shall be hand-insertable up to 400 psi. The flow meter shall have two contra-rotating axial turbines, with electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Wetted metal components shall be nickel-plated brass (unless optional 316 SS is otherwise specified). Optional 316 SS construction is required for HW applications operating over 250º F, and for any application in non-metallic pipe. The maximum operating temperature shall be 280º F, 300º F peak. Each flow meter shall be individually wet calibrated against a primary volumetric standard that is accurate to within ± 0.1% and traceable to N.I.S.T.*. The manufacturer's certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 0.5% of rate at the calibrated velocity, within ± 1% of rate over a 10:1 turndown (3.0 to 30 ft/s) and within ± 2% of rate over a 50:1 turndown (from 0.4 to 20 ft/s). The flow meter shall include two integral analog output(s), 4-20 mA, 0-10 V, (Optional 0-5 V). The flow meter shall be covered by the manufacturer's two-year warranty.

2.09 AUTOMATIC CONTROL VALVES

A. Manufacturers:
   1. Belimo.
   2. Siemens.
   3. Johnson Controls.
   4. Seibe Environmental.

B. General:
   1. All automatic control valves shall be fully proportioning, unless specified otherwise. The valves shall be quiet in operation and fail-safe in either normally open or normally closed position in the event of control air failure. All valves shall be capable of operating at varying

rates of speed to correspond to the exact dictates of the controllers and variable load requirements. The valves shall be capable of operating in sequence with other valves and/or dampers when required by the sequence of operation. All control valves shall be sized by the control vendor and shall be guaranteed to accommodate the flow rates as scheduled. All control valves shall be suitable for the pressure conditions and shall close against the differential pressures involved. Body pressure rating and connection type construction shall conform to fitting and valve schedules. Control valve operators shall be sized to close against a differential pressure equal to the design pump heads plus 10 percent.

2. Power for control valves, unless specifically stated otherwise, shall be 24VAC.
3. Cold water, and hot water, throttling type, and bypass valves shall have equal percentage flow characteristics. Full port ball valves are unacceptable.
4. Unless otherwise specified, control valves 2 inches and smaller shall have cast iron or bronze bodies with screwed NPT connections.
5. Valves between 2-1/2 inch and larger shall have cast iron bodies with flanged connections.
6. All automatic control valves installed exposed to the elements shall be provided with electric actuators with operating characteristics and accessories as described in herein. Actuators shall have NEMA 4X enclosure and heater to prevent condensation.
7. All automatic control valves controlled by the BAS shall be furnished by the controls contractor unless noted otherwise in these documents.
8. All automatic control valves shall be installed by the mechanical trade.
9. Sizing of modulating water control valves shall not cause a pressure drop exceeding 3.5 PSI.
10. The controls contractor shall provide wiring as follows:
    a. Power wiring for electric valve actuators shall be provided by the controls contractor and installed by a licensed electrician. Coordinate with electrical trade.
    b. All wiring between the central building automation system (BAS) and the valve actuator shall be wired by the controls contractor.
    c. All wiring between the valve actuator and their associated thermostats, pressure switches, control devices, etc. shall be wired by the controls contractor.
    d. All wiring shall comply with code requirements. Segregate high and low voltage wiring & circuits and segregate the FAS and controls (BAS) terminals.

C. Hot Water / Condenser Water / Control Valves
1. Single-seated.
2. Fully proportioning with modulating plug or V-port inner valves.
3. Body pressure rating and connection type construction shall conform to fitting and valve schedules. The ANSI rating of the valve shall match the ANSI rating of the piping in which the valve is installed. Minimum ANSI rating shall be ANSI 125.
4. Stainless steel stems and trim.
5. Spring loaded Teflon packing.
6. Quiet in operation.
7. Fail-safe in either normally open or normally closed position in the event of power failure.
8. Capable of operating in sequence with other valves and/or dampers when required by the sequence of operation.
9. Capable of operating at varying rates of speed to correspond to the exact dictates of the controller and variable load requirements.

D. Differential Pressure Control Valves:
1. Provide for all water systems where modulating water flow conditions are required to prevent excessive pump pressure build-up. Provide a valve for each closed loop water system.

Valve to be globe type. Provide valves 2" and smaller with screwed end bodies and provide valves 2-1/2" and larger with flanged ends.

E. Butterfly Valves.

1. Furnish automatic butterfly valves for isolation requirements as shown on the drawings or required herein.
2. Butterfly valves shall have body ratings in accordance with the piping specifications.
3. Valves that are in high static locations or where flanges are ANSI300 per the piping design shall be high performance, fully lugged with carbon steel body ANSI 300 as required by pipe specifications.
4. Valves that are in locations where ANSI150 flanges are allowed shall be ANSI 150 valves.
5. Valves shall be bubble tight with 316 stainless steel disc, stainless steel shaft and reinforced Teflon seat.
6. Actuators shall be fail in place with factory mounted open and closed position limit switches mounted.
7. Provide fail in place, electric actuators with waterproof enclosure and crankcase heater for actuator and accessories mounted outside.
8. Provide manual override hand wheels for each valve.
9. Butterfly valves will only be approved for cooling tower bypass and all two-position (open or close) applications.
10. Valves must have full lug type body connections.

2.10 ELECTRONIC ACTUATOR SPECIFICATION

A. Manufactures:

1. Belimo.
2. Siemens.
3. Johnson Controls.

B. ELECTRONIC VALVE ACTUATORS

1. Actuator shall be fully modulating, floating (tri-state), two position, and/or spring return as indicated in the control sequences. Specified fail safe actuators shall require mechanical spring return.
2. Modulating valves shall be positive positioning, responding to a 2-10VDC or 4-20mA signal. There shall be a visual valve position indicator.
3. The actuator shall have the capability of adding auxiliary switches or feedback potentiometer if specified.
4. Actuator shall provide minimum torque required for proper valve close-off. The actuator shall be designed with a current limiting motor protection. A release button (clutch) or handle on the actuator shall be provided to allow for manual override (except when actuator is spring return type).
5. Actuators shall be UL listed.

C. ELECTRONIC DAMPER ACTUATORS

1. Actuator shall be direct coupled (over the shaft), enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator-to-shaft clamp shall use a "V" bolt and "V" shaped, toothed cradle to attach to the damper shaft for maximum holding strength. Single bolt or set screw type fasteners are not acceptable.
2. Actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. End switches to deactivate the actuator at the end of rotation or magnetic clutch are not acceptable.
3. For power-failure/safety applications, a mechanical, spring return mechanism shall be used.

4. Actuators with spring return mechanisms shall be capable of either clockwise or counter-clockwise spring return operation by simply changing the mounting orientation.
5. Proportional actuators shall accept a 2-10VDC, 4-20mA signal
6. All actuators shall have an external manual gear release (clutch) or manual crank to aid in installation and for allowing manual positioning when the actuator is not powered.
7. All actuators shall have an external direction of rotation switch to aid in installation and to allow proper control response.
8. Actuators shall be provided with a factory-mounted 3-foot electrical cable and conduit fitting to provide easy hook-up to an electrical junction box.
9. Actuators shall be listed under Underwriters Laboratories Standard 873 and Canadian Standards Association. They must be manufactured under ISO 9001.
10. Dampers actuators shall be sized for not less than 7 in-lbs. per square foot of damper section.

PART 3 EXECUTION

3.01 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.02 INSTALLATION

A. Provide all relays, switches, sources of emergency and UPS battery back-up electricity and all other auxiliaries, accessories, and connections necessary to make a complete operable system in accordance with the sequences specified. All field wiring shall be by this contractor.

B. Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.

C. Mount surface-mounted control devices on brackets to clear the final finished surface on insulation.

D. Install equipment level and plumb.

E. Install control valves horizontally with the power unit up.

F. Unless otherwise noted, install wall mounted thermostats and humidistat 48" above the floor measured to the center line of the instrument but level with adjacent light switching devices. or as otherwise directed by the Architect.

G. Install averaging elements in ducts and plenums in horizontal crossing or zigzag pattern.

H. Install damper motors on outside of duct in protected areas, not in locations exposed to outdoor temperatures.

I. Install labels and nameplates on each control panel listing the name of the panel referenced in the graphics and a list of equipment numbers served by that panel.

J. Furnish hydronic instrument wells, valves, and other accessories to the mechanical contractor for installation.

K. Furnish automatic dampers to mechanical contractor for installation.

3.03 ELECTRICAL WIRING SCOPE

A. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.

1. Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.

B. This contractor shall not be responsible for power to control panels and control devices that are furnished by others unless it is part of the control interlock wiring.

C. Refer to Coordination section for what devices this contractor is responsible to mount, and which are turned over to others to mount.

D. This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.

E. Wiring for controls furnished by others:

1. Provide control wiring for HVAC controls furnished by others. Wiring may include, but not limited to, the following items:
   a. Thermostats.
   b. Leak detectors.
   c. Humidifier controls.
   d. Manual switches for HVAC equipment (not shown on electrical drawings).
   e. Emergency shutdown switches (not shown on electrical drawings).

F. Provide network wiring for equipment that is called to be integrated to the BAS.

3.04 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. All low voltage control wiring shall be class 2. Control wiring that is not class 2 shall be run in separate conduits from class 2 wiring.

B. Floor level network wiring between terminal units can be combined with thermostat and other low voltage wiring in the same conduit. All other network wiring shall be in dedicated conduits.

C. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."

D. Install building wire and cable according to Division 26 Section "Conductors and Cables."

E. Installation shall meet the following requirements:

1. Conceal cable and conduit, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway or conduit.
3. Install concealed cable using plenum rated cable.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of building automation system, except local individual room control cables.
7. All wiring in lab areas shall be in conduit.
8. All unsupported risers shall be rigid steel conduit. Supported risers shall be EMT.

F. Raceway located outdoors shall be in rigid conduit shall be steel, hot dip galvanized, threaded with couplings, ¾ inch minimum size, manufactured in accordance with ANSI C-80-1. Electrical metallic tubing (EMT) with compression fittings or intermediate metallic conduit (IMC) may be used as conduit or raceway where permitted by the NEC.

G. Concealed control conduit and wiring shall be provided in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90 degree angles.

H. Install conduit adjacent to machine to allow service and maintenance.

I. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

J. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

K. Ground equipment.

3.05 COMMUNICATION WIRING

A. Network cable jacket color must meet owner cable standards. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

B. Do not install communication wiring in raceway and enclosures containing Class 1 wiring.

C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

D. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

E. Cable bundling:

1. Cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.
2. Cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.
3. Cabling run between floors shall be in a communication only conduit.
4. Conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.
5. Ethernet cabling shall be in a communication only conduit.
6. Fiber optics can be run with Ethernet and RS485/ TP/FT-10 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.

F. RS485 Cabling

1. RS485 shall use plenum rated low capacitance, 20-24 gauge, twisted shielded pair.
2. The shields shall be tied together at each device.
3. The shield shall be grounded at one end only and capped at the other end.
4. Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.

G. TP/FT-10 channel type Cabling:

1. Uses transceivers that conform to the ISO/IEC 14908-2 Free-Topology Twisted Pair Channel Specification.

H. Ethernet Cabling

1. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
2. CAT5e or CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
3. Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.
4. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.

I. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.

J. All runs of communication wiring shall be unspliced length when that length is commercially available.

K. All communication wiring shall be labeled to indicate origination and destination data. All communication wiring must have a purple jacket.

L. Grounding of coaxial cable shall be in accordance with NEC regulations article on “Communications Circuits, Cable, and Protector Grounding.”

3.06 IDENTIFICATION

A. Control Equipment and Device labeling:

1. Labels and tags shall match the unique identifiers shown on the as-built drawings.
2. All Enclosures shall be labeled to match the as-built drawing by either control panel name or the names of the DDC controllers inside.
3. All sensors and actuators shall be labeled.
4. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.
5. Duct static pressure taps shall be tagged at the location of the pressure tap.
6. Each device inside enclosures shall be tagged.
7. Terminal equipment need only have a tag for the unique terminal number, not for each device. Match the unique number on:
   a. First, the design drawings, or
   b. Second, the control as-builts, or
   c. Third, the DDC addressing scheme.
8. Tags on the terminal units shall be displayed on the Operator Workstation Graphics.

B. Tags shall be mechanically printed on permanent adhesive backed labeling strips, 12-point height minimum. Refer to Specification Section 230553 “Identification for HVAC Piping and Equipment.”

C. Manufacturers’ nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

D. Identification of Wires

1. Tag each wire with a common identifier on each end of the wire, such as in the control panel and at the device termination. Use shrink wrap labels.
2. Tag each network wire with a common identifier on each end. Network cabling must be in purple jackets.
3. Tag each 120V power source with the panel and breaker number it is fed by.

E. Identification of Conduits:

1. Identify the low voltage conduit runs as BAS conduit, power feeds not included.
2. Identify each electric box, junction box, utility box and wiring tray with a blue paint mark or blue permanent adhesive sticker.
3. For conduit runs that run more than 8 ft between junction boxes in 1 room, place a blue identifier at least every 8 feet.
4. Place a blue identifier on each side of where a conduit passed through a wall or other inaccessible path.
5. Identify all BAS communication conduits the same as above.

3.07 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

B. Replace damaged or malfunctioning controls and equipment.
1. Start, test, and adjust building automation systems.
2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.08 DDC TEMPERATURE CONTROLS CONTRACTOR (TCC) BALANCER COORDINATION

A. First Day: The TCC shall have a technical representative present with the Balancer on the first day of balancing for a minimum of 4 hours of active balancing - temperature controls coordination.

B. Remainder of Balancing: The TCC shall either:
1. Have a technical representative continuously present at each step of the continuation of the balancing OR
2. Furnish the Balancer with the latest DDC software and any required interface device for the duration of the balancing process. This option includes instructing the Balancer in the use of the software until the Balancer is proficient in the use of the software. Software and interface device shall be returned to TCC when balance report has been accepted. There shall be no charge to the owner or to the Balancer for the use of the software, OR
3. Furnish the Balancer with the latest DDC software and any required interface device, and a portable computer for the duration of the balancing process. This option includes instructing the Balancer in the use of the portable computer and the software until the Balancer is proficient in the use of the software. Portable computer, interface device, and software shall be returned to the TCC when balance report has been accepted. There shall be no charge to the Owner or to the Balancer for the use of the software or portable computer.

3.09 SYSTEM CHECKOUT AND STARTUP

A. Inspect each termination in the control panels and devices to make sure all wires are connected according to the wiring diagrams and all termination are tight.

B. After the controls devices and panels are installed and power is available to the controls, perform a static checkout of all the points, including the following. Submit a Point-To-Point report to the engineer including BAS values, measured values, successful function and issues found:
1. Inspect the setup and reading on each temperature sensor against a thermometer to verify its accuracy.
2. Inspect the setup and reading on each humidity sensor against a hygrometer to verify its accuracy.
3. Inspect the reading of each status switch to verify the DDC reads the open and close correctly.
4. Command each relay to open and close to verify its operation.
5. Command each 2-position damper actuator to open and close to verify operation.
6. Command each 2-position valve to open and close to verify operation.
7. Ramp each modulating actuator to 0%, 25%, 50%, 75% and 100% to verify its operation.
8. Ramp each modulating output signal, such as a VFD speed, to verify its operation.
9. Test each safety device with a real life simulation, for instance check freezestats with ice water, water detectors with water, etc.

C. Document that each point was verified and operating correctly. Correct each failed point before proceeding to the dynamic startup.

D. Verify that each DDC controller communicates on its respective network correctly.

E. After all of the points are verified, and power is available to the mechanical system, coordinate a startup of each system with the mechanical contractor. Include the following tests:
   1. Start systems from DDC.
   2. Verify that each setpoint can be met by the system.
   3. Change setpoints and verify system response.
   4. Change sensor readings to verify system response.
   5. Test safety shutdowns.
   6. Verify time delays.
   7. Verify mode changes.
   8. Adjust filter switches and current switches for proper reactions.
   9. Adjust proportional bands and integration times to stabilize control loops.

F. Perform all program changes and debugging of the system for a fully operational system.

G. Verify that all graphics at the operator workstations correspond to the systems as installed. Verify that the points on the screens appear and react properly. Verify that all adjustable setpoints and manual commands operate from the operator workstations.

H. Setup and test alarms described in the sequence of operation and points summary.

I. After the sequence of operation is verified, setup the trends that are listed in the sequence of operations and points summary for logging and archiving.

3.10 SYSTEM COMMISSIONING, DEMONSTRATION AND TURNOVER

A. At the time of project turnover, time schedules, alarm definitions and trend history definitions must be defined and programmed.
   1. Time schedules:
      a. Define multiple schedules. As a minimum, schedule shall be defined as follows, owner request additional schedules be defined. All schedules may be linked to a master schedule for the building.
         1) Patient Rooms.
         2) Clean/Soiled Rooms.
         3) Waiting Room.
         4) Storage Areas.
         5) Office Areas.

B. Integrations will have the following meet the following conditions
   1. All physical I/O must be reflected in the graphical environments
   2. Objects shall be mapped with both read and write capabilities to the extent possible. Minimum write points are as follows.
      a. Occupied mode.
      b. Unoccupied mode.
      c. Room setpoint (or room setpoint parameters).
   3. All control loop setpoints shall be unbundled/mapped and reflected in the graphical environment. Some examples of control loop setpoints are:
      a. Room occ temp setpoint.
      b. Room unocc cooling setpoint.
      c. Room unocc heating setpoint.
      d. Room occ max setpoint.
      e. Room occ min setpoint.
      f. Discharge temp setpoint.

g. Fan speed setpoint.
h. Bldg. pressure setpoint.
i. VAV cool min flow setpoint.
j. VAV cool max flow setpoint.
k. VAV heat min flow setpoint.
l. VAV heat max flow setpoint.

4. All modes points will be reflected in the graphical environments.
   a. Occupied mode.
   b. Unoccupied mode.
   c. Dehum mode.
5. Optimization sequences present in the parent system shall be implemented in integrated systems.
   a. Pressure reset based on damper position
   b. Discharge temp reset based on valve or damper position or outside air condition
   c. Warmup based on room temp, time schedule and mass algorithm
   d. Central plant or Air handler notification of heat/cool request
6. Alarm notifications shall occur as defined in district standard details.
   a. Alarm modes, time delays and parent systems shall be observed to prevent nuisance alarms.
   b. All alarms will exist in the parent system. Alarm objects within the integrated system's environment may are not acceptable.

C. Functional Testing: The BAS Contractor shall demonstrate functional aspects for the owner engineer testing all aspects of controls operation including modes, control loops, alarm functions, trending, and time of day scheduling. This process will occur until engineer and owner acceptance has been obtained.

D. Building Automation System Commissioning: If specified, the BAS contractor shall conduct functional testing in accordance with commissioning specifications.
   1. 230800 Commissioning of HVAC.

E. The BAS contractor shall fix punch list items within 30 days of acceptance.

F. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

G. User Occupancy Meeting: The BAS contractor shall prepare documentation describing thermostat operation, thermal zoning, and user operation for owners use during user occupancy presentation.

H. Pre - User Occupancy Testing: Prior to user occupancy and after testing and balance activities are complete, BAS contractor shall conduct a pre-user occupancy test period that last one week. During the test period BAS contractor defines temporary trending and alarm conditions (beyond what has been specified) in an attempt to verify operation and reveal hidden functional issues. Contractor will call the project each day for 1 full week to check trending, alarms, and search for issues. At the end of the week, BAS contractor shall submit to engineer for review observations made during the week and trend documentation showing issues or function.

I. Post user occupancy Monitoring: Temporary trending and alarms are removed and for a period of one month, the BAS contractor calls the project each morning and searches for issues such as untuned loops, poor system response, temperature, humidity, or pressure that are out of range. In addition, BAS contractor optimizes system setpoints for efficiency comfort. During the user occupancy monitoring period, BAS contractor submits to the engineer, weekly reports containing observations on his activities.

3.11 PROJECT RECORD DOCUMENTS

A. Project Record Documents: Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:

1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11 x 17 inch prints.
2. Testing and Commissioning Reports and Checklists submitted electronically in PDF format. Completed versions of reports, checklists, and trend logs used to meet requirements in the Building Automation system Demonstration and Acceptance section of this specification.
3. Operation and Maintenance (O & M) Manual submitted electronically in PDF format.
    a. As-built versions of the submittal product data.
    b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and building automation systems.
    c. Operator's Manual with procedures for operating building automation systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
    d. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
    e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
    f. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
    g. Graphic files, programs, and database on electronic media.
    h. List of recommended spare parts with part numbers and suppliers.
    i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
    j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
    k. Licenses, guarantees, and warranty documents for equipment and systems.

B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system submitted electronically in PDF format. As a minimum include the following:

1. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.
2. Description of manual override operation of all control points in system.
3. BAS system manufacturers complete operating manuals.

C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:

1. Complete as-built installation drawings for each building system.
2. Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.
3. Photographs and/or drawings showing installation details and locations of equipment.
4. Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.
5. Parts list with manufacturer's catalog numbers and ordering information.
6. Lists of ordinary and special tools, operating materials, supplies, and test equipment recommended for operation and servicing.

7. Manufacturer's operation, set-up, maintenance, and catalog literature for each piece of equipment.
8. Maintenance and repair instructions.
9. Recommended spare parts.

D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:
1. Complete programming manuals, and reference guides.
2. Details of any custom software packages and compilers supplied with system.
3. Information and access required for independent programming of system.
4. If owner already possess items listed above, then do not provide another copy.

3.12 TRAINING

A. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware, and accessories.

END OF SECTION 230900

SECTION 232113
HYDRONIC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Heating water piping, above ground.
   2. Chilled water piping, above grade.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Hydronic piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

1.03 SUBMITTALS

A. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
   2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
   3. Hangers and Supports: Submit manufacturers catalog information including load capacity.

1.04 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves, equipment and accessories.

B. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

C. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

D. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.

1.07 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in “Piping Schedule” article for applications of pipe, tube, fitting materials and joining methods for specific services, service locations, and pipe sizes.

2.02 STEEL TUBE AND FITTINGS, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40 (0.375 inch (10 mm) wall for sizes 12 inch (300 mm) and larger), black.
   1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
   2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.

B. Steel Pipe: ASTM A53/A53M, Schedule 40 (0.375 inch (10 mm) wall for sizes 12 inch (300 mm) and larger), black, cut grooved ends.
   1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, or ASTM A234/A234M carbon steel, grooved ends.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated compatible with steel piping sizes.
      b. Gasket: Elastomer composition for operating temperature range suitable for service.
      c. Accessories: Zinc electroplated steel bolts, nuts, and washers, comply with ASTM A449.
      d. Rigid: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Installation-Ready, for direct stab installation without field disassembly.
      e. Flexible: Use in locations where vibration attenuation and stress relief are required.
   3. Fittings: Cold press mechanical joint fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria of IAPMO PS117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer.

2.03 COPPER TUBE AND FITTINGS, ABOVE GROUND

A. Copper Tubing: ASTM B88 (ASTM B88M), Type L, hard drawn.
   1. Fittings: ASME B16.22 solder wrought copper.
   2. Tee Connections: At contractor’s option, mechanically extracted collars with notched and dimpled branch tube may be used.
   3. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F (220 to 280 degrees C). Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F (640 to 805 degrees C).
   4. Copper Pressure-Seal-Joint Fittings: ASME B16.18 or ASME B16.23.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Viega, Plumbing and Heating Systems.
         2) Preapproved equal.
      b. NPS 2 (DN50 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

c. NPS 2-1/2 to NPS 4 (DN 64 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

B. Copper Tubing: ASTM B88 (ASTM B88M), Type L, hard drawn, rolled grooved ends.
1. Fittings: ASME B16.22 wrought copper and bronze, or ASME B16.18 and ASTM B584 bronze sand castings, with copper-tube dimensioned grooved ends.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.
a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron with offsetting angle-pattern bolt pads, enamel coated, compatible with copper tubing sizes, to engage and lock.
b. Gasket: Elastomer composition for operating temperature range suitable for service.
c. Accessories: ASTM A449 compliant Zinc electroplated steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88 (ASTM B88M), Type M, hard drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F (220 to 280 degrees C).

2.04 UNIONS AND FLANGES

A. Unions for Pipe 2 inches (50 mm) and Smaller:
1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with soldered joints.
3. Dielectric Connections: Nipple with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches (65 mm) and Larger:
1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene gaskets.

C. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges, grooved joint couplings, or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems.

F. The installing contractor shall insure that internal components of the cold press mechanical joint press fitting are properly in place and free from damage. This is to include sealing elements, grip ring, and separator rings.

3.02 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”.

B. Support horizontal piping as scheduled.

C. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.

D. Place hangers within 12 inches (300 mm) of each horizontal elbow.

E. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

H. Provide copper plated hangers and supports for copper piping.

I. Prime coat exposed steel hangers and supports. Refer also to Division 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

K. Comply with requirements in Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment” for seismic restraint devices.

3.03 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

D. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

E. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

F. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

G. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

H. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers which shall have take-off out the top of the main line.

I. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

J. Install dielectric nipples or waterway fittings to join dissimilar metals, including copper coil connections with steel pipe.

K. Install flanges or grooved joint couplings on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

L. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration producing equipment.

1. Three flexible type grooved joint couplings may be used in lieu of flexible connectors at equipment connections in applicable piping systems. The couplings shall be placed in close proximity to the vibration source.

M. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, inline pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.

N. Press Connections: Copper press fittings shall be made in accordance with manufacturer’s installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

O. Install piping in accordance with ASME B31.9.

P. Route piping parallel to building structure and maintain gradient. Diagonal runs are not permitted, unless expressly indicated.

Q. Install piping to conserve building space, and not interfere with use of space.

R. Group piping whenever practical at common elevations, spaced to permit applying insulation and servicing of valves.

S. Sleeve pipe passing through partitions, walls and floors.

T. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

U. Install pipe identification.

V. Install and anchor piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

W. Provide access where valves and fittings are not exposed.

X. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned.

Y. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

Z. Prepare exposed unfinished pipe, fittings, supports, and accessories, ready for finish painting.

AA. Install valves with stems upright or horizontal, not inverted.

BB. Insulate piping and equipment.

3.04 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
2. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.
3. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.

C. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Align threads at point of assembly.
3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
   a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

D. Grooved Joints: Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufacturer by the coupling manufacturer and verified as suitable for the intended service. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

E. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.05 VALVE APPLICATIONS:

A. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:

1. Shut-off duty: Use ball, valves for line size 2" and smaller, use butterfly valves above 2" size.
2. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

B. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

3.06 FIELD QUALITY CONTROL

A. Preparation for Testing - Prepare hydronic piping in accordance with ASME B 31.9 and as follows:

1. Leave joints including welds uninsulated and exposed for examination during the test.
2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.

B. Testing - Test hydronic piping as follows:

1. Use clean ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 125 PSIG. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the “SE” value in appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.
5. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks. Continue test for 6 hours minimum and re-examine for leaks.

3.07 ADJUSTING AND CLEANING

A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

B. During flushing use cleaning compounds specified in Division 23 Section “HVAC Water Treatment.”

C. The following procedure shall be used for cleaning and flushing of hydronic water piping.

1. Mix cleaning compound with clean water per chemical manufacturer's instructions and distribute into the chilled water lines.
2. Completely fill system with water and chemical and bleed air.
3. Circulate system for 48 hours. Verify that all valves are open.
4. Clean strainers a minimum of every 2 hours for the first 4 hours; then clean every 4 hours minimum.
5. Drain water and chemical from piping system. Drain all low points. Allow the drain to bleed while system is circulating and verify proper operation of automatic make-up water valve.
6. Refill with clean water and circulate for 4 hours using the automatic make-up.
7. Completely drain water from piping system. Drain all low points.
8. Refill with clean water and corrosion inhibitor in quantity as recommended by the chemical manufacturer, based on water samples taken at the site.
9. Test water sample; if test pH exceeds make-up pH continue flushing operation.

3.08 TESTING

A. 125 Pound Systems: Test hydronic piping subject to main system pressure at not less than 150 pounds per square inch gauge or 1-1/2 times the maximum working pressure devices connected to the piping system, whichever is greater, measured at the low point of the system.

B. Test Result: After cleaning and filling the mechanical system, operate the system for a period of not less than 48 hours continuously during which time water treatment samples shall be taken at 4 hour intervals and the results plotted on a graph. Testing and sampling shall continue until the graph indicates that the water treatment is maintaining the specified levels of chemical within plus or minus 10 percent under all conditions of load.

3.09 COMMISSIONING

A. Fill system with clean water, both new and existing systems which must be drained in order to make connections for new systems.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean strainers.
3. Check pump for proper direction of rotation and correct improper wiring.
4. Check air vents at high points of systems and determine if all are installed and bleed all air completely from the system.
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Lubricate motors and bearings.
8. After air is eliminated, circulate hydronic water systems for a minimum of 72 hours prior to water balancing.

3.10 PIPING SCHEDULE

Application	Piping	Fittings
Chilled Water, Heating Water and Glycol Piping 2" (50 mm) and Smaller (Above Grade)	ASTM A53/A53M Steel Pipe	Threaded, Malleable Iron
	Hard Copper Tube, Type L	Wrought Copper, Soldered Joints
		Copper Pressure Sealed Joints
	ASTM A53/A53M Steel Pipe	Forged Steel, Welded
		Grooved-Joint

Chilled Water, Heating Water and Glycol Piping 2-1/2" (65mm) and Larger (Above Grade)	Hard Copper Tube, Type L	Grooved-Joint Wrought Copper Soldered Joints
		Copper Pressure Seal Joints

END OF SECTION 232113

SECTION 23 21 16
HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Flexible connectors.
   2. Expansion tanks.
   3. Air vents.
   4. Air separators.
   5. Strainers.
   6. Manual calibrated balance valves.
   7. Automatic balance valves.
   8. Relief valves.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 SUBMITTALS

A. Product Data: Submit for manufactured products and assemblies used in this Project.
   1. Manufacturer's data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
   2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
   3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
   4. Submit electrical characteristics and connection requirements.

1.03 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of actual locations of components and equipment.

B. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.05 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.08 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

PART 2 PRODUCTS

2.01 FLEXIBLE CONNECTORS

A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches (230 mm) long with copper tube ends; for maximum working pressure 300 psig (2070 kPa).

2.02 EXPANSION TANKS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Amtrol, Inc.
   2. Armstrong Pumps, Inc.
   3. Bell & Gossett/ITT Industries
   4. Taco, Inc.

B. Construction: Welded steel, rated for 125-psig (860-kPa) working pressure. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity. Bladder shall be removable for inspection or replacement.

D. Accessories: Pressure gage, stainless steel Schrader valve air-charge fitting with EPDM seats, tank drain; pre-charge to 12 psig (80 kPa) unless otherwise noted.

E. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow prevention device, test cocks, strainer, vacuum breaker, and by-pass valves.

2.03 AIR VENTS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Amtrol, Inc.
   2. Armstrong Pumps, Inc.
   3. Bell & Gossett/ITT Industries
   4. Taco, Inc.

B. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.

C. Automatic Float Type:
   1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

****** OR ******

   2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.04 AIR SEPARATORS

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

2. Armstrong Pumps, Inc.
3. Bell & Gossett/ITT Industries
4. Spirotherm
5. Taco, Inc.

B. Coalescing-type Air and Dirt Separators:
1. Tank: Fabricated steel tank; ASME constructed and stamped for 125-psig (862-kPg) working pressure and 270 deg F (130 deg C) maximum operating temperature.
2. Coalescing Medium: Stainless Steel.
3. Air Vent: Threaded to the top of the separator.
4. Inline Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for NPS 2-1/2 (DN 65) and larger.
5. Blowdown Connection: Threaded to the bottom of the separator.
6. Size: Match system flow capacity.

C. Tangential-Type Air Separators:
1. Tank: Welded steel; ASME constructed and labeled for 125-psig (860kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

2.05 STRAINERS

A. Size 2 inch (50 mm) and Smaller:
1. Screwed brass (ASTM B 62, Grade C) or iron body (ASTM A 126, Class B) for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.

B. Size 2-1/2 inch (65 mm) to 4 inch (100 mm):
1. Flanged iron body (ASTM A 126, Class B) for 175 psig (1200 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.

2. Grooved end ductile iron body (ASTM A 536, Grade 65-45-12) for 175 psig (1200 kpa) working pressure, Y pattern with 1/16 inch (1.6 mm) or 1/8 inch (3.2 mm) stainless steel perforated screen.

C. Size 5 inch (125 mm) and Larger:
1. Flanged iron body for 175 psig (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.
2. Grooved end ductile iron body (ASTM A 536, Grade 65-45-12) for 175 psig (1200 kpa) working pressure, Y pattern with 1/8 inch (3.2 mm) or 5/32 inch (4 mm) stainless steel perforated screen.

2.06 MANUAL CALIBRATED BALANCE VALVES (MANUAL BALANCE VALVES)

A. Manufacturer: Subject to compliance with requirements, provide calibrated balance valves by one of the following:
1. Armstrong Model CBV-VS/CBV-VT (1/2” through 2”)
2. Armstrong Model CBV-A/CBV-A (2 ½” through 12”)
3. IMI Hydronic Engineering Flow-set Model AS-S WT/AS-FPT (1/2” through 2”)
4. IMI Hydronic Engineering Flow-set Model AG/AF (2 ½” through 14”)

5. MEPCO Model MBVS/MBVT (1/2" through 2")
6. MEPCO Model MBVF (2 ½" through 12")
7. TACO Model ACUF-AC/ACUF-AT (1/2" through 2")
8. TACO Model ACUF-F (2 ½" through 4")
9. Victaulic / Tour & Anderson Model STAS/STAD (1/2" through 2")
10. Victaulic / Tour & Anderson Model STAG/STAF (2 ½" through 12")

B. General: Provide as indicated, calibrated balance valves equipped with readout test ports to facilitate connecting of a differential pressure meter to balance valves. Equip each readout test port with integral EPT check valve designed to minimize system fluid loss during balancing process. Provide calibrated nameplate to indicate degree of closure of precision machined orifice with tamper resistant memory step. Valves shall be capable of positive shut-off with no leakage.

C. Features: Balancing Valves in sizes ½" through 2" shall be of bronze body construction with solder or NPT connections to match piping systems. Balancing valves in sizes 2 ½" through 12" shall be of cast iron body design conforming to ASME/ANSI B16.5 with brass interior parts and flanged or grooved connections to match piping systems. Construct each valve for 250 psig working pressure at a temperature of 230°F and supplied with a preformed insulated housing suitable for use on heating and cooling systems. Insulation shall have a flame spread not to exceed 25, fuel contributed not to exceed 50 and smoke developed rating not to exceed 50.

1. Provide each valve with an engraved valve tag attached permanently to valve with brass chain or wire link manufactured specifically for that purpose. A valve schedule suitable for framing shall be provided referring each valve by sequenced number and indicating a minimum of valve size, model, manufacturer, piping system and unit served if applicable. A copy of the valve schedule shall be provided with balancing valve shop drawings submittals.

2.07 AUTOMATIC BALANCE VALVE

A. Manufacturer: Subject to compliance with requirements, provide automatic balance valves by one of the following:

1. Griswold
2. IMI Hydronic Engineering
3. Jomar Valve
4. Pre-approved equal

B. Capacity: Flow rate to match equipment served, regardless of system pressure fluctuation, within ± 5%. Control range shall be 1 to 14 PSI, 2 to 32 PSI, 4 to 57 PSI or 8 to 128 PSI depending on location within the piping system.

C. Submittal shall include a schedule which delineates the control range for each specific flow controller at every unit along with the valve size.

D. Features: All internal working parts shall be of passivated stainless steel or nickel plated brass. The valve shall be tamperproof when installed. Body pressure tappings suitable for pressure gauge and thermometer installation and verification of pressure differential across valve orifice shall be provided - Brass body - 150 PSI and 250°F rating - Units 1 1/2" and smaller located at coils shall have female threaded ball valve with lever handle on system side of controller for isolation with female sweat connection on unit side. A metal identification tag on chain will be provided for each valve. The tag will give valve model number, rated flow GPM, and pressure range. Units 3" and above shall be gray iron body Class 150 for flanged installation.

2.08 RELIEF VALVES

A. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

PART 3 EXECUTION

3.01 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Locate test plugs as indicated on Drawings.

B. Where large air quantities accumulate, provide enlarged air collection standpipes.

C. Install manual air vents at system high points at heat transfer coils, and elsewhere as required for system air venting.

D. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

E. Provide drain and hose connection with valve on strainer blow down connection.

F. Support pump fittings with floor mounted pipe and flange supports.

G. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

H. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

I. Pipe relief valve outlet to nearest floor drain, or to glycol mixing drum.

J. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 23 21 16

SECTION 23 31 13
METAL DUCTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Related Documents:

1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. High Efficiency Takeoffs (HETO)
4. Sheet metal materials.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

1.03 DEFINITIONS

A. Low Velocity Ductwork: Supply, return, make-up, and exhaust ductwork systems that are sized at 2,000 FPM or lower.

B. Medium Velocity Ductwork: Supply ductwork systems sized at greater than 2,000 FPM to 3,000 FPM.

C. Low Pressure Ductwork: Ductwork connected to fan systems with a 2” w.c. or less deadhead rating.

D. Medium Pressure Ductwork: Ductwork connected to fan systems with greater than 2” w.c. and less than 6” w.c. deadhead rating.

E. High Pressure Ductwork: Ductwork connected to fan systems with 6” w.c. or greater deadhead rating.

1.04 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. Minimum hard duct gauge thickness shall be 26 gauge. Additional thickness requirements shall be per SMACNA standards.

B. All work shall comply with the Mechanical Codes.

C. Structural Performance: Duct hangers and supports and seismic restraints 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" and ASCE/SEI 7.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.
   9. Penetrations through fire-rated and other partitions.
   10. Equipment installation based on equipment being used on Project.
   11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
   12. Hangers and supports, including methods for duct and building attachment**,** seismic restraints, and vibration isolation.

1.06 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   2. Suspended ceiling components.
   3. Structural members to which duct will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Penetrations of smoke barriers and fire-rated construction.
   6. Items penetrating finished ceiling including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Perimeter moldings.

1.07 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.

PART 2 PRODUCTS

2.01 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."

2.02 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.

1. Manufacturers: Subject to compliance with requirements, and Engineer approval.

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).

C. 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 (1524 mm) in Diameter: Flanged.

D. 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" with the following restrictions:

1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
3. Snaplock seams are not allowed on any ductwork (SMACNA RL-6A, RL-6B, RL-7, or RL-8)

E. 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".

2.03 HIGH EFFICIENCY TAKEOFFS (HETO)

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

1. Lindab, Inc.
2. McGill Airflow, LLC
3. SEMCO, Inc.
4. Sheet Metal Connectors, Inc.
5. Ductmate Industries, Inc.

B. General Requirements: Galvanized steel, stainless steel or aluminum construction with thickness matching required ductwork construction.

C. Construct in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible, Third Edition 2005, Chapter 4, Figure 4-6.

D. Rectangular opening with flange and neoprene gasket; 45 degree slope on the body.

E. Any volume dampers provided with HETO shall meet the requirements of manual volume dampers specified in this section.

2.04 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 (Z180).
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 (Z180).
2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick on both sides.
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. 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. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. 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.

H. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.05 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. 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: Minimum 3 inches (76 mm).
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. 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 wg (2500 Pa), 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.

D. 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 wg (2500 Pa), 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.

E. 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.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.06 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 (Table 5-1M), "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.

2.07 SEISMIC-RESTRAINT DEVICES

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

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Loos & Co.; Cableware Division.
6. Mason Industries.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 EXECUTION

3.01 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 on Shop Drawings and Coordination Drawings.

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 (25 mm), 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 (38 mm).

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."

3.02 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

A. Seal ducts in accordance with the following:

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Ductwork and all plenums with pressure class ratings shall be constructed to Seal Class A.

3.04 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "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 (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. 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 intervals of 16 feet (5 m).

F. 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.

3.05 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7**.**

1. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
2. Brace a change of direction longer than 12 feet (3.7 m).

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.06 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.

3.07 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 9.

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Test the following systems:
    a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections**,** selected by Engineer from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    b. Supply Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections [, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    c. Return Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    d. Exhaust Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections. Additional ductwork may require testing at Engineer’s discretion, if tested duct is found to be defective.

E. Prepare test and inspection reports.

3.09 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   6. Supply-air ducts, dampers, actuators, and turning vanes.
   7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts or duct accessories.
   4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   5. Provide drainage and cleanup for wash-down procedures.
   6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 SCHEDULES

A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply (Heating Only Systems)	Galvanized Steel, Aluminum
Supply (System with Cooling Coils)	Galvanized Steel, Aluminum
Return and Relief	Galvanized Steel, Aluminum
General Exhaust	Galvanized Steel, Aluminum
In-Duct Humidifier Supply	Stainless Steel, Aluminum
Outside Air Intake	Galvanized Steel

B. Ductwork Pressure and Leakage Class Schedule:

AIR SYSTEM	PRESSURE CLASS	SEAL CLASS	LEAKAGE CLASS	
			ROUND	RECT
Low-Pressure Supply	2 inch wg (500 Pa).	A	6	12
Medium Pressure Supply (upstream of VAV & CV boxes)	6 inch wg (1500 Pa)	A	3	6
Return and Relief	2 inch wg (500 Pa)	A	6	12
General Exhaust	2 inch wg (500 Pa)	A	3	6

NOTE: In no case shall the duct construction class be less than the peak pressure obtainable on the fan curve at the design fan RPM, unless pressure relief devices are installed on the effected sections of ductwork.

C. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
   2. PVC-Coated Ducts:
      a. Exposed to Airstream: Match duct material.
      b. Not Exposed to Airstream: Match duct material.
   3. Stainless-Steel Ducts:
      a. Exposed to Airstream: Match duct material.
      b. Not Exposed to Airstream: Match duct material.
   4. Aluminum Ducts: Aluminum.

D. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. Velocity 1000 fpm (5 m/s) or Lower:
         1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
         2) Mitered Type RE 2 with single thickness vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
      b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
         1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
         2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
         3) Mitered Type RE 2 with single thickness vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
      c. Velocity 1500 fpm (7.6 m/s) or Higher:
         1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
         2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
         3) Mitered Type RE 2 with single thickness vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
        1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
        2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
        3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
    b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
    c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Welded.
    d. At Contractor’s option, adjustable elbows with fully sealed gores (sealed per Part 2.6 Sealant and Gaskets article) are acceptable for low velocity, round elbows 12” and smaller in diameter.

E. 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: 45-degree entry.
    b. Rectangular Main to Round Branch: HETO.
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 1000 fpm (5 m/s) or Lower: Conical tap, or “low loss” tee.
    b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap, or “low loss” tee.
    c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral, or “low loss” tee.

END OF SECTION 23 31 13

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Control dampers.
3. Fire dampers.
4. Smoke dampers.
5. Combination fire and smoke dampers.
6. Corridor dampers.
7. Remote damper operators.
8. Duct-mounted access doors.
9. Duct pressure relief doors.
10. Flexible connectors.
11. Flexible ducts.
12. Duct accessory hardware.

1.03 SUBMITTALS

A. Product Data: For each type of product used in this project.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
   a. Special fittings.
   b. Manual volume damper installations.
   c. Control damper installations.
   d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

C. Source quality-control reports.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.05 EXTRA MATERIALS

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

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 (Z180).
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.02 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers (Under 1500 FPM Velocity):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. Flexmaster U.S.A., Inc.
   d. McGill AirFlow LLC.
   e. METALAIRE, Inc.
   f. Nailor Industries Inc.
   g. Pottorff; a division of PCI Industries, Inc.
   h. Ruskin Company.
   i. Vent Products Company, Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Round Dampers: Galvanized steel, 0.040 inch (1.02 mm) thick (20 gauge), 7” minimum length, with rolled stiffener beads.
   b. Rectangular Dampers: Galvanized steel with mitered and welded corners.
      1) Dampers up to 36” wide x up to 12” High: 0.034 inch (0.86 mm) thick (22 gauge), 3” minimum width with center “V” grove for reinforcement.
      2) Dampers over 36” wide or over 12” High: 0.052 inch (1.32 mm) thick (18 gauge), 5” x 1” minimum hat shaped channels with corner braces.
      3) For Dampers Over 48” Wide or Over 48” High: 0.064 inch (1.62 mm) thick (16 gauge), 5” x 1” minimum hat shaped channels with corner braces.
5. Blades:
   a. Round Dampers: Galvanized Steel.
      1) Dampers up to 16” Diameter: 0.040 inch (1.02 mm) thick (20 gauge) single blade.

2) Dampers Above 16” up to 24” Diameter: 0.064 inch (1.62 mm) thick (16 gauge) minimum single blade, or two sandwiched 20 gauge blades.

3) For Dampers Above 24” Diameter: Utilize multiple blade rectangular dampers as specified below with field fabricated square to round transitions.

b. Rectangular Dampers: Galvanized Steel.

1) Dampers up to 36” Wide x Up to 12” High: 0.034 inch (0.86 mm) thick (22 gauge) minimum single blade.

2) Dampers Over 36” Wide or Over 12” High: 0.052 inch (1.32 mm) thick (18 gauge) minimum opposed blades with 8” maximum width and reinforcement grooves or stiffeners.

3) Dampers Over 48” Wide or over 48” High: 0.064 inch (1.62 mm) thick (16 gauge) minimum opposed blades with 8” maximum width and reinforcement grooves or stiffeners.

6. Blade Axles: Cadmium plated steel.

a. Round Dampers Up to 16” Diameter or Rectangular Dampers up to 36” Wide x 12” High: 3/8 minimum square axle shaft, full width, extending through frame. Dampers 12” and smaller may utilize separate axles at each end of blade in lieu of full width.

b. Round Dampers Over 16” diameter and Rectangular Dampers Over 36” Wide or 12” High: 1/2” minimum square or hex axle shaft(s), full width, extending through frame.

7. Bearings:

a. Molded synthetic or oil-impregnated bronze.

b. Bearings at both ends of operating shaft.

8. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2” stand-off for external insulation.

9. Tie Bars and Brackets: Galvanized steel.

B. Standard, Steel, Manual Volume Dampers (1500 FPM to 3000 FPM Velocity):

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

a. Air Balance Inc.; a division of Mestek, Inc.

b. American Warming and Ventilating; a division of Mestek, Inc.

c. Flexmaster U.S.A., Inc.

d. McGill AirFlow LLC.

e. METALAIRE, Inc.

f. Nailor Industries Inc.

g. Pottorff; a division of PCI Industries, Inc.

h. Ruskin Company.

i. Vent Products Company, Inc.

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.

4. Frames:

a. Round Dampers: Galvanized steel, 7” minimum length, with rolled stiffener beads.

1) Dampers 18” diameter and less: 0.040 inch (1.02 mm) thick (20 gauge).

2) Dampers over 18” up to 24” diameter: 0.052 inch (1.32 mm) thick 18 gauge).

3) For Dampers Above 24” Diameter: Utilize multiple blade rectangular dampers as specified below with field fabricated square to round transitions.

b. Rectangular Dampers: Galvanized steel, 0.064 inch (1.62 mm) thick (16 gauge), 5” x 1” minimum hat shaped channels with mitered and welded corners, and corner braces.

5. Blades:
   a. Round Dampers: Galvanized Steel.
      1) Dampers up to 18” Diameter: 0.064 inch (1.62 mm) thick (16 gauge) single blade.
      2) Dampers Above 18” up to 24” Diameter: 0.078 inch (1.98 mm) thick (14 gauge) minimum single blade, or two sandwiched 20 gauge blades.
      3) For Dampers Above 24” Diameter: Utilize multiple blade rectangular dampers as specified below with field fabricated square to round transitions.
   b. Rectangular Dampers: Galvanized Steel, 0.064 inch (1.62 mm) thick (16 gauge) minimum opposed blades with 8” maximum width and reinforcement grooves or stiffeners.
6. Blade Axles: Cadmium plated steel, 1/2” minimum square or hex axle shaft(s), full width, extending through frame.
7. Bearings:
   a. Molded synthetic or oil-impregnated bronze.
   b. Bearings at both ends of operating shaft.
8. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2” stand-off for external insulation.
9. Tie Bars and Brackets: Galvanized steel.

C. Standard, Aluminum, Manual Volume Dampers (Up to 3000 FPM):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. Flexmaster U.S.A., Inc.
   d. McGill AirFlow LLC.
   e. METALAIRE, Inc.
   f. Nailor Industries Inc.
   g. Pottorff; a division of PCI Industries, Inc.
   h. Ruskin Company.
   i. Vent Products Company, Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Round Dampers: Aluminum, 0.063 inch (1.59 mm) minimum thick, 7” minimum length, with rolled stiffener beads.
   b. Rectangular Dampers: Aluminum with mitered and welded corners.
      1) Dampers up to 36” wide x up to 12” High: 0.08 inch (2.04 mm) thick, 3” minimum width with center “V” groove for reinforcement.
      2) Dampers over 36” wide or over 12” High: 0.08 inch (2.04 mm) thick, 5” x 1” minimum hat shaped channels with corner braces.
      3) For Dampers Over 48” Wide or Over 48” High: 0.08 inch (2.04 mm) thick, 5” x 1” minimum hat shaped channels with corner braces.
5. Blades:
   a. Round Dampers: Aluminum.
      1) Dampers up to 16” Diameter: 0.063 inch (1.59 mm) thick minimum single blade.

2) Dampers Above 16” up to 24” Diameter: 0.063 inch (1.59 mm) thick minimum single blade, or two sandwiched blades.

3) For Dampers Above 24” Diameter: Utilize multiple blade rectangular dampers as specified below with field fabricated square to round transitions.

b. Rectangular Dampers: Aluminum.

1) Dampers up to 36” Wide x Up to 12” High: 0.08 inch (2.04 mm) thick minimum single blade.

2) Dampers Over 36” Wide or Over 12” High: 0.08 inch (2.04 mm) thick minimum opposed blades with 8” maximum width and reinforcement grooves or stiffeners.

3) Dampers Over 48” Wide or over 48” High: 0.08 inch (2.04 mm) thick minimum opposed blades with 8” maximum width and reinforcement grooves or stiffeners.

6. Blade Axles: Aluminum.

a. Round Dampers Up to 16” Diameter or Rectangular Dampers up to 36” Wide x 12” High: 3/8 minimum square axle shaft, full width, extending through frame. Dampers 12” and smaller may utilize separate axles at each end of blade in lieu of full width.

b. Round Dampers Over 16” diameter: and Rectangular Dampers Over 36” Wide or12” High: 1/2” minimum square or hex axle shaft(s), full width, extending through frame.

7. Bearings:

a. Molded synthetic or oil-impregnated bronze.

b. Bearings at both ends of operating shaft.

8. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2” stand-off for external insulation.

9. Tie Bars and Brackets: Aluminum.

D. Low-Leakage, Steel, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.

b. American Warming and Ventilating; a division of Mestek, Inc.

c. Flexmaster U.S.A., Inc.

d. McGill AirFlow LLC.

e. METALAIRE, Inc.

f. Nailor Industries Inc.

g. Pottorff; a division of PCI Industries, Inc.

h. Ruskin Company.

i. Vent Products Company, Inc.

2. Low-leakage rating**,** with linkage outside airstream**,** and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

3. Suitable for horizontal or vertical applications.

4. Frames:

a. Galvanized-steel channels, 0.064 inch (1.62 mm) thick.

b. Mitered and welded corners.

c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.

b. Parallel- or opposed-blade design.

c. Stiffen damper blades for stability.

d. Galvanized, roll-formed steel, 0.064 inch (1.62 mm) thick.

6. Blade Axles: Cadmium plated steel.
7. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Galvanized steel.
11. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2" stand-off for external insulation.

E. Low-Leakage, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. Flexmaster U.S.A., Inc.
   d. McGill AirFlow LLC.
   e. METALAIRE, Inc.
   f. Nailor Industries Inc.
   g. Pottorff; a division of PCI Industries, Inc.
   h. Ruskin Company.
   i. Vent Products Company, Inc.
2. Low-leakage rating,with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
   d. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
6. Blade Axles: Aluminum or Stainless steel.
7. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Aluminum.
11. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2" stand-off for external insulation.

F. Jackshaft:

1. Size: 1-inch (25-mm) diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

G. Damper Hardware:
1. Locking quadrant zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated stand-off for insulated duct mounting.

2.03 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Flexmaster U.S.A., Inc.
4. McGill AirFlow LLC.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Pottorff; a division of PCI Industries, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.

B. Low-leakage rating**,** with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage. AMCA, Class 1A. Leakage shall not exceed 3 CFM/square foot (15.2L/s per square meter) against 1-inch wg (250 Pa) differential static pressure

C. Frames:
1. Hat shaped.
2. 0.064-inch- (1.62-mm-) thick, galvanized sheet steel.
3. Mitered and welded corners.

D. Blades:
1. Multiple blade with maximum blade width of 6 inches (152 mm).
2. Opposed-blade design.
3. Galvanized-steel.
4. 0.064 inch (1.62 mm) thick single skin or 0.0747-inch- (1.9-mm-) thick dual skin.
5. Blade Edging: Closed-cell neoprene.

E. Blade Axles: 1/2-inch- (13-mm-) diameter; plated steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

F. Bearings:
1. Stainless-steel sleeve.
2. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.04 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   3. Greenheck Fan Corporation.
   4. McGill AirFlow LLC.
   5. METALAIRE, Inc.
   6. Nailor Industries Inc.
   7. Pottorff; a division of PCI Industries, Inc.
   8. Prefco; Perfect Air Control, Inc.
   9. Ruskin Company.
   10. Vent Products Company, Inc.
   11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Dynamic rated and labeled according to UL 555 by an NRTL. Static rated fire dampers are not acceptable.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) velocity.
   1. Clamps – Sizes 3 through 18 inches:
      a. Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action.
      b. Plenum rated nylon strap with minimum tensile strength of 175 lbs.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 inch (1.3 mm) thick, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

2.05 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   3. Greenheck Fan Corporation.
   4. Nailor Industries Inc.
   5. PHL, Inc.
   6. Ruskin Company.

B. General Requirements: Label according to UL 555S “Dynamic” by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

1. In low velocity systems (≤1,800 fpm), the minimum rated velocity shall be 2,000 fpm, with a minimum 2.0”w.c. close-off, but in no case shall the qualified close off pressure be less than 1.2 times the dead-head pressure of the fan.
2. In medium velocity systems (1,801 to 2,800 fpm), the minimum rated velocity shall be 3,000 fpm, with a minimum 4.0”w.c. close-off, but in no case shall the qualified close off pressure be less than 1.2 times the dead-head pressure of the fan. Damper blades shall be airfoil design.
3. In high velocity systems (>2,800 fpm), the minimum rated velocity shall be 4,000 fpm, with a minimum 6.0”w.c. close-off, but in no case shall the qualified close off pressure be less than 1.2 times the dead-head pressure of the fan, nor the qualified velocity be less than 1.1 times the design velocity. Damper blades shall be airfoil design.

H. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: Two-position action, unless noted to have modulating action. Automatic reset after system test or power failure.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size to meet UL 555S.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor to meet UL 555S.

K. Accessories:

1. Auxiliary switches for position indication when smoke dampers are part of an engineered smoke control system.

2.06 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.

3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Type: Dynamic rated and labeled according to UL 555 and UL 555S by an NRTL for dynamic operation. Static rated dampers are not acceptable.

C. Rated pressure and velocity to exceed design conditions.

1. In low velocity systems (≤1,800 fpm), the minimum rated velocity shall be 2,000 fpm, with a minimum 2.0”w.c. close-off, but in no case shall the qualified close of pressure be less than 1.2 times the dead-head pressure of the fan.
2. In medium velocity systems (1,801 to 2,800 fpm), the minimum rated velocity shall be 3,000 fpm, with a minimum 4.0”w.c. close-off, but in no case shall the qualified close off pressure be less than 1.2 times the dead-head pressure of the fam. Damper blades shall be airfoil design.
3. In high velocity systems (>2,800 fpm), the minimum rated velocity shall be 4,000 fpm, with a minimum 6.0”w.c. close-off, but in no case shall the qualified close off pressure be less than 1.2 times the dead-head pressure of the fan, nor the qualified velocity be less than 1.1 times the design velocity. Damper blades shall be airfoil design.

D. Fire Rating: 1-1/2 and 3 hours.

E. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

F. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

G. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

H. Leakage: Class II for low velocity applications (≤1800 FPM) and Class I for medium or high velocity applications.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.

K. Damper Motors: Two-position action, unless noted to have modulating action. Automatic reset after system test or power failure.

L. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size to meet UL 555 and 555S.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque to meet UL 555 and 555S.

M. Accessories:
   1. Auxiliary switches for position indication when smoke dampers are part of an engineered smoke control system.

2.07 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc.
   2. Ventfabrics, Inc.
   3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed, 3/4 inches (19 mm) deep.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.08 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   3. Ductmate Industries, Inc.
   4. Flexmaster U.S.A., Inc.
   5. Greenheck Fan Corporation.
   6. McGill AirFlow LLC.
   7. Nailor Industries Inc.
   8. Pottorff; a division of PCI Industries, Inc.
   9. Ventfabrics, Inc.
   10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Panels - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
      d. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
      c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
      d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:
   1. Door and Frame Material: Galvanized sheet steel.

2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set to prevent over pressurization of protected duct, based on specified pressure class. Set pressure relief device to limit maximum pressure to 125% of rated pressure class.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

2.09 DUCT ACCESS PANEL ASSEMBLIES (FIRE RATED DUCT ASSEMBLIES)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Flame Gard, Inc.
   3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) carbon or 0.0428-inch (1.1-mm) stainless steel, to match duct material.

D. Fasteners: Carbon or stainless steel, to match duct material. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).

F. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative. Higher if required by maximum fan static pressure at design RPM.

2.10 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. Ventfabrics, Inc.
   4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
   2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).

2. Minimum Tensile Strength: 500 lbf/inch (88 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m).
2. Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).
2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

I. 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 (6-mm) movement at start and stop.

2.11 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Thermaflex
2. Flexmaster U.S.A., Inc.
3. ATCO
4. Pre-approved equal.

B. Insulated, Flexible Duct: UL 181, Class 1, woven and coated fiberglass supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 2.0-inch wg (500 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20 m/s).
3. Temperature Range: Minus 20 to plus 250 deg F (Minus 29 to plus 121 deg C).
4. Insulation R-value: R-6.0 per ASTM C-518.

C. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

2.12 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories 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. 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.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke dampers according to UL listing.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. Upstream and downstream from turning vanes.
8. Control devices requiring inspection.
9. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
5. Body Access: 25 by 14 inches (635 by 355 mm).
6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).

J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect terminal units to supply ducts utilizing rigid ducts. Flexible ducts are not allowed on inlet connections to terminal units.

N. Connect supply diffusers to ducts directly or with maximum 72-inch (1800-mm) lengths of flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with draw bands. Flexible ducts are not allowed on negative pressure ductwork, in exposed areas, or on inlets to terminal units.

P. Install duct test holes where required for testing and balancing purposes.

Q. For utility fan sets with 5-inch W.C. (1250Pa) or higher discharge pressure, 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 (6-mm) movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Single Duct Variable or Constant volume terminal units.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 REFERENCES

A. American Refrigeration Institute:
   1. ARI 880 - Air Terminals.
   2. ARI 885 -Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. National Fire Protection Association:
   1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

D. Underwriters Laboratories Inc.:
   1. UL 181 - Factory-Made Air Ducts and Connectors.

1.03 SUBMITTALS

A. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures indicated in schedules.

B. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

1.05 QUALITY ASSURANCE

A. Test and rate air terminal units' performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.

PART 2 PRODUCTS

2.01 SINGLE DUCT CONSTANT AND VARIABLE VOLUME AIR TERMINAL UNITS

A. Manufacturers:
   1. Krueger
   2. Titus
   3. The Trane Co.
   4. Nailor
   5. Price

6. Johnson Controls

B. Product Description: Variable air volume terminal units for connection to central air systems.

C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.

D. Basic Assembly:

1. Casings: Minimum 22 gage (0.8 mm) galvanized steel.
2. Lining: Minimum 1/2 inch (13 mm) thick foil lined fiber insulation, 1.5 lb./cu ft (24 g/L) density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with UL listed film or provide foil faced insulation.
3. Primary Air Inlets: Round stub connections for duct attachment.
4. Primary Air Outlets: S slip-and-drive connections.
5. Insulated, factory installed bottom access panel.

E. Basic Unit:

1. Configuration: Air volume damper assembly with airflow measuring ring inside unit casing. Measuring ring shall be provided with balancing test ports. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inch (0.25 kPa) inlet static pressure.
3. Unit inlet shall be equipped with a multi-point flow sensor with amplifying pressure pick-up points connected to central averaging chamber. The sensor shall amplify duct velocity pressure and shall maintain control accuracy with the same size inlet duct in any configuration.
   a. Pneumatic tees with caps for airflow verification equipment connection shall be installed in both pneumatic tubing lines.

F. Attenuation Section: Line attenuation sections with 2 inch (50 mm) thick insulation.

G. Hot Water Heating Coil:

1. Construction: 1/2 inch (13 mm) copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig (10380 kPa) pressure, factory installed.

H. Automatic Damper Operator:

1. Electric Actuator: 24 volt.

I. Wiring and Controls:

1. Units shall incorporate a single point or dual point electrical connection as shown in electrical connection schedule. Provide and factory install low voltage control transformer, disconnect switch and fan relay. Factory install DDC controller and damper actuator supplied by the successful temperature controls contractor. All electrical components shall be UL/ETL recognized and installed in accordance with the national electric code. All electrical components are to be mounted in a NEMA 1 control enclosure. Separation shall be maintained be maintained between high and low voltage wiring such that low voltage components, such as controller and damper operator, may be accessed without being exposed to line voltage wiring. All pneumatic tubing shall be UL listed fire retardant (FR) type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify ductwork is ready for air terminal installation.

3.02 INSTALLATION

A. Connect to ductwork in accordance with other Division 23 sections.

B. Install ceiling access doors or locate units above easily removable ceiling components.

C. Support units individually from structure. Do not support from adjacent ductwork.

D. Contractor is responsible for coordinating control box and coil connection locations.

E. All hydronic coils shall be piped in a counter flow configuration.

3.03 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to scheduled minimum. Set units with heating coils for scheduled heating air flow.

END OF SECTION 23 36 00

SECTION 23 37 13
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.02 SUMMARY

A. Extent of outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

B. Types of outlets and inlets required for project include the following:

1. Ceiling air diffusers.
2. Wall and floor registers and grilles.
3. Linear slot diffusers

C. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.

D. Refer to other Division 23 sections for balancing of air outlets and inlets; not work of this section.

1.03 QUALITY ASSURANCE:

A. Manufacturers Qualifications: Firms regularly engaged in manufacture of outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
4. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

C. Performance Requirements:

1. Noise Criterion (NC): NC rating for all air inlets and outlets shall be NC 30 maximum, when rated in accordance with ASHRAE 70-01 with room absorption of 10dB, re 10^{-12} watts.

1.04 SUBMITTALS:

A. Product Data: Submit manufacturer's data on outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, type, and number furnished, model number, size, and accessories furnished.
2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

2. Duct access panels.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 PRODUCTS

2.01 CEILING AIR DIFFUSERS:

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Standard color of diffusers is white, unless noted otherwise. Where diffusers are installed in hard ceilings or soffits, coordinate with Architect for finish color.

E. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule. Use all steel diffusers where fire dampers are required. Opposed blade dampers shall be provided only if specifically indicated on the drawings.

F. Manufacturer: Subject to compliance with requirements, provide diffusers of one of the following:

1. Krueger Mfg. Co.
2. Titus Products Div.; Philips Industries, Inc.
3. Air Guide
4. Price
5. Nailor
6. Carnes

2.02 WALL AND FLOOR REGISTER AND GRILLES:

A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide wall or floor registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Wall or Floor Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall or floor systems and that are specifically manufactured to fit into wall or floor construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Standard color of grilles is white, unless noted otherwise. Where grilles are installed in hard ceilings, sidewalls, or soffits, coordinate with Architect for finish color.

E. Types: Provide wall or floor registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule. Provide all steel registers where fire dampers are required. Opposed blade dampers shall be provided only if specifically indicated on the drawings.

F. Manufacturer: Subject to compliance with requirements, provide registers and grilles of one of the following:
   1. Titus Products Div.; Phillips Industries, Inc.
   2. Krueger
   3. Air Guide
   4. Price
   5. Nailor
   6. Carnes

2.03 LINEAR SLOT DIFFUSER

A. Linear slot diffuser designed for variable air volume application. Diffuser shall discharge air uniformly across slot length, horizontally along ceiling.

B. Plenum/casing shall be constructed of minimum 26 gauge, welded, galvanized steel. Slot edges shall be formed over to provide double thickness. Interior surfaces of plenum shall be acoustically and thermally insulated with 1/2" thick, 1-1/2 pound density foil faced glass fiber insulation meeting NFPA 90A and UL 181. Hanger holes shall be provided at each end of casing for installation.

C. Ceiling mounted diffusers shall be suitable for installation in a standard 2’ x 2’ exposed "T" bar ceiling grid system. Diffusers 4' in length shall be equipped with a notch to allow diffuser to set over cross "T" located at 2' point. Two way blow diffusers shall be provided with an intermediate slot for installation over "T".

D. Opposed blade dampers shall be provided only if specifically indicated on the drawings.

E. Manufacturer: Subject to compliance with requirements, provided registers and grilles of one of the following:
   1. Krueger
   2. Tempmaster
   3. Trane
   4. Titus
   5. Price
   6. Nailor

2.04 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.02 INSTALLATION

A. Install diffusers, registers, and grilles 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. Locate units so that ceiling grid is not cut. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Install balancing damper with locking quadrant in runout to supply diffusers.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

ELECTRICAL INDEX

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 GENERAL CONDITIONS:

A. The General Conditions, Supplementary General Conditions, General Requirements, and Special Conditions shall be and are hereby made a part of this Section of the specifications.

B. In case of conflicts between the electrical drawings and Division 26 of these specifications, the more stringent requirements shall govern. In all cases, notify the Engineer for direction.

C. The requirements of COMMON WORK RESULTS FOR ELECTRICAL establish minimum requirements, apply to, and are hereby made a part of all sections of Division 26, 27, and 28 of this specification.

D. The Contractor shall be responsible for excavation of all earth, soil, and rock conditions at the site. Review the elevations and soil boring logs and include all associated costs.

1.02 DESCRIPTION:

A. The electrical work shall include all labor, materials, tools, transportation, equipment, services and facilities, required for the complete, proper and substantial installation of all electrical work shown on the plans, and/or outlined in these specifications. The installation shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the drawings but which are necessary to make a complete working installation of all electrical systems.

B. All of the electrical related work required for this project (unless specified otherwise) is a part of the Electrical Contract price but is not necessarily specified under this division of the specifications or shown on the electrical drawings. Therefore, all divisions of the specifications and all drawings shall be consulted.

C. The plan drawings are schematic only and are not intended to show the exact routing of raceway systems unless dimensions are noted on the drawings. Final routing will be governed by field conditions (structural members, mechanical equipment, ductwork, underground piping, duct banks, etc.) and shall be determined by the Contractor and approved by the Architect. Any changes in routing shall not change the design of the raceway system.

D. The plan drawings showing device and equipment locations are schematic only and are not intended to show exact locations unless dimensions are noted on the drawings. The Contractor shall review all contract drawings that may affect the location of devices and equipment to avoid possible interference and permit full coordination of all work. The right to make any reasonable change in location within 6'-0", is reserved by the Architect up until the time of rough-in at no extra cost.

E. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, switchgear, panelboards, motor control, and other items, arrangement for specified items in general are shown on drawings.

F. Electrical service entrance equipment (arrangements for temporary and permanent connections to the power company's system) shall conform to the power company's requirements. Coordinate fuses, circuit breakers and relays with the power company's system, and obtain power company approval. Provide all required temporary building power and lighting. Remove when finished. Installation of temporary power and lighting shall comply with N.E.C. and OSHA requirements.

G. Ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized.

1.03 MINIMUM REQUIREMENTS:

A. Codes Rules and Regulations: Execute all work under ADA, the latest rules and regulations of the National Electrical Code (NEC), the National Fire Protection Association, and with all laws, regulations and ordinances of the County, State, City, and the Utility Company.

B. Codes shall govern in case of any direct conflict between codes, plans and specifications; except when plans and specifications require higher standards than those required by code. Variance from the plan and specifications made to comply with code must be approved by the Architect. If approved they shall be made with no increased cost to the Owner.

1.04 STANDARDS:

A. All material and equipment shall be listed, labeled or certified by UL LLC, where such standards have been established. Equipment and material which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Certified: Equipment is "certified" if:
   a. Equipment has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards, or to be safe for use in a specified manner.
   b. Production is periodically inspected by a nationally recognized testing laboratory.
   c. It bears a label, tag, or other record of certification.
2. Nationally recognized testing laboratory: A testing laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.05 QUALIFICATIONS (PRODUCTS AND SERVICES):

A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

B. Product Qualification:

1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
2. The Engineer reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will respond within two hours of receipt of notification that service is needed. Submit name and address of service organization.

1.06 MANUFACTURED PRODUCTS:

A. Materials and equipment furnished shall be new, of best quality and design, free from defects, of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts should be available. All items used on this project shall be free of asbestos, PCB, and mercury material.

B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer unless indicated otherwise.
2. Manufacturers of equipment assemblies, which include components made by others, shall be completely responsible for the final assembled unit.
3. Components shall be compatible with each other and with the total assembly for the intended service.
4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory and Field wiring shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Testing is Specified:

1. The Engineer shall have the option of witnessing factory tests. The Contractor shall notify the Engineer a minimum of 15 working days prior to the manufacturer making the factory tests.
2. Four copies of certified test reports containing all test data shall be furnished to the Engineer prior to final inspection and not more than 90 days after completion of the tests.
3. When equipment fails to meet factory test and reinspection is required, the Contractor shall be liable for all additional expenses, including expenses of the Engineer.

1.07 EQUIPMENT PROTECTION:

A. Equipment and material shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain.

B. During installation, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter and be vacuum cleaned both inside and outside before testing, operating and painting.

C. Damaged equipment shall be, as determined by the Engineer, placed in satisfactory operating condition or be returned to the source of supply for repair or replacement.

D. Painted surfaces shall be protected with factory installed removable heavy Kraft paper, sheet vinyl or equal.

E. Damaged paint on equipment and materials shall be restored to the original quality of paint and workmanship as used by the manufacturer so repaired area is not obvious.

1.08 GENERAL WORK REQUIREMENTS:

A. Arrange, phase and perform work to assure electrical service both temporary and permanent for buildings at all times.

B. Coordinate location of equipment and conduit with other trades to minimize interferences.

C. Examination of Site:

1. Visit the site, inspect the existing conditions and check the drawings and specifications so as to be fully informed of the requirements for completion of the work.
2. Lack of such information shall not justify an extra to the contract price.

D. Permits:

1. Obtain and pay for all licenses and permits, fees, inspection and certificates required for the execution of this work.
2. Pay fees and charges for connection to outside services and use of property.
3. Deliver permits and certificates to the Architect to be transmitted to the Owner.

E. Services:

1. This Contractor shall pay for all expenses, deposits, reimbursements, etc., required by the local rules and codes for the service to the buildings, complete and ready for use. See plot plan.
2. Consult Power Company for their requirements and for coordinating with their installation. Contractor shall provide any work thus required beyond that indicated by the drawings and specifications. He shall bear all expense involved for the complete installation of the electrical service (both temporary and permanent) to the building ready for operation, including utility service charges, except as specifically excluded on the plans.
3. This Contractor shall consult all local departments to verify requirements and bid installation of service in accordance with local codes and Utility company rules and regulations.
4. This Contractor shall bear all expense involved for the complete telephone and internet service conduit installation and pull wire ready for cable installation. Verify complete

installation with the local telephone company and internet service provider and bid installation to comply with their requirements.

F. Responsibility:
   1. This Contractor will be held responsible for any and all damage to any part of the building or to the work of other contractors, as may be caused through this contractor's operation.
   2. Any mutilation of building finishes or equipment initiated by electrical construction shall be properly corrected by the respective finishing contractor and paid for by the Electrical Contractor.
   3. The operation of the temporary power and the permanent electrical system shall be the responsibility of this Contractor until acceptance of the building by the Owner.

G. Work to be done by General Contractor:
   1. Build in all openings, sleeves, chases, etc., for conduit and equipment as established, furnished and set by this Contractor. The General Contractor shall seal or grout all openings after this Contractor has installed the conduits.
   2. Build in bolts, brackets, hangers etc., for work established, furnished and set by this Contractor.
   3. All concrete work required for equipment furnished and set by this Contractor including clean up pads under electrical gear, fixture bases, transformer bases, etc.
   4. Painting: All painting of electrical equipment installed in finished areas shall be done by the General Contractor. Painting will not be required on receptacles, switches, circuit breakers etc. All fixtures and exterior poles specified to be factory-primed shall be painted by General Contractor. Paint all wiremold, exposed conduit and equipment, etc., to match final wall colors.
   5. Provide fireproofing above fixtures located in fire rated ceilings per U.L. requirements.
   6. Pay all utility costs for operation of electrical system during construction until acceptance of building by the Owner.

H. Work done by the Mechanical Contractor:
   1. The Mechanical Contractor shall furnish wiring diagrams and temperature control drawings of all equipment furnished to the Electrical Contractor. (Catalog information is unacceptable, provide point to point drawings.)
   2. The Mechanical Contractor shall furnish and install all control equipment requiring connections to air, water, steam, etc., such as pneumatic electric relays, remote bulb temperature controls, solenoid valves, aquastats and pressure controls.
   3. The Mechanical Contractor shall reimburse the Electrical Contractor for any changes in system design i.e.; control or equipment which affects the Electrical Contractor. Also refer to equipment connections, controls and instrumentation in 260500.

I. Workmanship and Coordination:
   1. Make installation substantially as shown on the plans.
   2. Make alterations in location of apparatus or conduit as may be required to conform to building construction without extra charge.
   3. Mechanical equipment service clearances and electrical apparatus service clearances as specified in their respective manufacturer's product data shall be maintained free from conduit.
   4. Cooperate with other trades in their installation of work.
   5. Complete the installation in a workmanlike manner, completely connected and ready to give proper and continuous service.
   6. Use only experienced licensed electricians.

J. Cutting and Patching:

1. Notify the General Contractor in ample time, of the location of all chases, sleeves, and other openings required in connection with the work of this contract.
2. Cutting and patching made necessary because of failure to comply with the above shall be done by the General Contractor at the expense of the Electrical Contractor.
3. When it is necessary for the Electrical Contractor to cut building materials, it shall be done in a neat and workmanlike manner meeting with the approval of the Architect.
4. Holes through concrete shall be carefully drilled with a "Concrete Termite" drill. A Star Drill or Air Hammer will not be permitted. Structural members shall not be cut without approval from the Architect.
5. Any penetrations thru the roof shall be made with "Stoneman" 900 Series flashing connections as manufactured by Elmdor/Stoneman, City of Industry, California, or as approved by the Architect.
6. Any penetrations made in exterior or basement foundation walls shall be sealed with Thunderline "Link-Seal" connections, as manufactured by Thunderline Corporation, Wayne, Michigan.

K. Manufacturer's Instructions:
1. Apply, install, connect, erect, use, clean, and condition articles, materials and equipment as directed by the manufacturer.

L. Provide separate support for all devices mounted in or to lay-in ceiling tile. Ceiling tile shall not be used to support any device.

1.09 EQUIPMENT INSTALLATION AND REQUIREMENTS:

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working spaces shall not be less than specified in the National Electrical Code for all voltages specified.

C. Inaccessible Equipment:
1. Where the Engineer determines that the Contractor has installed equipment without proper clearances or not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled as directed at no additional cost to the Owner.
   a. Install access panels as approved by the Architect to provide access to all equipment, J-boxes and outlets located in non-accessible spaces. Panels shall be flush locking type with a fire rating equal to the ceiling system.
2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and ductwork. Outlet and box covers shall be removable by using regular length (8") screw drivers.

D. Distribution Equipment:
1. All items of Electrical Distribution Equipment (switchboards - panelboards - disconnects) shall be of one manufacturer, unless specifically noted on the drawings, in the specifications, or approved by the Engineer. Intermixing of distribution equipment by different manufacturers will not be permitted.
2. Equipment layouts on the drawings are based on one manufacturer. Verify all actual equipment sizes with equipment manufacturer prior to bidding.
3. If layout changes are required due to differing electrical manufacturer's equipment size, they must be submitted to and approved by the Engineer. National Electric Code working clearances must be maintained at all times. Extra remuneration will not be allowed for layout changes that differ from those shown.
4. Provide and install all steel supports as required for mounting of electrical equipment.
5. Anchor all free standing electrical equipment including switchboards, switchgear, substations, motor control centers, paralleling gear, transfer switches, transformers, etc. to

the floor with plated, 1/2" diameter minimum, anchor bolts or as recommended by the manufacturer.

1.10 EQUIPMENT CONNECTIONS, CONTROLS AND INSTRUMENTATION:

A. General: The following applies to all electrical power and control connections for all equipment requiring electrical installation work provided by others.

B. Electrical Contractor shall install and connect the following items for equipment requiring electrical power that is either furnished or specified by other Contractors and/or the Owner. Where these required items are not furnished with the equipment being connected, it shall be the Electrical Contractors responsibility to provide the necessary items including conduit, boxes and wiring.

1. Disconnecting Devices
2. Thermal Overload Devices
3. Overcurrent Devices
4. Short Circuit Protective Devices
5. Voltage Transformation Equipment
6. Control Devices (Local and Remote)
7. Equipment Mounting Structures
8. Additional Miscellaneous Devices

C. In general, all major equipment will be specified to be factory prewired with only service and interconnecting wiring required at the site by the electrical contractor; however, the Electrical Contractor shall check all divisions of the specification to verify if the equipment is specified factory prewired and if not, then it shall be the responsibility of the Electrical Contractor to provide the complete wiring of the equipment in accordance with wiring diagrams provided by other contractors and/or Owner to the Electrical Contractor. All interconnecting of equipment shall be by the Electrical Contractor.

A. All line and low voltage wiring/connections required to control equipment shall be provided as indicated below. Where the Mechanical Contractor (MC) is indicated, this also includes the Temperature Controls Contractor (TCC) if utilized on the project.

1. Line voltage conduit by EC
2. Line voltage wiring and connections by EC
3. Controls provided by MC
4. Low voltage control wiring and terminations shall be provided and installed by the
5. Conduit and rough-ins for low voltage control wiring shall be provided by

B. The Electrical Contractor shall provide 120 volt control power supply; #12 Ga. CU. THHN/THWN in 1/2"C. minimum at all points required by controls, instrumentation and sprinkler risers. Circuit as shown on the plans or to the nearest 120 volt panel if no circuiting is indicated. Use spare 20 Amp. breakers. Each control panel shall be on a separate circuit unless otherwise indicated. If the controlled equipment is fed from the emergency system, then the control power supply must feed from the emergency system.

C. The Contractor shall become familiar with the equipment to be furnished by the other Contractors and/or the Owner in connection with this work and include provisions for such connections and work in the Contractor's price. Extra remuneration will not be allowed for such work.

D. Connections to all equipment have been designed from units as specified on the drawings or in the specifications. In the event equipment or control differs on approved shop drawings it shall be the responsibility of the Supplying Contractor to coordinate electrical connections to the units and reimburse Electrical Contractor for any changes in system design. These changes shall not involve additional cost to the Owner.

E. Review all plans and specifications to verify all equipment connections that are required by mechanical and/or other contractors. Although the electrical drawings will show equipment

connection requirements, it is the Electrical Contractor's responsibility to connect all equipment furnished by other Contractor's at no extra cost to the Owner, even if this equipment connection is not shown on the electrical drawings. Coordinate all required connections not shown on the electrical drawings with the Engineer.

1.11 NAMEPLATES:

A. General: The following items shall be equipped with nameplates:

1. Disconnect switches (fused or nonfused), transformers, switchgear and switchboards (including branch circuit breakers/switches), panelboards, separately mounted circuit breakers, starters, contactors, relays, junction boxes and pull boxes.

B. Inscription: Nameplates shall adequately describe the function or use of the particular equipment involved. Nameplates for panelboards and switchboards shall include the panel designation, voltage, and phase, A.I.C. rating of the supply (see schedules, one-line diagram, and color coding). For example, "Panel A" 120/208 V, 3-Phase, 4-Wire, 10,000 A.I.C. or “50,000 AIC with 22 KA Breakers, Series with class ‘J’ Fuses”:

1. Phase A - Black
2. Phase B - Red
3. Phase C - Blue
4. Neutral - White
5. Ground - Green

C. The name used for a machine nameplate shall be the same as the one used on the machine's motor starter, disconnect and P.B. station nameplates. Nameplates for fused switches and panels shall also indicate fuse type and size.

1. In addition to the instructions listed above:
    a. All panelboards and transfer switches fed from the critical branch shall be labeled “Critical Branch”.
    b. All panelboards and transfer switches fed from the life safety branch shall be labeled “Life Safety”.
    c. All panelboards and transfer switches fed from the equipment branch shall be labeled “Equipment”.
    d. All panelboards and transfer switches fed from the standby system shall be labeled “Standby System.

D. Construction:

1. Nameplates shall be as follows:
    a. Normal power - laminated phenolic plastic white front and back with black core.
    b. Critical Branch - laminated phenolic plastic orange front and back with white core.
    c. Life Safety Branch - laminated phenolic plastic yellow front and back with black core.
    d. Equipment Branch - laminated phenolic plastic green front and back with white core.
    e. Standby Power - laminated phenolic plastic blue front and back with white core.
2. Lettering shall be engraved through front layer to form 1/4" characters. Nameplates shall be securely fastened to the equipment to be identified, with No. 4 Phillips, round head, cadmium plated, steel self tapping screws or nickel plated brass bolts. Motor nameplate may be nonferrous metal not less than 0.03 inches thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Letters engraved thus, shall be filled with contrasting enamel. All nameplates and their installation are part of this work. Free hand lettering or dymo label marker will not be acceptable.

1.12 MATERIALS OF APPROVED EQUAL:

A. Where items of equipment and/or materials are specifically identified herein by a manufacturer's name, model or catalog number, and only such specific items may be used in the base bid, except as hereinafter provided.

B. Unless requests for changes in base bid specifications are received, approved and noted by written addendum prior to the opening of bids, the successful contractor will be held to furnish specified items.

C. After contract is awarded, changes in specifications shall be made only as defined under "Substitution of Equipment".

1.13 SUBSTITUTION OF EQUIPMENT:

A. After execution of the contract, substitution of equipment of makes other than those specifically named in the contract documents, may be approved by the Engineer, only if the equipment named in the specifications cannot be delivered to the job in time to complete the work in proper sequence and due to conditions beyond control of the Contractor. Provide documentary proof in writing from the manufacturer that the specified equipment will not be available in time. If the Contractor is responsible for the delay, the substitution will not be approved.

B. Requests for substitutions must be accompanied by documentary proof of equality or difference in price and delivery, if any, in form of certified quotations from suppliers of both specified and proposed equipment.

1.14 SUBMITTALS: IN ACCORDANCE WITH SECTION SAMPLES AND SHOP DRAWINGS, FURNISH THE FOLLOWING:

A. The Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.

B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

C. Submittals shall be complete and submitted together for each section. Individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assemble as a whole. Partial submittals will not be considered for approval.

1. Mark the submittals, "SUBMITTED UNDER SECTION_____". Mark out all statements on sheets that do not apply otherwise. The Engineer may select options and equipment not originally specified. All options that are not marked out will be assumed that the Contractor will furnish the same.
2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
3. Submit each section separately.
4. Mark catalog cuts to indicate equipment, capacities, finishes, sizes, etc. Each individual item shall have its own sheet provided for approval. (Example: Separate sheets for each panelboard.)

D. The submittals shall include the following:

1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

4. Quantities of materials will not be verified by the Architect or Engineer. Approval stamp on shop drawings does not constitute approval of quantities listed on shop drawings.
5. Shop drawings:
   a. All shop drawings shall be checked and signed by this contractor and general contractor prior to submittal to the Architect/Engineer.
   b. Shop drawings submitted without Contractor's signatures or approval and verification will not be approved.
   c. Shop drawings shall be submitted on wire, cables, devices, lighting fixtures (including distribution curves), panelboards, disconnects, transformers, conduit, raceway systems, low-voltage systems, etc.
6. Each sheet shall be either 8 1/2" x 11"; 8 1/2" x 13"; or 11" x 17" bond with a 5" x 3" clear area for engineer's stamp. (This area shall not be used by this contractor or the general contractor's stamp.) Larger drawings shall be able to be blue printed.
7. Submittals for low-voltage systems (fire alarm, security, PA, controls, sound, clock, nurses' call, intercom, etc.) shall include complete riser diagrams showing all conductors and conduit sizes.

E. Engineer's acceptance of Compliance Submittals will not relieve the Contractor from his responsibility for any deviations from the requirements of the contract documents, unless Contractor has in writing called Engineer's attention to such deviation at the time of submission and the Engineer has given written approval to the specific deviation; nor shall any acceptance by Engineer relieve Contractor from responsibility for errors or omissions in Compliance Submittals.

F. Quantity of Submittals: See the general specification sections.

1.15 ELECTRICAL WORK COMPLETION:

A. Before requesting final inspection the following work must be completed.

B. Operating Instructions:

1. The Contractor shall submit along with the shop drawings of the equipment, three (3) copies of operating instructions for all items. Instructions shall be prepared by the manufacturer of the equipment.
2. After the operating instructions have been approved by the Engineer, the Contractor shall include the three (3) copies in maintenance instructions brochures.
3. The Contractor shall also obtain all manufacturers' instructions, manuals, and one complete set of drawings and turn these over to the Architect at the completion of the project.
4. The Contractor shall keep in a safe place; all keys and special wrenches furnished with equipment under this contract and shall give same to the Architect at the completion of the project.
5. The Contractor shall prepare a complete brochure, in triplicate, covering all systems and equipment furnished and installed under his contract. Brochures shall be submitted to the Architect-Engineer for approval and delivery to the Owner. The cost of this brochure shall be included in the contract cost. Brochures shall contain the following:
   a. Certified equipment drawings and/or catalog data clearly marked for equipment furnished as required for approval submission under detailed section of the specifications.
   b. Complete operating and maintenance instructions for each item of equipment.
   c. Complete part list for each equipment item.
   d. Any special emergency operating instructions or a list of service organizations (including addresses and telephone numbers) capable of rendering emergency service to the various parts of the system.
6. Brochures shall be bound in hard backed three ring binders with an index, sub dividers and reinforced sheets.

a. Project name and address.
b. Section of work covered by brochure, i.e., "Electrical Work".
c. Name and address of Architect.
d. Name and address of Engineer.
e. Name and address of Contractor.
f. Telephone number of Contractor, including night or emergency number.

7. In addition to these written instructions, each respective Contractor shall fully and carefully instruct the Owner, or Owner's selected representatives, as to the proper operation, care and maintenance of each system and its equipment.

1.16 TESTING AND ADJUSTMENT:

A. Record loads on each phase of all panelboards, distribution panels, switchboards, transformers and submit final readings to the Architect for records. This Contractor shall adjust equipment, instruments, gages, meters etc., as required to test and adjust these systems.

B. Check, test, and adjust the mechanisms of all electrical equipment and adjustable parts of lighting fixtures as required for optimum performance.

C. Perform tests for insulation resistance in accordance with the requirements of the National Electrical Code and insure that all circuits are free from short circuits.

D. Keep a calibrated voltmeter and ammeter available at all times and provides service for test readings when and as required, up until the project is accepted by the Owner.

E. Electrical Testing and Verification: Refer to the following specification sections (as applicable) for required tests and verifications:

1. 260519 – Low Voltage Electrical Power Conductors and Cables
2. 260526 – Grounding and Bonding for Electrical Systems
3. 262200 – Low Voltage Transformers
4. 262416 – Panelboards
5. 262726 – Wiring Devices
6. 270501 – Common Work Results for Communications Systems
7. 271200 – Communications Infrastructure Cabling
8. 275116 – PA System
9. 275224 – Wireless Nurse Call
10. 275314 – Wireless Synchronized Clock System
11. 281300 – Access Control
12. 282300 – Video Surveillance System
13. 284621 – Addressable Fire-Alarm Systems
14. 285500 – RF Survey for Emergency Radio Antenna Repeater BDA System

1.17 AS-BUILT DRAWINGS:

A. Show on black or blue line prints in red ink all changes from original plans made during the installation. Return two (2) sets of red marked drawings, specifications and addenda, as set forth in the General Conditions, to the Architect upon completion of the project.

1.18 FINAL INSPECTION:

A. Final inspection will be made upon written request from the General contractor after the project is completed; in accordance with the Supplementary General Conditions.

B. Furnish a workman familiar with this project to accompany the Engineer on final inspection and have available ladders, drop cords, and other equipment as required to gain access to any portion of this system.

C. This Contractor and his principal subcontractors shall be represented at the inspection by a person of authority responsible to demonstrate to the engineer that his work conforms to the intent of the plans and specifications.

D. Extra inspections made necessary by the Electrical Contractor's failure to comply with the conditions as set forth above shall be charged to the Contractor for the Inspector's time both on the job and spent in travel between the office and the project site.

1.19 GUARANTEE:

A. Guarantee all work, material and equipment for a period of one year after date of substantial completion.

B. During the one year guarantee period the Electrical Contractor shall be responsible for any defects which develop in the electrical systems. Upon notification of a defect by the General Contractor the Electrical Contractor shall make immediate effort to correct it and shall notify the Architect when this work is completed. This guarantee does not include ordinary lamp failure.

C. Repairs and/or replacements shall be made with no cost to Owner.

D. Provide as part of the work of this contract, in addition to the first year's guarantee on equipment and materials, the following routine maintenance and inspection. (The one year time period will not start until each item is completed in accordance with plans and specifications and accepted by the Owner). Correct and adjust all emergency systems, controls, fire alarm, transformer, etc. This service to be provided throughout the guarantee period.

1.20 SINGULAR NUMBER:

A. Where any device or part of equipment is referred to in these specifications in the singular number (such as "the switch"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.21 LOW VOLTAGE SYSTEMS:

A. Power wiring for low voltage systems shall be furnished and installed by the contractor as shown on the drawings and as required by the equipment manufacturer.

B. Rough-in for low voltage outlets shall be installed as shown on the drawings or as required by the application or by the equipment manufacturer. Where no specific requirement is noted the rough-in shall match that specified for a typical telecom outlet.

C. Nurse call, code blue, medical gas, and fire alarm systems shall be completely installed in separate conduit systems. All cable for these systems shall be in conduit and shall not be combined with any other system cable. Conduits systems shall be furnished and installed by the Electrical Contractor.

D. Conduit for low-voltage systems other than nurse call, code blue, medical gas, and fire alarm shall be limited to the following and shall be furnished and installed by the Electrical Contractor.

1. Conduit in walls, from outlets to accessible ceilings, terminated with open end bushing above ceiling.
2. Conduits between floors, terminated with open end bushings.
3. Conduits across fire and/or smoke walls, terminated with open end bushings, and sealed with approved fire rated material.
4. Other conduits as shown on drawings.

E. Conduits shall be sized as required by the number and type of conductors applied and/or as noted on plans (minimum 1") and shall be not smaller than sizes recommended by the equipment manufacturer. All conduits shall be labeled to identify which system it is to be used for i.e.: Fire Alarm, Nurse Call, Code Blue, P.A. etc.

F. When ceiling voids are used as air return plenums, only U.L. Listed plenum cable shall be used or cables shall be completely routed in conduit.

G. All low voltage wiring installed in ceiling voids shall be bundled, neatly routed, suspended above the grid system or located in cable tray and labeled with appropriate tags as to service.

H. Low voltage wire and cable shall be specifically designed to function with equipment supplied. Cable shall be color coded for ease of installation and service, twisted, shielded, and grounded for control of voice circuits and covered with wear-resistant moisture proof protective insulation. Wire shall bear manufacturer's trademark either embossed or printed on cable.

I. Low-voltage systems shall be provided with a minimum of 20% spare capacity upon completion of the project unless otherwise noted.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 260500

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. Section includes:
   1. Building wires and cables rated 600 VAC and less.
   2. Connectors, splices, and terminations rated 600 VAC and less.
   3. Wire lubricating compound.
   4. Control wiring.
   5. Communication and signal wiring.
   6. Fireproofing tape.

1.03 SUBMITTALS

A. Product Data (Where indicated in Section “Common Work Results for Electrical”, provide the following information): For each type of product indicated.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.

B. Comply with NFPA 70.

C. Comply with NEMA WC 70.

PART 2 PRODUCTS

2.01 CONDUCTORS AND CABLES (POWER AND LIGHTING):

A. Conductors and Cables: NEMA WC 70, except as hereinafter specified.
   1. All conductors shown on plans are sized for copper.
   2. UL label required.

B. Single Conductor:
   1. Soft annealed copper.
   2. Stranded for sizes No. 8 and larger. Solid or stranded for sizes No. 10 and smaller, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise.
   3. Minimum size No. 12, except where larger sizes are shown. (Size No. 14 minimum for controls).

C. Stranding:
   1. Conductors between stationary and moving devices, such as hinged doors or panels, shall have Class H or Class K stranding. All other conductors shall have Class B or Class C stranding.

D. Insulation:
   1. THHN-THWN, XHHW - Sizes No. 12 and larger.

E. Hospital Grade Metal Clad (Type MC) and Hospital Grade Armored Cable (Type AC):
   1. Refer to 260519-2.1B for minimum conductor sizes.
   2. Hospital Grade Metal Clad Cable shall be as manufactured by Southwire – Type HCF MC-AP, aluminum armor.

a. Cable assembly shall include conductors with THHN insulation, an insulated ground conductor, mylar tape conductor insulation covering, and an interlocked armor aluminum outer jacket with a bonding wire.

3. Hospital Grade Armored Cable shall be as manufactured by AFC Cable Systems – Type HCF, steel or aluminum armor or Southwire Type AC-HCF.
   a. Cable assembly shall include conductors with THHN insulation, an insulated ground conductor, paper wrap conductor insulation covering, and an interlocked armor (galvanized steel or aluminum) outer jacket with a bonding wire.
4. Cable shall be UL compliant for one, two and three hour wall penetration fire ratings. The cable shall have passed UL 1479 and meet NEC 300.22(C) for Environmental Air Handling spaces.

2.02 SPLICES AND JOINTS:

A. In accordance with UL 486 A, B, D and NEC.

B. Split-bolt type connectors are not allowed.

C. Branch circuits (No. 10 and smaller):
1. Connectors: Solderless, screw-on, reusable pressure cable type, 600 volt, 105 degree C. with integral insulation, approved for copper and aluminum conductors.
2. The integral insulator shall have a skirt to completely cover the stripped wires.
3. The number, size, and combination of conductors, as listed on the manufacturer's packaging shall be strictly complied with.

D. Branch Circuits (No. 8 and No. 6):
1. Connectors: Pre-insulated, mechanical, reusable cable type, 600 volt, 90 degree C. with integral insulation, approved for copper and aluminum conductors, cold temperature rated to -45 degree C. Connectors shall be equal to those manufactured by Polaris Connectors.
2. Provide connectors rated for the location where installed.
3. The number, size, and combination of conductors, as listed on the manufacturer's packaging shall be strictly complied with.

E. Feeder Circuits:
1. All feeder conductors shall be the same size and type and be continuous from the overcurrent device to the panel or equipment the feeder terminates at.
2. Connectors shall be indent type, UL listed for use with the size and type of wire installed of high conductivity and corrosion-resistant material. Do not install more than one conductor per connector unless the connector is UL listed for use with the number of conductors installed.
3. Power distribution blocks shall be provided for splices or where quantity or size of conductors exceeds the terminal rating of the device to be connected. Power distribution blocks shall be equal to Square D by Schneider Electric Class 9080 Type LB or Mersen Electrical Power MPDB series. Provide with covers. Power distribution blocks shall be securely mounted in a code sized enclosure.
4. Field installed compression connectors for cable sizes 250 kcmil and larger shall have not less than two clamping elements or compression indents per wire.
5. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Insulation rating shall be not less than that of the conductor that is being joined.
6. Plastic electrical insulating tape: Flame retardant, cold and weather resistant.

2.03 CONTROL WIRING:

A. Unless otherwise specified in other sections of these specifications, size control wiring as specified for power and lighting wiring, except the minimum size shall be not less than No. 14,

90 degrees C. insulation. Where stranded conductors are used, provide with spade type insulated copper terminals.

B. Size wire large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

2.04 COMMUNICATION AND SIGNAL WIRING:

A. Shall conform to the recommendations of the manufacturers of the communication and signal systems; however, not less than what is shown.

B. Wiring shown is for typical systems. Provide wiring as recommended by the manufacturer for the systems being furnished.

C. Multi-conductor cables shall have the conductors color coded.

2.05 WIRE LUBRICATING COMPOUND:

A. The cable pulling lubricant shall be compatible with all cable jackets. The lubricant shall be UL (or CSA) listed. The lubricant shall contain no waxes, greases, silicones, or polyalkylene glycol oils or waxes.

B. A 200-gram sample of the lubricant, when placed in an one-foot, split metal conduit and fully dried for 24 hours at 105 degrees C, shall not spread a flame more than three-inches beyond a point of ignition at a continued heat flux of 40 kW/m^2. Total time of test shall be one-half hour.

C. Approved Lubricant is:

1. Polywater J from American Polywater Corporation

PART 3 EXECUTION

3.01 INSTALLATION, GENERALLY:

A. Install in accordance with the NEC, and as specified.

B. Install all wiring in raceway systems.

C. Where No. 10 or No. 12 stranded conductors terminate at receptacles, toggle switches, or other devices with a screw-type connection, provide a solid conductor pigtail or spade-type connector listed for use with the appropriate class of stranded wire.

D. Install a ground wire sized per NEC 250.122 in each conduit containing phase conductors.

E. Color Code:

1. All conductors shall be identified by circuit number and color coding at all termination points and splices. All conductors shall be identified in all pull and junction boxes by the following method of color coding. Means of identification shall be permanently posted at each branch circuit panel with a nameplate identifying color coding system used in that panelboard.

Phase	208Y/120V	480Y/277V
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
Iso. Grd	Green w/Yellow	Green w/Yellow

2. Use solid color compound or solid color coating for No. 6 and smaller branch circuit conductors and neutral sizes.

3. Phase conductors No. 4 and larger color code using one of the following:

a. Solid color compound or solid color coating.

b. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three-inches for terminal points, and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent

possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.

c. Yellow stripe on isolated ground may be 1/4-inch wide yellow tape on top of green.

4. Where neutrals are located in the same raceway, junction box or enclosure, neutrals shall be marked or labeled to indicate which circuit conductor (phase conductor) they are associated with. Neutrals (with stripes matching the associated phase conductor color) meeting the requirements of NEC Section 200.6 are acceptable for this purpose.
5. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
6. Provide plastic engraved color code legend on each panelboard and switchboard per NEC Section 210.5 (C).
7. All improperly color coded conductors will be completely replaced at no additional cost to Owner.

F. All cable and wiring shall be continuous between electrical equipment. Splices shall not be added except as required for taps in branch circuits or as approved by the engineer.

G. Splice cables and wires only in outlet boxes, junction boxes, pull boxes, manholes, or handholes. Do not splice cables in panelboards, switchboards, disconnects, etc.

H. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.

I. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, and tie all cables.

J. Seal cable and wire entering a building from underground between the wire and conduit, where the cable exits the conduit, with a non-hardening approved compound.

K. Wire Pulling:

1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
2. Use ropes made of nonmetallic material for pulling feeders.
3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Engineer.
4. Pull multiple cables into a single conduit with a single continuous pull.
5. Use wire lubricant per this specification when recommended by the cable manufacturer or as required to prevent damage to cables during installation.

L. Individual neutrals shall be provided for each circuit. Multi-wire branch circuits (i.e. Two or more phase sharing a neutral conductor) shall not be allowed, unless specifically noted or shown on the plans. Where multi-wire branch circuits are shown or noted on the plans, provide a disconnecting means that will simultaneously disconnect all phase conductors at the panel where the branch circuit originates.

3.02 INSTALLATION IN MANHOLES:

A. Install and support cables in manholes on the steel racks with porcelain or equal insulators. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

3.03 SPLICE INSTALLATION:

A. Splices and terminations shall be mechanically and electrically secure.

B. Where the Engineer determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Owner.

3.04 CONTROL, COMMUNICATION, AND SIGNAL WIRING INSTALLATION:

A. Unless otherwise specified in other sections of these specifications, install wiring as described below. Wiring shall be connected to perform the functions shown and specified in other sections of this specification.

B. Except where otherwise required, install a separate power supply circuit for each system, or control equipment, or control power. Circuit to nearest 120 volt panel or nearest emergency panel if equipment controlled is connected to emergency system. Use spare 20 Amp breakers in panels where none are designated. Verify all requirements with actual equipment supplied in field.

C. Install a breaker lock-on clip on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems. Lock-on clips for circuit breakers serving fire alarm systems shall be painted red.

D. System voltages shall not exceed 120 volts and shall be lower voltages where shown on the drawings or required by the NEC.

E. Wire and cable identification:

1. Install a permanent wire marker on each wire at each termination, outlet box, junction box, panel, and device. Markers shall be typed or handwritten and shall be clearly legible.
2. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
3. Wire markers shall retain their markings after cleaning.
4. In each manhole and handhole, install permanent, waterproof tags to identify the cable type/system and the building or area served.

3.05 FEEDER IDENTIFICATION:

A. In each, interior pullbox and junction box, identify each phase, neutral and/or ground conductor by conductor color coding or tape based on system voltage.

B. In manholes and handholes, install permanent, waterproof tags to identify the cable type. Identify each phase, neutral, and/or ground conductor by conductor color coding or tape based on system voltage.

3.06 FIELD TESTING:

A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices such as fixtures, motors, or appliances.

B. Test shall be performed by megger and conductors shall test free from short-circuits and grounds.

C. Test conductors' phase-to-phase and phase-to-ground.

D. Megger motors after installation but before start-up and test free from grounds.

E. The Contractor shall furnish the instruments, materials, and labor for these tests.

3.07 HOSPITAL GRADE METAL CLAD CABLE (TYPE MC) AND HOSPITAL GRADE ARMORED CABLE (TYPE AC)

A. Hospital Grade Metal Clad Cable and Hospital Grade Armored Cable may only be used on normal power and lighting circuits. Hospital Grade Metal Clad Cable and Hospital Grade Armored Cable is not allowed for use on emergency power and lighting circuits or in damp or wet locations.

B. Hospital Grade Metal Clad Cable or Hospital Grade Armored Cable may be utilized for branch circuit wiring from junction boxes to fixtures and wiring devices. All home runs shall be in conduit.

C. The use and installation of Hospital Grade Metal Clad Cable and Hospital Grade Armored Cable shall conform to NEC Article 320 or 330 as applicable, state and local codes and this specification. In all cases, the most restrictive requirements shall govern.

D. Color coding of insulation shall comply with this specification.

E. Support:

1. Hospital Grade Metal Clad Cable shall be supported at intervals not exceeding 6 feet and within 12 inches of every box, cabinet, fitting or other cable termination. Comply with additional requirements of Article 330, Paragraph 330.30.

2. Hospital Grade Armored Cable shall be supported at intervals not exceeding 4 feet 6 inches and within 12 inches of every box, cabinet, fitting or other cable termination. Comply with additional requirements of Article 320, Paragraph 320.30.

F. Install in a neat and workmanlike manner. Align and run cable parallel or perpendicular to the building lines.

END OF SECTION 260519

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. This section includes grounding and bonding systems and equipment.

1.03 SUBMITTALS:

A. Product Data (Where indicated in Section “Common Work Results for Electrical”, provide the following information): For each type of product indicated.

B. As-Built Data: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.

C. Test Records: Submit the following test records to the Engineer for review and approval, and include in the operational and maintenance manuals:

1. Grounding system tests per paragraph FIELD QUALITY CONTROL in Part 3 of this Section.

1.04 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.01 CONDUCTORS:

A. Insulated General Purpose: UL and NFPA 70 approved types, copper, with THW, XHHW or dual rated THHN-THWN insulation color identified green.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.

C. Size conductors not less than what is shown on the drawings and not less than required by the NFPA 70.

2.02 GROUND BUS:

A. Pre-drilled rectangular bars of annealed copper, 1/4 by 4 inches in cross-section with 9/32 inch holes spaced 1-1/8 inches apart. Stand-off insulators shall comply with UL 891 for use in switchboards, 600V and shall be Lexan or PVC, impulse tested at 5000V.

2.03 GROUND RODS:

A. Copper-clad steel, sectional type, 3/4-inch diameter by 20 feet long.

2.04 CONNECTORS:

A. Listed and labeled by a NRTL acceptable to the authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connections:

1. Exothermic welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
2. For structural steel, steel grounding stud for compression connector.

D. Compression Connectors: Hydraulic crimped, irreversible compression type kits. Connectors shall be factory filled with oxide inhibitor. All crimps shall be made with a hydraulic tool that embosses the index number on the outside of the connector.

E. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long barrel, two-bolt connection to ground bus bar.

F. All splices and grounding electrode connections shall be made with exothermic welds or with hydraulic compression fittings.

2.05 INTERSYSTEM GROUND BAR:

A. Complies with UL 467.

B. Base and cover shall be impact resistant and UV rated.

C. Shall be rated for copper and aluminum conductors.

D. Shall have provisions for one main grounding electrode conductor and a minimum of four bonding conductors.

PART 3 EXECUTION

3.01 APPLICATIONS:

A. Conductors: Install solid or stranded conductors for #10 AWG and smaller and stranded conductors for #8 AWG and larger unless otherwise indicated.

B. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

C. Isolated Ground Conductors: Green colored insulation with continuous yellow stripe. On feeders with isolated ground, identify isolated grounding conductor with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors or hydraulic compression connectors except as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.
4. Aboveground Connections to Ground Rods: Bolted connectors.

3.02 INSTALLATION, GENERALLY:

A. Ground in accordance with the NFPA 70 as shown, and as hereinafter specified. All equipment ground conductors shall be terminated on a ground bus or ground lug attached to equipment can.

B. Service Grounding:

1. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus.
2. Install a main bonding jumper between the neutral and ground buses.

C. System Grounding:

1. Secondary service neutrals shall be grounded at the supply side of the secondary disconnecting means and at the related transformers.
2. Separately derived systems (transformers downstream from the service entrance) ground the secondary neutral.
3. Individual Buildings: Bond Main Disconnect ground bus to building steel, 20 foot re-bar in foundation, water pipe, driven ground, and ground ring.

D. Equipment Grounding:

1. Metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be grounded for personnel safety and to provide a low impedance path for possible ground fault currents.

3.03 SECONDARY EQUIPMENT AND CIRCUITS:

A. Transformers:

1. Exterior: Exterior transformers supplying interior service equipment shall also have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the nearest cold water pipe and the nearest structural steel that are effectively grounded. If neither of these are available, provide a driven ground rod or other code approved grounding electrode.

B. Conduit Systems:

1. Ground all metallic conduit systems.
2. Non-metallic conduit systems shall contain a grounding conductor.
3. Conduit provided for mechanical protection containing only a grounding conductor, bond to that conductor at the entrance and exit from the conduit via grounding bushings.

C. Feeders and Branch Circuits: Install green grounding conductors with feeders and branch circuits in all feeders and branch circuits and in any raceway containing a phase conductor.

D. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the grounding wires to each pullbox, junction box, outlet box, cabinets, and other enclosures through which the ground wires pass (except for special grounding systems for intensive care units and other critical units shown.).
2. Make ground wire connections to ground bus in motor control centers, panelboards, etc.

E. Receptacles and toggle switches are not approved for grounding through their mounting screws. Ground with a ground wire from green ground terminal on the device to the outlet box ground screw.

F. Ground lighting fixtures to the green grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixture connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

G. Fixed electrical appliances and equipment shall have a ground lug installed for termination of the green ground conductor.

3.04 CONDUCTIVE PIPING:

A. Bond all conductive piping systems in the building to the electrical system ground. Bonding connections shall be made as close as practical to the water pipe ground or service equipment ground bus.

3.05 SPLICES:

A. All splices and grounding electrode connections shall be made with exothermic welds or with hydraulic compression fittings.

3.06 GROUNDING RESISTANCE:

A. Grounding system ground resistance must not exceed 5 ohms. Final tests shall assure that this requirement is met.

B. Where permanent ground connections are required, make the connections by the exothermic process or hydraulic compression method to form solid metal joints.

C. Where rock prevents the driving of vertical ground rods, install grounding electrodes in horizontal trenches to achieve the specified resistance.

D. Where more than one ground rod is required to meet the specified resistance, they shall be located at least 10 feet apart. Interconnect with grounding electrode conductor below grade and as otherwise indicated.

3.07 PATIENT CARE SPACES – ADDITIONAL GROUNDING REQUIREMENTS

A. Panelboards serving the same individual patient care spaces shall have their equipment grounding busses bonded together with a minimum #6 AWG CU conductor. This includes normal and essential panelboards and essential panelboards fed from different transfer switches.

B. Bond non-powered fixed conductive equipment within the patient care vicinity to the panel ground bus with #10 insulated stranded copper conductor.

C. Grounding Resistance Testing:

1. This contractor shall test the grounding system in patient care spaces using an independent NETA certified testing provider. Testing methods and testing equipment shall comply with the requirements of NFPA 99.
2. Patient Care spaces shall be defined as a location intended for the examination and treatment of patients, extending 6 feet beyond the normal location of the bed, chair, table, treadmill, or other device that supports the patient during examination and treatment and extending vertically to 90 inches above the floor. Other locations shall be included at the discretion of the Owner, Authority having Jurisdiction, and/or Engineer of Record.
3. Testing shall be performed for both renovated and new construction patient care spaces.
4. Testing shall be submitted to the Engineer of Record for review as part of the local, state, or other authorities' required documentation submission process, and shall be a requirement of the project final closeout documentation process. Testing reports shall be submitted to the Engineer of Record no less than 10 business days prior to the submission to the Authority Having Jurisdiction.
5. The grounding system in all patient care spaces shall be tested by voltage and impedance measurements. A grounding reference point shall be utilized as defined in NFPA 99.
   a. Comply with NFPA 99.
   b. The voltage limit shall be 20 mV.
   c. The impedance limit shall be 0.2 ohm for systems containing isolated ground receptacles and 0.1 ohm for all others.

3.08 INSTALLATION:

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where subject to strain, impact, or damage.

B. Grounding electrode conductors shall be continuous.

3.09 FIELD QUALITY CONTROL:

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation. Inspect compression type connections for proper die index number embossment.

B. Perform the following testing:

1. After installing grounding system, but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system as each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance no fewer than two full days after the last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81. Submit test results to the Engineer.

c. Excessive Ground Resistance: If resistance to ground exceeds specified values, promptly notify Engineer, and include recommendations for reducing ground resistance.

END OF SECTION 260526

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Description:

1. This section includes the furnishing, installation, and connection of raceways, fittings, and boxes to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
2. The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

B. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Non-metallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Non-metallic wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes and enclosures.
7. Handholes and boxes for exterior underground cabling.

1.03 DEFINITIONS:

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

D. RGS: Rigid galvanized steel.

1.04 ACTION SUBMITTALS:

A. Product Data (Where indicated in Section “Common Work Results for Electrical”, provide the following information): For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings (Where indicated in Section “Common Work Results for Electrical”, provide the following information): For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.05 INFORMATIONAL SUBMITTALS:

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
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.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

PART 2 PRODUCTS

2.01 RACEWAYS:

A. Raceway Size: In accordance with the NFPA 70 but not less than 1/2-inch unless otherwise shown. Where permitted by the NFPA 70, 1/2-inch flexible conduit may be used for connections to recessed lighting fixtures.

B. Raceway Supports:
1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
2. Pipe Straps: Fed. Spec. FF-S-760, Type I, Style A or B.
3. Individual Raceway Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
4. Multiple Raceway (trapeze) hangers: Not less than 1-1/2 by 1-1/2 inch, 12 gauge steel, cold formed, lipped channels or not less than 2-1/8 by 2-1/8 inch, 18 gauge B-Line “4Dimension Channel”; with not less than 3/8-inch diameter steel hanger rods.
5. Solid Masonry and Concrete Anchors: Fed. Spec. FF-S-325; Group III self-drilling expansion shields, or machine bolt expansion anchors Group II, Type 2 or 4, or Group VIII.

C. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2.02 CONDUIT:

A. Install raceway types as shown on drawings and as listed below.

B. Metal Conduit:
1. Rigid steel: UL 6 and ANSI C80.1.
2. Rigid aluminum: UL 6A and ANSI C80.5.
3. Rigid intermediate steel conduit (IMC): UL 1242 and ANSI C80.6.
4. Electrical metallic tubing (EMT): U.L. 797 and ANSI C80.3. Maximum size 5-inch. Permitted only with cable rated 600 volts or less.
5. Flexible steel conduit (commercial Greenfield): UL 1, zinc-coated steel.
6. Liquid-tight flexible metal conduit: UL 360 flexible galvanized steel tubing covered with extruded liquid-tight jacket of polyvinyl chloride (PVC). Provide conduit with a continuous copper bonding conductor spiral between the convolutions.
7. PVC Coated Rigid Steel: NEMA RN 1. Conduit and fittings shall be as manufactured by Robroy Industries; Plasti-Bond, Perma-Cote, and KorKap or Thomas & Betts; Ocal. Any deviation will require approval of the specifying Engineer or Owner.
   a. Shall be UL listed.
   b. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.
   c. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.

C. Conduit Fittings for Metal Conduit:
1. Comply with NEMA FB 1 and UL 514B.
2. Rigid steel and IMC conduit fittings:
   a. Standard threaded couplings, locknuts, bushings, and elbows: Fed. Spec. W-F-408, except only material of steel or malleable iron is acceptable. Integral retractable type IMC couplings are acceptable also.
   b. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure

c. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted. Bushings for conduit smaller than 1-1/4-inch shall have flared bottom with ribbed sides.

d. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

e. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank coverplates having the same finishes as that of other electrical plates in the room.

f. In trade sizes 2-1/2 inches to 4-inches for rigid steel raceway or intermediate metal raceway, contractor may use Allied 'Kwik-Couple' fittings in lieu of individual steel couplings. 'Kwik-Couple' fittings shall not be used in hazardous locations. Where 'Kwik-Couple' fittings are used exterior for vertical risers, install fitting with taper end up.

3. Rigid aluminum conduit fittings:

a. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials. Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.

b. Locknuts and bushings: As specified for rigid steel and IMC raceways.

c. Set screw fittings: Not permitted for use with aluminum raceway.

4. Electrical metallic tubing fittings:

a. Fed. Spec. W-F-408, except only material of steel for compression type. Steel or die-cast is acceptable for set screw type. Die-cast compression is not acceptable.

b. Couplings and connectors: Concrete tight and rain tight, with connectors having flared throats. Use gland and ring compression type or set screw type couplings and connectors. Set screw type couplings for conduit 2 inches and larger shall be four set screws each. Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.

c. Indenter type connectors or couplings are prohibited.

d. In trade sizes 1-1/4 inches to 4 inches, contractor may use Allied “Kwik-Fit EMT” or “Kwik-Fit Compression EMT” fittings in lieu of individual steel couplings.

5. Flexible steel conduit (greenfield) fittings:

a. Fed. Spec. W-F-406 and UL 5, except only steel or malleable iron material is acceptable.

b. Clamp type, with insulated throat.

6. Liquid-tight flexible metal conduit fittings:

a. Fed. Spec. W-F-406, except only steel or malleable iron material is acceptable.

b. Type incorporating a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.

7. Expansion and deflection couplings:

a. UL 467 and UL 514.

b. Accommodate, 1.9 cm (0.75”) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, NFPA 70 Section 250.98, and the NFPA 70 code tables for ground conductors.

d. Shall be watertight, seismically qualified, corrosion-resistant, threaded for and compatible with rigid or intermediate metal conduit.

e. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

f. Expansion fittings shall accommodate a minimum of 4-inches of movement.

D. Nonmetallic Conduit:

1. PVC Conduit: NEMA TC 2 and UL 651 Schedule 40, conduit size is 3/4-inch minimum.

E. Conduit Fittings for Non-Metallic Conduits:

1. PVC Conduit: Comply with NEMA TC 3; match to conduit type and material.

2.03 CONDUIT SLEEVES

A. Conduit sleeves shall be one of the following:

1. Rigid steel or IMC conduit with threaded ends and non-metallic bushings on each end.
2. EMT conduit with U.L. Listed slide on non-metallic bushings on each end.

B. Fire rated conduit sleeves shall be:

1. Provided at fire rated walls or penetrations and as indicated on the drawings.
2. EZ-Path, 'Hilti' #CP 653 or approved equal.

2.04 CABLE SUPPORTS

A. Appropriate cable supports shall be used at all times to prevent unnecessary tension or slag in the cable bundles. Support spacing and size shall be as required to comply with applicable ANSI Standards and manufacturers recommendations.

B. Cable Tray: Cable tray shall be provided as shown on the drawings. Cable tray shall be sized to support all cable with a maximum fill of 40%. Refer to section "CABLE TRAYS FOR ELECTRICAL SYSTEMS".

C. J-Hooks: J-Hooks shall be sized to support all cable with a maximum fill of 40%.

1. nVent Caddy #Cat HP Series or approved equal.

D. Cable Wraps: All cable wraps shall be plenum rated re-enterable hook and loop type, sized as required. The use of plastic ties, cable wraps, "zip ties" or compression ties of any kind are prohibited.

2.05 OUTLET BOXES:

A. UL-50, UL514A and NEMA OS 1.

B. Cast metal where required by NFPA 70 or shown, and equipped with rustproof boxes; NEMA FB 1.

C. Sheet metal boxes: 4-inch square, galvanized steel, except where otherwise shown.

D. Boxes installed in concrete or masonry and boxes larger than two gang shall be masonry type.

E. Box extensions used to accommodate building finishes shall be of the same material as the recessed box.

F. Boxes for use with IMC or RGS raceways shall be cast 'F' type or stainless steel unless noted otherwise on the drawings.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

2.06 WIREWAYS AND AUXILIARY GUTTERS:

A. Sized according to NFPA 70.

B. Equip with hinged covers, except where removable covers are shown. Wireways shall only be permitted as indicated on the drawings or approved by the Engineer.

C. Fittings and accessories: Include covers, couplings, offsets, elbows expansion joints, adapters, hold down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

D. Metal Wireways:

1. Sheet metal complying with UL 870 and NEMA 250.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70 and shall be marked for intended location and application.

2.07 PULL AND JUNCTION BOXES:

A. Small boxes shall comply with NEMA OS 1.

B. Larger boxes shall comply with UL 50 and NEMA 250.

C. Pull and junction boxes shall be code gauge steel boxes with hinged, bolted or screwed covers. Boxes shall be flush or surface mounted as shown or required.

D. Junction and pull box shall be installed where shown on drawings and additional boxes shall be installed if required for pulling of wire provided location and installation is approved by the Architect. All boxes shall be code construction with screw type cover and shall be installed in accessible locations.

E. Pull and junction boxes for use with IMC or RGS raceways shall be cast 'FS' type or stainless steel unless noted otherwise on the drawings. Comply with NEMA FB 1 and UL 1773 with gasketed cover.

2.08 POKE THROUGH OUTLETS:

A. Shall be UL listed for a minimum 2-hour floor rating and shall be as specified on the drawings and/or in the Special Outlet Schedule.

B. Flush, 3" core poke thru shall be provided with 20A, 120 volt duplex receptacle and/or other devices indicated. Verify colors with Architect.

C. Flush 4" core (service fitting type) poke thru shall be low profile type with interchangeable service fitting plates. When used for both communications and power; provide two separate raceways through the floor with two separate junction boxes below the floor for conduit connection. Provide with 20A. 120 volt duplex receptacle(s) and other devices as indicated.

D. Approved manufacturers shall be Hubbell, Steel City or MonoSystems, Inc.

2.09 SURFACE METALLIC RACEWAY:

A. Raceways shall be Wiremold #500 minimum or #700 for small sizes and Wiremold Series 2000, 3000, and 4000 for larger capacities or equal by MonoSystems, Inc. In all cases, do not exceed the fill per the manufacturers published data.

B. Use outlets and fittings by the same manufacturer and approved for use with the raceway.

C. Provide multiple compartment raceways where power and low voltage wiring are located in the same raceway.

PART 3 EXECUTION

3.01 RACEWAY:

A. Minimum 1/2-inch for above grade or Access Control, 3/4-inch for below grade or Fire Alarm, and 1-inch on site or for Telecommunications, unless otherwise noted.

B. A ground wire, sized per NFPA 70 Section 250.122 shall be installed in all conduits containing phase conductor(s).

C. RGS or IMC must be used at all times when exposed to weather or physical abuse and in all NFPA 70 classified hazardous locations. EMT may not be used in direct contact with earth, or in concrete slabs on grade.

D. All nonmetallic (PVC and fiberglass) conduits shall be provided with separate ground conductor sized per NFPA 70.

3.02 PENETRATIONS:

A. Cutting or Holes:

1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Structural Engineer prior to drilling through structural sections.

2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space.

B. Fire Stop:

1. Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases, and maintains specified fire rating. Fire stops shall be UL listed for the wall rating and construction method. Completely fill and seal clearances between raceways and openings with the fire stop material.
2. Fire stops shall be installed according to applicable codes.
3. Each firestopping location shall be labeled on each side of the penetrated fire barrier, within 300 mm (12 in.) of the firestopping material as specified in the latest edition of ANSI/TIA-606. Documentation of fire stops shall be in accordance with the latest edition of TIA-606.

C. Fire Barrier Penetration Seals:

1. Manufacturer: Subject to compliance with requirements, provide fire barrier penetration seals of one of the following:
   a. Electro Products Div./3M
   b. Nelson; Unit of General Signal.
2. Provide seals for any opening through fire-rated walls, floors, ceilings, or assemblies used as passage for components such as conduits or cables.
3. Cracks, voids or holes up to 4-inch diameter: Use putty or caulking, one-piece intumescent elastomer, non-corrosive to metal, compatible with synthetic cable jackets, and capable of expanding 10 times when exposed to flame or heat and UL-listed.
4. Openings greater than 4-inch diameter and raceway sleeves thru floors at telephone terminal boards: Use sealing system capable of passing 3-hour fire test in accordance with ASTM E-814, consisting of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 degrees to 350 degrees F (121 to 177·C), that is UL-listed. KBS "Sealbags" manufactured by P-W Industries will be acceptable.
5. Execution: Fill entire opening with sealing compound. Adhere to manufacturer's installation instructions. All fire barrier seals shall meet the rating of the wall.

D. Waterproofing:

1. Install sleeves and sleeve seals at exterior floor, exterior wall, and roof conduit penetrations and completely seal clearances around the conduit and sleeve and make watertight as specified in Section, SEALING AND CAULKING.

3.03 CONDUIT SYSTEMS INSTALLATION, GENERAL:

A. Installation: In accordance with UL, NFPA 70, as shown, and as hereinafter specified.

1. Where non-metallic (PVC or fiberglass) conduits are used, a ground wire sized per NFPA 70 Section 250.122 shall be provided if not already specified.

B. All branches of the emergency system shall be installed entirely independent of other raceway systems. Common supports and hangers may be used.

C. Raceway Burial Depths: (Underground work)

1. 18” minimum, 30” maximum cover to grade or bottom of floor slab.
2. 24” minimum under streets, highways, roads, alleys, driveways and parking lots.
3. 2” minimum below concrete slab inside a building.
4. Prior to any underground work, contractor shall verify and locate all existing underground utilities. All existing utilities may not be shown on the drawings. Verify in field with owner and with utility locating services. The contractor shall exercise extreme caution when trenching or boring, hand digging at all crossings and where in close proximity of existing

utilities. Repair existing parking lots, streets, roads, alleys, driveways, etc. to its original condition in a timely manner prior to substantial completion. Contractor shall be responsible for any damage to underground utilities.

5. Underground conduits shall be installed in a sand bed and in an organized manner.

D. Install raceways as follows:

1. Comply with NECA 1, comply with NECA 101 for metal conduit and NECA 102 for aluminum conduit except where requirements on drawings or this article are stricter.
2. In complete runs before pulling in cables or wires.
3. Flattened, dented, or deformed raceways are not permitted. Remove and replace the damaged raceways with new undamaged material.
4. Assure raceway installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
6. Mechanically and electrically continuous.
7. Independently support raceway. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts.). Group raceways with common supports where possible. Conduit shall be supported within 12-inches of connectors.
8. Close ends of empty raceway with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
9. Raceway installations under fume and vent hoods are prohibited.
10. Secure raceways to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For RGS and IMC raceway installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make raceway connections to junction box covers.
11. Flashing of penetrations of the roof membrane is specified in Section, FLASHING AND SHEET METAL.
12. Raceways shall not be used as a support.
13. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the raceways.
14. Tightening set screws with pliers is prohibited.
15. Keep raceways a minimum of 6 inches away from parallel runs of flues and steam or hot-water pipes.

E. Raceway Bends:

1. Make bends with standard raceway bending machines.
2. Raceway hickey may be used for slight offsets, and for straightening stubbed out raceways.
3. Bending of raceways with a pipe tee or vise is prohibited.

F. Raceways Installed Under Metal - Corrugated Sheet Roof Decking

1. Where rigid metal conduit or intermediate metal conduit is not used, raceways shall be installed and supported so the nearest outside surface of the raceway is not less than 1.5 inches from the nearest surface of the roof decking.

G. PVC coated RGS:

1. Use only fittings listed for use with this type of conduit.
2. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduit and fittings. Use sealant recommended by conduit manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit.

4. All clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide should be vigorously followed. Installer certification, before installation, is required.

3.04 CONCEALED WORK INSTALLATION:

A. General:

1. Raceway and Outlet Boxes Installation: All raceway systems work and outlet boxes shall be installed concealed in walls, floor and roof construction or concealed within furred spaces or above ceilings. In equipment or mechanical rooms exposed work shall include feeders and connections to equipment unless noted otherwise.

B. In Concrete:

1. Raceway: RGS, IMC, PVC or EMT; except do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
2. Align and run raceways in direct lines.
3. Install raceways through concrete beams only when the following occurs:
   a. Where shown on the structural drawings.
   b. As approved by the Structural Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of raceways in concrete that is less than three inches thick is prohibited. All raceways installed in concrete shall be approved by the Structural Engineer.
   a. Raceway outside diameter larger than one-third of the slab thickness is prohibited.
   b. Space between raceways in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
   c. Install raceways approximately in the center of the slab so that there will be a minimum of 3/4-inch of concrete around the raceways.
5. Make couplings and connections watertight.

C. Above Furred or Suspended Ceilings and in Walls:

1. Raceways for conductors 600 volts and below:
   a. RGS, IMC, rigid aluminum, or EMT. Types mixed indiscriminately in the same system are prohibited.
   b. Do not use aluminum in wet locations or in contact with concrete.
2. Raceways for conductors above 600 volts:
   a. RGS or rigid aluminum. Do not use aluminum in wet locations or in contact with concrete.
   b. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
3. Align and run raceways parallel or perpendicular to the building lines.
4. Connect recessed or lay-in lighting fixtures and all other devices installed in a lay-in ceiling to raceway runs with flexible metal conduit extending from a junction box to the fixture. Provide a ground wire in all flexible conduits.
5. Tightening set screws with pliers is prohibited.

3.05 EXPOSED WORK INSTALLATION:

A. Raceways for Conductors 600 volts and below:

1. RGS, IMC, rigid aluminum, or EMT. Types mixed indiscriminately in the system are prohibited.
2. Do not use aluminum in wet locations or in contact with concrete.
3. All raceways exposed to physical abuse and in all industrial pump, treatment plant locations shall be RGS, or IMC.

B. Raceways for conductors above 600 volts:

1. RGS or rigid aluminum. Do not use aluminum in wet locations.
2. Aluminum mixed indiscriminately with other types in the same system is prohibited.

C. Align and run raceways parallel or perpendicular to the building lines.

D. Install horizontal runs close to the ceiling or beams and secure with raceway straps.

E. Surface metallic raceways:

1. Surface metallic raceway shall only be used where shown on the drawings, and in remodels and modifications to existing where wall and ceiling voids do not permit concealed installation but shall not be used at any other location unless called for on the drawings.
2. All surface raceway and outlets must be painted to match the surface it is attached to.
3. Install a ground wire sized per NFPA 70 Section 250.122 for the largest circuit in the raceway if not already specified.

F. Painting:

1. Paint exposed raceways as specified in Section, PAINTING.
2. Paint raceways containing cables rated over 600 volts safety orange as specified in Section, PAINTING. In addition, paint legends, using 2-inch high black numerals and letters, showing the cable voltage rating. Provide legends where raceways pass through walls and floors and at maximum 20-foot intervals in between.

3.06 WET OR DAMP LOCATIONS:

A. Unless otherwise shown, use raceways of RGS or IMC above grade. Use PVC conduit below grade, except RGSfiberglass ells and risers shall be used.

B. Provide sealing fittings, to prevent passage of water vapor, where raceways pass from warm to cold locations, i.e., (refrigerated spaces, constant temperature rooms, air conditioned spaces) or similar spaces.

C. When RGS ells and risers are used below grade or when RGS or IMC conduit or RGS ells and risers are used below concrete building slabs in contact with soil, gravel, or vapor barriers, conduit shall be PVC coated RGS or PVC coated IMC.

D. Rooftops:

1. Where raceways or cables are exposed to direct sunlight on or above rooftops, raceways or cables shall be installed a minimum of 7/8” above the roof to the bottom of the raceway or cable.
2. The ampacity of conductors or cables shall be de-rated in accordance with N.E.C. Section 310.15(B)(3)(c).
3. Raceways or cables shall be supported up off the surface of the roof with a polymeric rooftop support equal to Caddy Pyramid series. Supports shall be non-penetrating and shall be designed to prevent damage to the roofing materials. Wood supports are not allowed.

3.07 CORROSIVE LOCATIONS:

A. Conduit shall be PVC coated RGS.

3.08 MOTORS AND VIBRATING EQUIPMENT:

A. Use flexible metal conduit (Type FMC) for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission. Provide liquid-tight flexible metal conduit Type (LFMC) for installation in exterior locations, kitchens, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, treatment plants, pump stations, and locations subject to seepage or dripping of oil, grease or water. Provide a green ground wire with all flexible metal conduit.

3.09 EXPANSION JOINTS:

A. Expansion fittings shall be used wherever the change in length of PVC conduit due to temperature variation exceeds 0.25-inches per NEC Section 352.44.

B. All conduits routed outdoors or in non-conditioned spaces (i.e., attics, non-insulated plenums, etc.) shall have expansion fittings per the following:

1. Steel: One expansion fitting in runs longer than 40 feet. Provide additional expansion fittings every 200 feet.
2. Aluminum: One expansion fitting in runs longer than 20 feet. Provide additional expansion fittings every 100 feet.
3. PVC: One expansion fitting in runs longer than 20 feet. Provide additional expansion fittings every 50 feet.

C. Equip raceways 3-inches and larger, that are rigidly secured to the building structure on opposite sides of a building expansion joint, with expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

D. Equip raceways smaller than 3-inches, that are rigidly secured to the building structure on opposite sides of a building expansion joint, with junction boxes located 12-inches either side of the expansion joint. Connect junction boxes with 24-inches of flexible conduit that is slack (to allow for movement). Flexible conduit shall have an insulated copper bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 3-inches and larger conduits are acceptable.

3.10 RACEWAY SUPPORTS, INSTALLATION:

A. All raceways shall have supports at maximum spacing of 10-feet and within 3-feet of a fitting, elbow, change of direction, box outlet or enclosure. Safe working load shall not exceed 1/4 of proof test load of fastening devices. This shall apply to both vertical and horizontal conduit runs.

B. Use pipe straps or individual raceway hangers for supporting individual conduits.

C. Support multiple raceway runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the raceways, wires, hanger itself, and 200 pounds. Attach each raceway with U-bolts or other approved fasteners.

D. Support raceways independently of junction boxes; pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:

1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
2. Existing Construction:
   a. Steel expansion anchors not less than 1/4-inch bolt size and not less than 1-1/8 inch embedment.
   b. Power set fasteners not less than 1/4-inch diameter with depth of penetration not less than 3-inches.
   c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts are permitted. Bolts supported only by plaster are not acceptable.

G. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

H. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

I. Chair, wire, or perforated strap shall not be used to support or fasten conduit.

J. Spring steel type supports "caddy clips" that are listed for the intended use are acceptable in appropriate locations.

K. Vertical Supports: Vertical raceway runs shall have riser clamps and supports in accordance with NFPA 70 and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.11 BOX INSTALLATION:

A. Boxes for Concealed Raceways:

1. Mount flush. Boxes protruding from the finished wall surface or with more than 1/8-inch gap between the wall or outlet mounted in the box will be changed out with all wall reconstruction expense paid by the Electrical Contractor.
2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

D. Outlet boxes in the same wall mounted back-to-back are prohibited.

E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4-inches square by 2-1/8 inches deep, with device covers for the wall material and thickness involved.

F. Where lighting fixtures and appliance outlets are to be mounted in concrete or in plaster finish on concrete, outlet boxes shall be installed in forms at exact dimensions from bench marks, columns, walls or floors.

G. Where lighting fixtures and appliances outlets are to be mounted on masonry walls and/or plastered furring or other finish, outlet boxes shall be roughed in to general location before installation of wall and furring and shall be reset to exact dimensions before walls and furring are constructed.

H. All outlet boxes shall be set true to horizontal and vertical lines parallel to walls, floors and ceilings and true to finish lines. All boxes shall be secured to ceilings or walls so all installations are solidly mounted.

I. Boxes mounted to wall studs shall be secured to a horizontal box mounting bracket equal to B-Line Series #BB2 or Caddy Series #SGB. B-Line Series #BB4, Caddy Series #H23 or equal one piece support brackets may be used for mounting light switch boxes only. However, metal stud clips with far side box supports are not acceptable.

J. Boxes for exterior exposed work (where approved by the engineer) shall be Appleton or Pyle National Type FS or FSC for shallow devices and Type FD or FDC for deep devices. Boxes for ceiling mounted light fixtures shall have approved no-bolt fixture studs. Boxes used as junction boxes shall have beveled edge flat steel blank cover.

K. Where outlet boxes are mounted exposed in unfinished areas, (where approved by the engineer) surface mounted boxes shall be 4-inches square, have rounded corners and 1/2-inch raised steel cover plates.

L. Location of outlets on small drawings is approximate and exact dimensions for locations of outlets shall be as taken from large scale plans and details on drawings or as directed by the Architect/Engineer.

1. Outlets shall be located generally from column centers and finished wall lines or to center of wall or joints between wall panels. Ceiling outlets shall be installed at elevation of suspended ceiling connected to outlets in ceiling or slab above. Where necessary to fit and center with panel or ceilings and wall spaces, the contractor must, at no expense the Owner, shift the lighting outlets or other outlets as required by the Architect.

M. Clock outlets shall be mounted 7-inches below ceiling height unless otherwise noted on the drawings. All other outlets shall be mounted at heights above floor as called for on drawings or as directed.

N. Bracket lights over mirrors shall be centered on mirrors with 2-inch fixture clearance above mirror.

O. Boxes for switches and receptacles installed in columns shall be located off center to allow for future partitions.

P. Boxes for switches at or near door shall be installed on the side opposite the hinge. Verify door swing direction prior to rough-in.

Q. To prevent sound from traveling through walls, electrical devices from different rooms shall not be mounted in the same stud place. Through-wall boxes shall not be used. In fire rated walls or partitions, outlet boxes on opposite sides of walls or partitions shall be separated by a horizontal distance of 24-inches. Outlet boxes larger than 4-inch square shall not be installed in fire rated walls or partitions. Verify location of fire rated walls or partitions with Architectural drawings prior to rough-in.

R. Mark all junction boxes and pull boxes and/or the conduit where it enters the box with panel designation and circuit number in permanent, black marker. Mark on the outside where located in unfinished spaces and mark on the inside in finished spaces.

S. Verify exact location of floor boxes and poke-throughs with Architect prior to rough-in.

3.12 DIVISION 27 AND DIVISION 28 SYSTEMS CONDUIT:

A. These specifications include the furnishing of all labor and materials necessary for the complete installation of a system of conduits, outlets, and boards for use by the system suppliers.

B. This installation must be done according to the requirements of the system suppliers and the general specifications covering "Light and Power" herewith.

C. Low Voltage Cable Pathways:

1. Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.
2. All pathway components shall be installed according to the manufacturer’s specifications.
3. Grounding/Earthing and bonding of pathways shall comply with applicable codes and regulations.
4. Pathways shall not have exposed sharp edges that may come into contact with low voltage systems cables.
5. Pathways shall not be located in elevator shafts.
6. Vertically routed cables through chases must be supported per manufacturer's instructions and applicable ANSI Standards to prevent cable tension from occurring.
7. Cable Tray: All cabling should be installed in low voltage cable trays where possible. Power cable must never reside in the same cable tray as the low voltage system cabling. All cabling installation procedures shall also adhere to the recommended “Do’s” and Don’ts” in TIA 568.
8. J-Hooks: J-Hooks shall be used in common areas where cable trays are not available and/or as indicated on the plans. J-Hooks shall be located with a maximum spacing of 3’-0” on center. Cables shall not contact the ceiling, piping, light fixtures, ducts, etc. All cables must be suspended independently from other supports.
9. Cable Wraps: Cable wraps shall be used at appropriate intervals to secure cable between j-hooks or cable trays, and to provide strain relief at termination points. These wraps shall not be over tightened to the point of deforming or crimping the cable sheath. Cable wraps should rotate 360 degrees when applied correctly. Spacing shall be a maximum of 3’-0”. Placement shall not be over cable labels. Cable wraps (zip-tie type) shall not be used as a means of support.
10. Conduit Sleeves. Conduit sleeves shall be provided where cables are indicated to pass though walls and at other locations as indicated on the plans. Sleeves shall be 2-inch conduit minimum extending 6-inches on either side of walls. Where possible, sleeves shall be located 6-inches above ceiling.

D. Provide and install pull boxes at all locations as required by the system suppliers. Mark all pull boxes and/or the conduit where it enters the box with type of system in permanent, black marker. Mark on the outside where located in unfinished spaces and mark on the inside in finished spaces.

E. Provide and install conduit sleeves thru floors and walls as required by the system suppliers.

F. The systems shall be provided with main service conduit sized as indicated on drawings. Each phone, data or TV location requires 1-inch empty conduit with pull rope unless noted otherwise. Conduits shall be routed to nearest associated telephone or data terminal board or above lay-in ceiling. If ceiling is an air return plenum, cables shall be routed completely in conduit or must be rated for use in air return plenum. Verify conditions of job prior to rough-in.

G. Install the raceway system as shown on drawings.

H. All conduit ends shall be equipped with non-metallic insulated bushings.

I. All 2, 3 and 4-inch conduits within buildings shall include pull boxes after every two 90 degree bends. Size per the latest edition of TIA-569.

J. Vertical conduits/sleeves through closets floors shall terminate not less than 3-inches above the floor and not less than 3-inches below the ceiling of the floor below.

K. Terminate conduit runs to/from the associated telephone or data backboard in a closet or designated space at the top or bottom of the backboard. Conduits shall enter closets next to the wall and be flush with the backboard.

L. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.

M. All empty conduits located in equipment closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.

N. Conduit runs shall contain no more than two quarter turns (90 degree bends) between pull boxes/backboards.

O. Furnish and install nylon pull rope in all empty conduits. (Sleeves through floor/wall are exceptions).

3.13 COLOR CODING OF BOXES, ENCLOSURES, CONDUIT AND RACEWAYS:

A. All boxes and enclosures shall be color coded as follows:
   1. Essential Electrical System:
      a. Life Safety Branch: Yellow
      b. Critical Branch: Orange
      c. Equipment Branch: Green

B. All boxes, enclosures, conduit and raceways, shall be color coded as follows:
   1. Other Systems:
      a. Fire Alarm: Red
      b. Building Automation and Controls: Blue

END OF SECTION 260533

SECTION 26 05 36
CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY:

A. Scope: Extent of the work required by this Section is indicated on the drawings and by the requirements of this Section.

B. Types: Types of cable tray specified in this Section include the following:

1. Provide continuous, rigid, welded steel wire mesh cable management system as shown on drawings for low voltage system cables.

1.02 QUALITY ASSURANCE:

A. Codes and Standards: Provide cable tray systems conforming to the following:

1. National Electrical Manufacturers Association (NEMA): Comply with the current applicable sections of NEMA standards publications, including:
   a. VE 1 Metallic Cable Tray Systems.
2. National Fire Protection Association (NFPA): Comply with applicable sections of NFPA 70, "National Electrical Code."
3. UL Solutions (UL): Provide cable tray systems that are listed and labeled by UL.

B. Standard Products and Experience: Comply with the applicable sections of Division 1.

C. Certification: Contractor shall be a certified installer from the manufacturer.

1.03 SUBMITTALS:

A. Product Data: Submit manufacturer's data to verify conformance with the requirements of these specifications and of the drawings. Include the following data:

1. Materials.
2. Finishes.
3. Dimensions.
4. Protection of cable insulation.
5. Fittings.
6. Electrical continuity of trays and fittings for grounding purposes.
7. Working load capacities including load/span designations.
8. Load and deflection tests.

B. Shop Drawings: Provide shop drawings showing the following minimum data:

1. Type.
2. Width and loading depth.
3. Straight sections, fittings, and accessories.
4. Radii of elbows.
5. Supports.

PART 2 PRODUCTS

2.01 GENERAL:

A. Manufacturer. Subject to compliance with requirements, provide cable tray products from the following:

1. Cablofil Inc., EZ Tray
2. Flextray
3. B-Line
4. MonoSystems, Inc.

5. Cope Cable Tray Systems
6. Basor Electric
7. Snake Tray
8. Chatsworth
9. Or approved equal

B. Basket-Style Cable Tray: Cable Tray shall be constructed of high quality electroplated, carbon steel wire ASTM A510 Grade 1008 welded steel wire, 2, 4, 6, 8, 12, 18 & 24 inch wide with 4 inch x 2 inch wire mesh spacing. Side stringers shall be 2 inch for 2 inch and 4 inch wide tray, 4 inch for trays 6 inch wide and larger and shall have safety edges. Cross members shall be welded together to create a mesh net for cable support. Provide surface treatment after welding and bending. Wire diameter – 0.177 inches min.

C. Accessories and special transitions shall be provided for all changes in direction and offsets. Transitions shall have 12 inch bend radius. Use manufacturers standard fittings including bolting assemblies for all end-to-end connections. Provide cable drop out bending radius protectors at each location cable exits the tray.

D. For connection of cable tray segments, provide the fast splice device with stabilgrip edge.

E. Color shall be “Black” in telecommunications rooms. Otherwise, color shall be “Silver”.

F. U L Listed System

G. NFPA 75: Standard for the Fire Protection of Information Technology Equipment.

2.02 SUPPORTS:

A. All Sections of the cable tray shall be supported to meet load criteria of L/240 and per the manufacturer recommendations.

B. Wall angle supports shall be steel angles 12 inch maximum tray width. Ends to be smooth without hooks or projections. Brackets shall be 600 lbs.

C. Suspended trays 8 inch wide and larger shall be supported on each side of the tray.

D. All horizontal and vertical 90-degree elbows, tees, and crosses shall be made with 12 inch bend radius and be attached to cable tray sections with standard mounting devices.

E. For cable entry and exit in telecommunications spaces, open cabling method pathways to cable tray, and at the last cable tray segment of a pathway, provide the cable drop out bracket for proper cable bend radius at all cable entrance/exits from tray.

F. Provide brackets as required for installation of cable tray in telecommunication rooms.

G. Supports for installation of cable tray shall include 3/8 inch threaded rod, (min.) with nut, washers, and all components necessary for a complete cable tray installation.

H. Before installation of all low voltage cabling being routed in cable tray, provide cable roll devices at each 90 turn in the cable tray pathway, at each entry into the telecommunications room and as required.

PART 3 EXECUTION

3.01 LOW VOLTAGE CABLE TRAY INSTLLATION

A. Installation and configuration shall conform to the requirements of the ANSI/EIA/TIA Standards 568A and 569, NFPA 70 (National Electrical Code), and applicable code.

B. Support cable tray on 5' centers. Support cable tray at every transition. Cable tray shall be anchored to the tops of equipment racks and walls using metal braces. Provide additional brackets on ends, and two additional brackets at tees and corners. Securely fasten tray to brackets and supports using clamps manufactured for the purpose. Provide all required cable dropouts, inserts, hardware and supports. Coordinate cable tray location with building structures, other trays and equipment.

C. Cable tray shall be braced or anchored to resist a lateral force facing in any direction in accordance with the IBC, UBC, NEC and all local amendments to these codes.

D. Install fire protection at all wall and floor penetrations. Install firestop material within installed cable trays after cables have been installed.

E. General:

1. Coordinate installation of cable tray to maintain at least 12 inches above and 6 inches to either side of the cable tray for working access after installation. Coordinate installation of cable tray with the communications system equipment. Do not install cable tray closer than 6 inches to any wall unless wall mounted. Coordinate exact routing with all trades to avoid interference.

3.02 GROUNDING:

A. Low Voltage Cable Tray:

1. Provide fully bonded tray system via approved mechanical connections or provide a green #6 AWG insulated ground wire bounded to tray at a maximum of every section, using clamps manufactured for the purpose. Provide bare ground wire in all areas where the cable tray is run in plenums.

2. Bond all tray/ground to building ground systems on maximum 300 feet centers.

END OF SECTION 260536

SECTION 26 05 73
ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY:

A. This Section includes computer-based, short-circuit and protective device coordination studies **.** Protective devices shall be set based on results of the protective device coordination study.

B. The studies shall be prepared for the electrical overcurrent devices to be installed under this project to assure proper equipment and personnel protection.

C. The studies shall be prepared for the electrical overcurrent devices for the emergency system to be installed under this project as required by N.E.C. Section 700.27 to assure proper equipment and personnel protection. The “Emergency System” shall be defined as both normal and emergency line side feeds to automatic transfer switches (ATS) and all devices on the load side of the ATS(s).

D. The protective device coordination study shall present an organized time-current analysis of each protective device in series from the branch circuit panelboard back to the Utility Company transformer . The study shall reflect the operation of each device during normal and abnormal current conditions.

E. Obtain all required information from the Utility Company. If published minimum values are available from the Utility Company, they shall be used for short circuit calculations. Actual values obtained from the Utility Company shall be used for arc flash calculations.

F. The Contractor is responsible for providing all pertinent information required by the preparers to complete the study**.**

1.03 REFERENCES:

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
3. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
4. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
5. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

B. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.04 ACTION SUBMITTALS:

A. Submit equipment shop drawings simultaneously with the protective device study based. The device study shall be based on equipment submitted as part of the equipment shop drawings.

B. Report shall include the following:

1. Executive Summary including Introduction, Scope of Work, and Results/Recommendations.
2. Short-Circuit Methodology Analysis Results and Recommendations.
3. Short-Circuit Device Evaluation Table.
4. Protective Device Coordination Methodology Analysis Results and Recommendations.
5. Protective Device Settings Table.
6. Time-Current Coordination Graphs and Recommendations.
7. Arc Flash Hazard Methodology Analysis Results and Recommendations, including:

a. Details of the incident energy and flash protection boundary calculations.
b. Arc Flash boundary distances.
c. Working distances.
d. Incident Energy levels.
e. Personal Protection Equipment levels.

8. Arc Flash Labeling showing types of labels to be provided. Include descriptive information as well as typical label images.
9. One-line system diagram shall be computer generated and shall clearly identify:
   a. Individual equipment buses
   b. Bus numbers used in the short-circuit analysis
   c. Cable and bus connections between the equipment
   d. Calculated maximum short-circuit current at each bus location
   e. Device numbers used in the time-current coordination analysis
   f. Other pertinent information

C. Certification: Two weeks prior to final inspection, deliver to the Engineer one copy of the following certifications:
   1. Certification by the Contractor that the protective devices have been adjusted and set in accordance with the approved protective device coordination study.

1.05 QUALITY ASSURANCE:

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified herein. Manual calculations are not acceptable.

B. The Contractor shall have the coordination study prepared by a qualified Registered Professional Engineer, licensed in the state where the Project is located. The Registered Professional Engineer shall be an employee of the electrical equipment manufacturer or an approved consultant.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

1.06 REQUIREMENTS:

A. The studies shall be calculated by a computer software program capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 2 PRODUCTS

2.01 STUDIES:

A. The complete study shall include a system one-line system diagram, short-circuit analysis, ground fault analysis, and protective coordination plots

B. Include calculation methods and assumptions.

C. Selected base per unit quantities.

D. Shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other information as related to the calculations.

E. Include notes regarding adequacy or inadequacy of equipment ratings.

F. Include discussion section evaluating the adequacy or inadequacy of the equipment and include recommendations as appropriate for improvements to the system.

2.02 DATA:

A. The Contractor shall furnish all data as required for the electrical system studies.

B. Source combination may include proposed, existing, and future motors and generators.

C. Load data may include proposed, existing, and future loads obtained from the Contract Documents, provided by the Owner and/or Contractor.

D. If applicable, the study shall include fault contribution from existing motors.

2.03 ONE-LINE DIAGRAM:

A. Show, on the one-line diagram, all electrical equipment and wiring to be protected by the overcurrent devices installed under this project. Clearly show, on the one-line, the schematic wiring of the electrical distribution system.

B. Also show on the one-line diagram the following specific information:

1. Calculated fault impedance, X/R ratios, and short circuit values at each bus.
2. Circuit breaker and fuse current ratings and types.
3. Transformer KVA, primary and secondary voltage ratings, percent impedance, X/R ratios, and wiring connections.
4. Voltage at each bus.
5. Identification of each bus.
6. Conduit material, conductor sizes, conductor material, insulation, length, and X/R ratios.
7. Busway ampacity and impedance.
8. Motor horsepower and code letter designation according to NEMA MG 1.
9. Generator kVA, size, voltage, and source impedance.

2.04 SHORT-CIRCUIT ANALYSIS:

A. Prepare short-circuit study for each protective device in series from the branch-circuit panelboard to the Utility Company transformer**.**

B. Fault-Current Study:

1. Systematically calculate the maximum available short-circuit current in amperes rms symmetrical at each bus. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit.

C. Ground Fault Study:

1. Systematically calculate the fault impedance to determine the ground fault currents at each bus.

D. Present the data determined by each study in a table format. Include the following:

1. Device identification.
2. Operating voltage.
3. Protective device.
4. Device rating.
5. Short circuit current.

2.05 PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS:

A. Prepare the coordination curves to determine the required settings of protective devices to assure selective coordination to 0.10 seconds. Graphically illustrate on a log-log graph that adequate time separation exists between series devices, including the Utility Company upstream device**.** Plot the specific time-current characteristics of each protective device in such a manner that all upstream devices will be clearly depicted on one sheet.

B. The following specific information shall also be shown on the coordination curves:

1. Device identification.
2. Voltage and current ratio for curves.
3. 3-phase and 1-phase ANSI damage points for each transformer.
4. No-damage, melting, and clearing curves for fuses.
5. Cable damage curves.

6. Transformer inrush points.
7. Maximum short circuit cutoff point.

C. Develop a table to summarize the settings selected for the protective devices. Include in the table the following:
1. Device identification.
2. Relay CT ratios, tap, time dial, and instantaneous pickup.
3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
4. Fuse rating and type.
5. Ground fault pickup and time delay.

2.06 ARC FLASH HAZARD ANALYSIS:

A. The arc flash hazard analysis shall be performed in conjunction with the short-circuit study and the protective device time-current coordination study.

B. The flash protection boundary and the incident energy shall be calculated for all points in the electrical distribution system (switchgear, switchboards, motor-control centers, panelboards, busways, disconnects, starters, etc.) where work could be performed on energized parts.
1. The following may be omitted from the study: Circuits 240 volt or less fed by a single transformer 125 kVA or less. These locations will be assumed to have a NFPA 70E hazard risk category of 0.

C. Working distances shall be based on IEEE 1584.

D. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions.
1. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions and the final report shall describe, where applicable, how these conditions from worst-case bolted fault conditions.

F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should not be considered beyond five (5) cycles.

G. All equipment requires at least one calculation to be made based on a device located upstream of the equipment to clear the arcing fault.

H. When performing incident energy calculations on the line side of a main breaker, the line and load side contributions must be included in the fault calculation.

I. Miss-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

J. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of two (2) seconds shall be used based on IEEE 1584. Where it is not physically possible to move outside of the flash protection boundary in less than two (2) seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

K. Present the data determined by each study in a table format. Include the following:
1. Arc-Flash Hazard Analysis shall include:
a. Device identification.

b. Bolted fault current level.
c. Arcing fault current level.
d. Flash protection boundary distances.
e. Working distances.
f. Personal-protective equipment classes.
g. Arc flash incident energy levels.

2. The Arc-Flash Hazard Analysis shall report incident energy levels based on recommended device settings for equipment within the scope of the study.
3. The Arc-Flash Hazard Analysis may include recommendations to reduce the arc flash incident energy levels and enhance worker safety.

PART 3 EXECUTION

3.01 FIELD ADJUSTMENTS, SETTINGS, AND MODIFICATIONS:

A. Contractor shall adjust relay and protective device settings according to the recommended settings table provided by the protective device coordination study without additional cost to the Owner.

B. Contractor and equipment supplier shall make necessary minor modifications to equipment as required to accomplish conformance with short-circuit and protective device coordination studies without additional cost to the Owner.

C. The Engineer shall be informed immediately if major equipment or distribution system modifications are required to comply with the protective device coordination study.

3.02 ARC FLASH LABELS:

A. Provide a 4.0 in. x 6.0 in. (minimum) thermal transfer type label of high adhesion polyester for each work location analyzed. Labels shall be printed by a thermal transfer type printer, with no field markings. Labels shall be equal to Brady ultra aggressive polyester or approved equal.

B. The labels shall be designed according to the following standards:
1. UL 969 – Standard for Marking and Labeling Systems
2. ANSI Z535.4 – Product Safety Signs and Labels
3. NFPA 70 – Section 110.16

C. The label shall include the following information:
1. Company information providing study including name and phone number
2. Study report number and issue date
3. Shock Hazard Voltage
4. Flash Protection Boundary (inches)
5. Flash Hazard Category or Minimum Arc Rating (cal/cm^2)
6. Limited, Restricted, and Boundaries (inches)
7. Name of Labeled Equipment
8. Protective device up-stream of labeled equipment
9. Characteristics of up-stream protective device (i.e. device type, manufacturer, trip characteristics, etc.)
10. Required PPE

D. Arc flash labels shall be provided for all equipment identified in the study and the respective equipment access areas per the following:
1. Floor Standing Equipment: Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis study.

2. Wall Mounted Equipment: Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.

E. Labels shall be field installed by the contractor. Contractor to remove any existing arc flash labels completely (including glue residue) prior to installation of arc flash labels. Technician installing the labels shall have completed an 8-hour instructor led Electrical Safety Training Course which includes NFPA 70E material including the selection of personal protective equipment.

F. The vendor supplying the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours).

END OF SECTION 260573

SECTION 26 09 43
NETWORK LIGHTING CONTROLS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Reference the following specification sections for additional related requirements:

1. 262726 Wiring Devices
2. 265100 Building Lighting

1.02 SUMMARY

A. This section includes performance and component requirements for network lighting control systems:

1. Approved manufacturers
2. System requirements
3. System components
4. Lighting control profiles
5. Energy analysis and reporting software
6. System start-up and support features

B. The system shall be capable of fixture level on/off and lighting control. System dimming range in each zone (rooms) shall match the luminaire dimming range within that zone.

C. The lighting control system specified in this section shall provide and digital lighting control.

D. All system devices shall be capable of being networked together, enabling digital communication between devices.

1. The system architecture shall be capable of facilitating remote operation via a computer connection.

E. The system architecture shall be capable of enabling stand-alone zones (rooms) of devices to function in some default capacity, even if network connectivity to the greater system is lost.

F. The system shall not require any centrally hardwired switching equipment.

G. The system shall be capable of architectures.

1.03 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)

1. C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

B. ASTM International (ASTM)

1. D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight.

C. International Electrotechnical Commission.

1. (IEC) 801-2 Electrostatic Discharge Testing Standard.
2. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.

D. International Organization for Standardization (ISO)

1. 9001:2000 – Quality Management Systems.
2. 27000 – Information Security Management

E. National Electrical Manufacturers Association (NEMA)
   1. WD1 (R2005) - General Color Requirements for Wiring Devices.
   2. WD7 (2011) – Occupancy Motion Sensors Standard
F. UL Solutions (UL):
   1. 94 (Current Edition, including all revisions) - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
   2. 489 (Current Edition, including all revisions) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   3. 508 (Current Edition, including all revisions) - Standard for Industrial Control Equipment.
   4. 1472 (1996) - Solid-State Dimming Controls.
   5. 924 (2016) - Emergency Lighting and Power Equipment.
   6. 1008(2014) – Transfer Switch Equipment
   7. 2900-1 - Cybersecurity

1.04 SUBMITTALS

A. Product Datasheets (general device descriptions, dimensions, electrical specifications, wiring details, nomenclature, warranty).
B. Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity.
C. Coordination drawings detailing major elements, components, and systems of lighting control equipment and materials in relationship with other systems, installations, and building component. Indicate locations where space is limited for installation and access and where sequencing and coordination of installation are of importance to the efficient flow of the work.
   1. Submit drawing to Engineer to review for completeness. These drawings will be reviewed and returned with comments. They will not be approved as a shop drawing.
D. Other Diagrams – as needed for special operation or interaction with other system(s).
E. Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up.
F. Hardware and Software Operation Manuals.
G. Other operational descriptions as needed.

1.05 PROJECT CLOSEOUT DOCUMENTATION

A. Provide a factory published manual:
   1. Warranty
   2. Technical support contact
   3. Device address list
   4. Electronic manual on for free download
   5. As-built drawings in accordance with Section 260500 Common Work Results for Electrical.

1.06 QUALITY ASSURANCE

A. All steps in sensor manufacturing process shall occur in North America, including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.
B. All components and the manufacturing facility where product were manufactured must be RoHS compliant.
C. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40-degree Fahrenheit (and Celsius) operation.
D. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

1.07 PROJECT CONDITIONS

A. Only install equipment after the following site conditions are maintained:

1. Ambient Temperature 14 to 105 degrees F (-10 to 40 degrees C)
2. Relative Humidity less than 90% non-condensing
3. Standard electrical enclosures are permanently installed
4. Equipment is protected from dust, debris and moisture

1.08 MAINTENANCE & SUSTAINABILITY

A. Provide new parts, upgrades, and/or replacements available for a minimum of 5 years to the end user.

B. Provide free telephone technical support.

PART 2 PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Lighting controls system (wired) shall match existing: nLight.

2.02 DIGITAL NETWORK LIGHTING CONTROL SYSTEM – GENERAL REQUIREMENTS

A. Sensor Layout and Tuning: Include as part of the base bid for Lighting Control Manufacturer's Sensor Layout and Tuning service

1. Lighting Control Manufacturer to take full responsibility for wired or wireless sensor layout and performance for sensors provided by Lighting Control Manufacturer.
2. Lighting Control Manufacturer to analyze the reflected ceiling plans, via coordination drawings, and design a detailed sensor layout that provides adequate occupancy sensor coverage and ensures occupancy and daylight sensor performance per agreed upon sequence of operations. Contractor to utilize the layouts for sensor placement.
3. During startup, Lighting Control Manufacturer to direct Contractor regarding sensor relocation, as required, should conditions require a deviation from locations specified in the drawings.
4. Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits within one calendar year from Date of Substantial Completion to fine-tune sensor calibration per the agreed upon sequence of operations.

B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.

C. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.

2.03 INPUT DEVICES

A. Coordinate device colors and wall plate finishes as specified in Section 262726 Wiring Devices

B. Wired Occupancy Sensor

1. General Requirements:
   a. Connects directly to compatible drivers and modules without the need of a power pack or other interface.
   b. Turns off or reduces lighting automatically after programmed time delay when a room or area is vacated by the last person to occupy the space.
   c. Accommodates all conditions of space utilization and all irregular work hours and habits.
   d. Comply with UL 94.
   e. Self-Adaptive Sensors: Continually adjusts sensitivity and timing to ensure optimal lighting control for any use of the space; furnished with field-adjustable controls for time delay and sensitivity to override any adaptive features.
   f. Provide capability to:
      1) Add additional timeout system-wide without need to make local adjustment on sensor.

2) Group multiple sensors.

g. Power Failure Memory: Settings and learned parameters to be saved in non-volatile memory and not lost should power be interrupted and subsequently restored.

h. Furnished with all necessary mounting hardware and instructions.

i. Class 2 devices.

j. Ceiling-Mounted Sensors: Indicate viewing directions on mounting bracket.

k. Wall-Mounted Sensors: Provide swivel-mount base.

l. Color: White.

2. Wired Passive Infrared Sensors:

a. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.

b. Ceiling-Mounted Sensors: Provide customizable mask to block off unwanted viewing areas.

3. Wired Dual Technology Sensors:

a. Passive Infrared: Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.

b. Ultrasonic: Utilize an operating frequency of 32 kHz or 40 kHz, crystal-controlled to operate within plus/minus 0.005 percent tolerance.

c. Ceiling-Mounted Sensors: Provide customizable mask to block off unwanted viewing areas.

d. Isolated Relay: Provide an internal additional isolated relay with Normally Open, Normally Closed, and Common outputs for use with HVAC control, Data Logging and other control options where indicated.

e.

C. Wireless Occupancy Sensor

1. General Requirements:

a. Operational life of 10 years without the need to replace batteries when installed per manufacturer's instructions.

b. Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.

c. Does not require external power packs, power wiring, or communication wiring.

d. Capable of being placed in test mode to verify correct operation from the face of the unit.

e. RF Range: 30 feet (9 m) between sensor and compatible RF receiving device(s).

f. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 15, for Class B application.

2.

D. Wall Station

1. Coordinate use of manual switches indicated on plans with Section 262726 Wiring Devices

2. Provide control stations with configuration as indicated or as required to control the loads as indicated.

3. Wired Control Stations:

a. General Requirements:

1) Power: Class 2 (low voltage).

2) UL listed.

3) Provide faceplates with concealed mounting hardware.

4) Borders, logos, and graduations to use laser engraving or silk-screened graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.

4. Multi-Scene Wired Control:
   a. General Requirements:
      1) Allows control of any devices part of the lighting control system.
      2) Allows for easy reprogramming without replacing unit.
      3) Replacement of units does not require reprogramming.
      4) Communications: Utilize RS485 wiring for low-voltage communication.
      5) Engrave keypads with button, zone, and scene descriptions //as indicated on the drawing// //to be selected by Architect// // as selected by Owner//.
5. Wireless
   a. Communicates via radio frequency to compatible dimmers, switches, and plug-in modules.
   b. Does not require external power packs, power or communication wiring.
   c. Allows for easy reprogramming without replacing unit.
   d. Button Programming:
      1) Single action.
      2) Toggle action.
   e. Defined action on press and defined action on release.
   f. Includes LED to indicate button press or programming mode status.
   g. Mounting:
      1) Capable of being mounted with a table stand or directly to a wall under a faceplate.
      2) Faceplates: Provide concealed mounting hardware.
   h. Power: Battery-operated with minimum 10-year battery life.
6. Software Configuration:
   a. Customizable control station device button functionality:
      1) Buttons can be programmed to perform single defined action.
      2) Buttons can be programmed to perform defined action on press and defined action on release.
      3) Buttons can be programmed using conditional logic off of a state variable such as time of day or partition status.
      4) Buttons can be programmed to perform automatic sequence of defined actions.
      5) Capable of deactivating select keypads to prevent accidental changes to light levels.
      6) Buttons can be programmed for raise/lower of defined loads.
      7) Buttons can be programmed to toggle defined set of loads on/off.

E. Daylight Sensor
1. General Requirements
   a. Open-loop basis for daylight sensor control scheme.
2. Exterior
   a. Mount exterior daylight sensors to point due north with constant view of daylight.
3. Interior
   a. Stable output over temperature from 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C).

b. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.

c. Provide linear response from 0 to 10,000 footcandles.

d. Mounting:

1) Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.

2) Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.

3) Provide temporary mounting means to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.

e. Meets California Title 24 requirements.

2.04 END DEVICES

A. Sensor Power Packs:

1. Provide sensor power packs where required for power connection to sensors.

2. For ease of mounting, installation and future service, power pack(s) to be able to mount through a 1/2 inch knockout in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer to provide power to a minimum of three sensors.

3. Plenum-rated.

4. Control Wiring Between Sensors and Control Units: Class 2, 18-24 AWG, stranded UL Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable

B. Relays

1. Electrically operated, mechanically held. Controlled via . Short circuit rating of not less than 5 KA.

C. DRIVERS

1. General Requirements:

a. Operate for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

b. Provide thermal protection by automatically reducing power output to protect LED driver and LED light engine/fixture from damage due to over-temperature conditions that exceed the LED driver's maximum operating temperature at the calibration point (tc).

c. Provide integral recording of operating hours and maximum operating temperature to aid in troubleshooting and warranty claims.

d. Designed and tested to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.

e. Manufactured in a facility that employs ESD reduction practices in compliance with ANSI/ESD S20.20.

f. UL 8750 recognized or listed as applicable.

g. UL Type TL rated or UL Class P listed where possible to allow for easier fixture evaluation and listing of different driver series.

h. Suitable for field replacement as applicable; listed in accordance with UL 1598C or UL 8750, Class P as indicated.

i. Designed and tested to withstand Category A surges of 4,000 V according to IEEE C62.41.2 without impairment of performance.

j. Class A sound rating; Inaudible in a 27 dBA ambient.

k. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

l. LED drivers of the same family/series to track evenly across multiple fixtures at all light levels.

m. Offer programmable output currents in 10 mA or smaller increments within designed driver operating ranges for custom fixture length and lumen output configurations, while meeting a low-end dimming range of 100 to 0.1 percent, 100 to 1 percent or 100 to 5 percent as applicable.

n. Meet NEMA 410 inrush requirements for mitigating inrush currents with solid state lighting sources.

o. Employ integral fault protection up to 277 V to prevent LED driver damage or failure in the event of incorrect application of line-voltage to communication link inputs.

p. LED driver may be remote located up to 100 feet (30 m) from LED light engine depending on power outputs required and wire gauge utilized by installer.

2. Digital Control

a. Employ power failure memory; LED driver to automatically return to the previous state/light level upon restoration of utility power.

b. Operate from input voltage of 120 V through 277 V at 50/60 Hz.

c. Automatically go to 100 percent light output upon loss of control link voltage and lock out system commands until digital control link voltage is restored. Manufacturer to offer UL 924 compliance achievable through use of external Lutron Model LUT-ELI-3PSH interface upon request.

d. Each driver responds independently per system maximum:

e. Up to 32 occupant sensors.

f. Up to 16 daylight sensors.

g. Responds to digital load shed command. (Example: If light output is at 30 percent and a load shed command of 10 percent is received, the ballast automatically sets the maximum light output at 90 percent and lowers current light output by three percent to 27 percent).

h. Digital low-voltage control wiring capable of being wired as either Class 1 or Class 2.

2.05 INTEGRATION

A. BMS

1. The system shall interface with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet MS/TP protocols. The following system integration capabilities shall be available via BACnet/IP and BACnet MS/TP protocols:

2. The system shall support control of individual devices, including, but not limited to, control of relay and dimming output.

3. The system shall support reading of individual device status information. The available status will depend on the individual device type and capabilities, which may include but not be limited to, relay state, dimming output, power measurement, occupancy sensor status, and photocell sensor states or readings. All system devices shall be available for polling for devices status.

4. The system shall support activation of pre-defined system Global Profiles (see Supported Sequence of Operations for further definition of Global Profile capabilities).

B. LAN/VLAN

1. System must interface directly with intelligent LED luminaires such that only CAT-5e/CAT-6/CAT-6a cabling is required to interconnect luminaires with control components such as sensors and switches.

2. Intelligent lighting control devices shall communicate digitally, require minimal current to function, and possess RJ-45 style connectors.

C. PARTITION CONTROL

1. Provide contact closure based on status of the partition wall (open/close) enabling automatic linking of controls.

D. CURTAIN/SHADE

1. Capable of operating shades and recalling shade presets via keypad, contact closure input, infrared receiver, lighting management system software, or other lighting control system interface.
2. Capable of operating any individual, group, or subgroup of shade electronic drive units within system without requiring separate group controllers.
3. Capable of assigning and reassigning individual, groups, and subgroups of shades to any control within system without requiring additional wiring or hardware changes.
4. Capable of controlling shade speed for tracking within plus or minus 0.125 inch (3.17 mm) throughout entire travel.
5. Provide 10 year power failure memory for preset stops, open and close limits, shade grouping and sub grouping and system configuration.
6. Capable of synchronizing multiple shade electronic drive units of the same size to start, stop and move in unison.
7. Capable of stopping shades within accuracy of 0.125 inch (3.17 mm) at any point between open and close limits.
8. Capable of storing up to 250 programmable stop points, including open, close, and any other position.
9. Capable of controlling lights and shades from single wall control button.
10. Capable of adjusting shade limits from user interface.

E. AV (RS232)

1. Provide ability to communicate via Ethernet or RS232 to audiovisual equipment, touchscreens, etc.
2. Provide control of:
   a. Light scene selections.
   b. Fine-tuning of light scene levels with raise/lower.
   c. Shade group presets
   d. Simulate system wall station button presses and releases.
3. Provide status monitoring of
   a. Light scene status.
   b. Wall station button presses and releases.
   c. Wall station LEDs.
4. Provide ability to send custom output strings.

2.06 SYSTEM START-UP AND SUPPORT FEATURES

A. System start-up requirements:

1. To facilitate start-up, all devices daisy-chained together shall automatically be grouped together into a functional lighting control zone.
   a. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
   b. Once software is installed, system shall auto-discover all system devices without requiring any commissioning.

2. All system devices shall be capable of being assigned unique user defined names.

B. System support features:

1. All devices within the network shall be able to have their firmware upgraded remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
2. All sensor devices shall be capable of performing self-diagnostics to detect improper communication wiring. Devices shall blink an indicator LED in a specific cadence to alert installation/startup personnel of improper condition(s).

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions.

B. Provide complete installation of system in accordance with Contract Documents and shop drawings.

C. Define each dimmer's/relay's load type, assign each load to a zone, and set control functions.

D. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

E. Network wire recommended is Belden#1502P (plenum) or equivalent. Wire shall meet color code requirements to insure proper installation of the network polarity.

F. All panels are "masters" and may be added to the network in any location and any amount as long as network installation guidelines are met.

G. Panels are designed to function independently from external control devices.

END OF SECTION 260943

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. General purpose distribution transformers.

1.03 SUBMITTALS:

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer to be provided.

B. Operation and Maintenance Data: Include operation and maintenance data for all transformers in the operation and maintenance manuals.

C. Test Records: Submit the following test records to the Engineer for review and include in the operational and maintenance manuals:

1. Recorded output voltages and tap settings per paragraph ADJUSTING in Part 3 of this Section.

1.04 QUALITY ASSURANCE:

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.05 COORDINATION:

A. Coordinate size and location of concrete bases with actual transformer provided.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

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

1. Square D by Schneider Electric.

2.02 GENERAL TRANSFORMER REQUIREMENTS:

A. Description: Factory assembled and tested designed 60-Hz service.

B. Core and coil assemblies:

1. Shall be rigidly braced to withstand the stresses caused by short circuit currents and rough handling during shipment.
2. Cores shall be grain-oriented, non-aging silicon steel with high magnetic permeability.
3. Coils shall have continuous windings without splices except for taps.
4. Primary, secondary, and tap connections shall be brazed or pressure type.
5. Coil windings shall have end fillers or tie downs for maximum strength.
6. Coil material shall be aluminum or copper.

7. Core and coil assemblies shall be bonded to their enclosures by adequate flexible bonding straps.
8. Coils shall be impregnated with nonhygroscopic thermosetting varnish.
9. Cores shall be constructed with low hysteresis and eddy current losses.
10. Cores shall have a flux density well below the saturation point to prevent core overheating caused by harmonic voltage distortion.
11. Cores shall be of common core construction. Use of more than one core, or Scott-T connections, shall not be acceptable.

C. Ratings shown on the Drawings are for continuous duty without the use of cooling fans.

D. Sound Level Requirements: In accordance with NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

E. Enclosures:
1. Shall be of a type compatible with the environment in which the transformer is installed.
2. Shall be not less than code gauge steel.
3. Ventilation openings shall prevent accidental access to live components.
4. Shall be thoroughly cleaned and painted at the factory with manufacturer's prime coat and standard finish.

F. Wall-Mount Brackets or Ceiling-Mount Brackets: Manufacturer's standard brackets.

2.03 GENERAL PURPOSE DISTRIBUTION TRANSFORMERS:

A. In addition to the General Transformer Requirements above, General Purpose Distribution Transformers shall meet the following requirements:

B. Comply with NEMA ST 20 and list and label as complying with UL 1561.

C. Taps: All transformers rated 30 kVA and larger shall have two 2.5% full capacity taps above normal rated primary voltage, and four 2.5% full capacity taps below normal rated primary voltage.

D. Insulation Class: 220 deg C, UL-component-recognized insulation system. Transformer enclosure warm spot shall not exceed 35 degrees C rise above a 30 degrees C ambient condition. Transformer shall have the following maximum temperature rise above 40 degrees C ambient temperature:
1. Transformers 0-10 kVA: 115 degrees C
2. Transformers 15 kVA and larger: 150 degrees C

E. Energy Efficiency Standard for Transformers Rated 15 kVA and Larger:
1. Meet Efficiency Levels for distribution transformers as specified in DOE 2016 Efficiency.

PART 3 EXECUTION

3.01 EXAMINATION:

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.02 INSTALLATION:

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. For floor mounted transformers, construct 3.5" high concrete bases and anchor transformers according to manufacturer's written instructions.

C. All transformers shall be protected on the primary side by Class 'L' or 'J' time delay fuses or a circuit breaker. Manufacturer shall size and coordinate to allow for transformer inrush and protect transformer from damage.

1. 112.5 kVA and Larger Transformers: Where circuit breakers are used for primary protection, provide Adjustable Electronic Trip Molded Case Circuit Breakers.

3.03 IDENTIFICATION:

A. Label each transformer with an engraved nameplate.

3.04 CONNECTIONS:

A. Ground equipment according to Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section "Low-Voltage Electrical Power Conductors and Cables."

C. Use flexible metal conduit, maximum of 6 feet in length, for conduit connections to the transformer.

3.05 CLEANING:

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.06 ADJUSTING:

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recorded output voltages and tap settings as test results.

END OF SECTION 262200

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. Section includes:

1. Lighting and appliance branch-circuit panelboards.

1.03 SUBMITTALS:

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage surge suppressor, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment, include the following information:

1. Dimensional data.
2. Enclosure type, per NEMA 250.
3. Detailed bus configuration, including current and voltage ratings.
4. Short-circuit current rating of panelboard and overcurrent protective devices.
   a. Where series ratings are permitted and utilized, submit evidence of series ratings for each selected combination of fuses and/or circuit breakers.
5. Evidence of NRTL listing for series rating of installed devices.
6. Detailed features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Layout or elevation of each panelboard showing the relative locations of all specified breakers, lugs, accessories, and features.
8. Wiring diagrams for power, signal, and control wiring.

C. Operation and Maintenance Data: Include operation and maintenance data for all panelboards and components in the operation and maintenance manuals. Data shall include, but not be limited to:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Summary of final settings for all adjustable overcurrent protective devices.
3. Print or copy of all final panel schedules in 8.5" x 11" format.

D. Test Records: Submit the following test records to the Engineer for review and approval, and include in the operation and maintenance manuals:

1. Load Balancing: Submit records of load readings before and after load balancing, per paragraph ADJUSTING in Part 3 of this Section.

1.04 QUALITY ASSURANCE:

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Selection for Restricted Space: Drawings may indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with any indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1 and NFPA 70.

1.05 COORDINATION:

A. Coordinate layout and installation of panelboards and components with other construction that penetrates wall or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and requires clearances for equipment access doors and panels.

B. Coordinate sizes and locations of any concrete bases with actual equipment provided.

1.06 PROJECT CONDITIONS:

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify Owner in writing, not fewer than days in advance of proposed interruption of service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS:

A. All panelboard components shall be the product and assembly of the same manufacturer. All similar units of all panelboards shall be of the same manufacturer.

B. All panelboards shall be completely factory assembled with molded case circuit breakers or switches.

C. Panelboards shall have main breaker, main switch, or main lugs, voltage, bus sizing, and flush or surface mounting as indicated on the Drawings.

D. Enclosures: Flush or surface mounted as indicated on the Drawings

1. Rated for environmental conditions at installed location:
   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Cabinets:
   a. Finish shall be galvanized steel.
   b. Shall not have ventilation openings for panels with bus ratings of 225 amperes or less.
   c. Back and sides shall be fabricated from one piece of formed steel for lighting and appliance branch-circuit panelboards.
   d. Shall contain a minimum of four interior mounted studs and necessary hardware for "in" and "out" adjustment of panel interior.
   e. Gutter sizes for cabinets containing through-feeders shall be increased by the amount required for auxiliary gutters in the NEC.
   f. For multi-section flush-mounted panelboards, all cabinets shall be the same height.
3. Front Trim:
   a. Shall include frame and door with concealed hinges.
   b. Shall be secured to cabinet with screws. Trim clamps are not allowed.
   c. Shall be galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting top coat.
   d. Shall be same width and height as cabinet for surface-mounted panels. Shall overlap cabinet by at least 0.75 inches for flush-mounted panels.
   e. Shall not have ventilation openings for panels with bus ratings of 225 amperes or less.
   f. Shall include a welded angle on the rear to support and align trim to cabinet.
   g. Shall be separate for each section of multi-section panelboards. For flush installations, trims and doors of all sections shall be the same height.
4. Doors:

a. Shall be galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting top coat.
b. Shall be provided with concealed butt hinges welded to the doors and trim.
c. In making switching devices accessible, doors shall not uncover any live parts.
d. Shall have metal directory card holder with transparent protective cover for card, permanently mounted to inside of door.
e. Shall have the manufacturer's standard flush lock. All panels (existing and new) shall use the same key.

E. Phase, Neutral, and Ground Buses:
1. Material shall be plated copper, with copper connection straps bolted together and rigidly supported on molded insulators.
2. Phase bus bars for panels with single pole branches shall be arranged for sequential phasing of branch circuit devices.
3. Phase bus bar connections for breakers with trip settings of 100 amperes and less shall be arranged so that a two-pole breaker may be substituted for two single-pole breakers, and a three-pole breaker may be substituted for three single-pole breakers, without any modifications to the bus bars or connecting straps.
4. Protective devices shall be able to be replaced without removing adjacent units or main bus connectors, and without drilling or tapping. Panel phase bus connections to protective devices shall be field removable by means of a screwdriver.
5. Neutral bus shall be full sized. Neutral bus shall be rated for 200 percent of phase bus ampacity for panels fed from K-Factor Rated transformers and as indicated on the Drawings.
6. Equipment ground bus shall be bonded to cabinet, and shall have adequate terminals and lugs for all branch circuit and feeder equipment grounding conductors.
7. Isolated ground bus shall be provided when indicated on the Drawings. It shall be insulated from the cabinet, and shall have adequate terminals and lugs for all branch circuit and feeder isolated grounding conductors.
8. In multi-section panelboards, the bussing in each section shall be full size. In all except the final section, provide sub-feed line-side lugs or feed-through load-side lugs for cable connections to the other sections. Sections with tapped bus or cross-over bus shall not be accepted.
9. Coordinate lug quantities and sizes with the feeders serving the panel, as scheduled on the Drawings.

F. Future Devices: Where designated on panel schedule or one-line diagram as "space" or "future", include all mounting brackets, bus connections, filler plates, and necessary appurtenances necessary for installation of devices.

G. Panelboard Short-Circuit Current Rating:
1. Refer to the Drawings for required A.I.C. ratings for each panelboard.
2. Panelboards shall bear a UL label indicating the integrated equipment rating.
3. Rating Options:
a. Fully rated panelboards and circuit breakers.

2.02 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS:

A. Shall comply with the GENERAL REQUIREMENTS FOR PANELBOARDS listed above.

B. 240 Volt Panelboards: Subject to compliance with requirements, provide product from one of the following list of manufacturers and types:
1. Square D by Schneider Electric: NQOD

C. Shall comply with NEMA PB 1, lighting and appliance branch-circuit type.

D. Branch Overcurrent Protective Devices: Shall be bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Shall have flush latch. For doors over 36" in height, provide two latches.

2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES:

A. Molded Case Circuit Breaker (MCCB):

1. Molded Case Circuit Breakers shall comply with the requirements specified in Section "Overcurrent Protective Devices".
2. Circuit breakers shall be factory-installed in the panelboards in the same numbered positions indicated on the Drawings.
3. Thermal-Magnetic or Non-Adjustable Electronic Trip Molded Case Circuit Breakers shall be provided for all panelboard circuit breakers less than 400 amperes, unless noted otherwise.
4. Adjustable Electronic Trip Molded Case Circuit Breakers shall be provided for all panelboard circuit breakers 250 amperes and larger, unless noted otherwise.
5. Where indicated on the drawings breaker shall be provided with a handle blocking clip, allowing the breaker to be blocked in the "ON" position.
6. Adjustable Electronic Trip Molded Case Circuit Breakers shall be provided for all panelboard circuit breakers feeding 112.5 kVA and larger low-voltage transformers.

B. Fused Switch:

1. Fused switches shall comply with requirements specified in Section "Enclosed Switches and Circuit Breakers".
2. Fuses shall comply with requirements specified in Section "Overcurrent Protective Devices".

2.04 SURGE PROTECTIVE DEVICES:

A. Shall comply with requirements specified in Section "Surge Protective Devices for Low-Voltage Electrical Power Circuits".

PART 3 EXECUTION

3.01 EXAMINATION:

A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

B. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION:

A. Where indicated on the Drawings, install panelboards on concrete bases, in addition to attaching them to the vertical finished or structural surface behind the panelboard.

B. Install wall-mounted panelboards so that the maximum height of the highest circuit breaker or switch above the finished floor does not exceed 78 inches. The bottom of the cabinet shall not be less than 6 inches above the finished floor.

C. Mount panelboard cabinet plumb and rigid, without distortion of the box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

D. Arrange panelboard sections for easy removal without disturbing other sections. Locate sections so that present and future conduits can be conveniently connected. Coordinate sizes of cabinets with the designated installation space.

E. Where flush-mounted panelboards are specified, install one 3/4-inch empty conduit into an accessible ceiling space for every three single-pole spare breakers or breaker spaces, for future use.

F. Multi-section panelboards shall be coupled together by conduit nipples appropriately sized for all feeder wiring installed between the sections.

G. Where multi-section panelboards are flush-mounted, sections shall be arranged side by side and shall be 1.5 inches apart.

H. Arrange conductors in gutters into neat groups and bundle and wrap with nylon cable ties.

I. At the direction of the Architect or Engineer, where panelboards are installed in public areas, paint the exposed surfaces of the trims, doors, and cabinets to match surrounding wall finishes after the panelboards are installed.

3.03 IDENTIFICATION

A. Identify all field-installed conductors, interconnect wiring, and components.

B. Panelboard Nameplates: Label each panelboard with a nameplate as indicated on the Drawings and as specified elsewhere.

C. Create a type-written schedule of circuits in each panelboard, after approval of the Engineer, and install in the directory holder in each panelboard.

1. Circuit descriptions shall include final room numbers, room descriptions, and items or equipment served.
2. Spare breakers and breaker spaces shall be marked in the schedule.
3. Schedules shall be typed on paper directory cards, or printed on card stock appropriately sized for the directory sleeves provided on the panel door.

3.04 ADJUSTING:

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Load Balancing: If the contractor modifies the circuiting arrangement from what is shown on the plans, the contractor shall be responsible for balancing the loads between phases. The maximum difference of load between phases shall not exceed 20%. Submit calculations to the engineer for review.

C. All adjustable trip circuit breakers shall be, as a default, set by the manufacturer to match as closely as possible the trip curve of a fuse of the same ampacity rating (Class J fuses for 600 amperes and less, Class L for over 600 amperes). Ground fault default settings shall be minimum time delay and low pickup, and shall be field adjusted up as necessary to avoid nuisance tripping.

1. Contractor may use reduced settings during construction if desired.

D. Set final values for all field-adjustable circuit breaker trip ranges as directed by the Engineer.

END OF SECTION 262416

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY:

A. This section includes the furnishing, installation, and connection of wiring devices.
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Receptacles with integral surge-suppression units.
   3. Isolated-ground receptacles.
   4. Hospital-grade receptacles.
   5. Tamper-resistant receptacles.
   6. Weather-resistant receptacles.
   7. Snap switches and wall-box dimmers.
   8. Pendant cord-connector devices.
   9. Cord and plug sets.

1.03 DEFINITIONS:

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
D. RFI: Radio-frequency interference.
E. SPD: Surge Protective Device.

1.04 ADMINISTRATIVE REQUIREMENTS:

A. Coordination:
   1. Receptacles for Owner Furnished Equipment: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

1.05 ACTION SUBMITTALS:

A. Product Data (Where indicated in Section “Common Work Results for Electrical”, provide the following information): For each type of product.
B. Shop Drawings (Where indicated in Section “Common Work Results for Electrical”, provide the following information): List of legends and description of materials and process used for premarking wall plates.

1.06 CLOSEOUT SUBMITTALS:

A. Operational and Maintenance Data: For wiring devices to include all manufacturers’ packing label warnings and instruction manuals that include labeling conditions.

PART 2 PRODUCTS

2.01 GENERAL WIRING DEVICE REQUIREMENTS:

A. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.
B. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with NFPA 70.

2.02 RECEPTACLES:

A. Comply with NEMA WD 1, NEMA WD 6, and UL 498.

B. LIST OF ACCEPTABLE RECEPTACLE MANUFACTURERS

Manufacturer	Volt	Hubbell / Kellems	Leviton	P&S	Bryant	Cooper Wiring Devices
3. Hospital Grade:						
Duplex:	20 A. 125 V.	HBL8300	8300	8300	BRY8300	8300
Ground Fault:	20 A. 125 V.	GFRST83	GFNT2-HG	2097HG	GF83*ST	---
Isolated Ground:	20 A. 125 V.	IG8300	8300-IG	IG8300	BRY8300IG	IG8300
Tamper Resistant:	20 A. 125 V.	HBL8300SGA	8300-SG	TR63H	BRY8300TR	TR8300
Weather Resistant:	20 A. 125 V.	---	---	---	BRY8300WR	---
Tamper Resistant Ground Fault:	20 A. 125 V.	GFTWRST83	GFTR2-UG	2097HGTR	---	---
Weather Resistant Ground Fault:	20 A. 125 V.	GFTWRST83	GFWT2-UG	---	---	---
Tamper/Weather Resistant GFCI:	20 A. 125 V.	GFTWRST83	GFWT2-UG	---	---	---

C. Weatherproof duplex receptacles shall be weather resistant GFCI grounded duplex receptacles.
   1. All receptacles shall be mounted with the same orientation (horizontal or vertical). When a different orientation is required or desired, obtain permission from the Architect/Engineer prior to rough-in.
   2. Damp Locations: Provide with a single weatherproof coverplate.
   3. Wet Locations: Provide “In-Use” extra-duty metallic weatherproof cover.
      a. Hubbell #WP26E (vertical) or #WP26EH (horizontal)
      b. Red Dot #CKMUV (vertical) or #CKMU (horizontal)
      c. Taymac #MX3200(vertical) or #MX3300 (horizontal
      d. Intermatic #WP1010MXD (vertical) or #WP1010HMXD (horizontal)See plans for Special Outlet Schedule.

D. Receptacle body shall be formed of high-impact nylon faced thermoplastic or urea and receptacle contacts shall be Bronze. Hard use industrial specification grade receptacles shall have a one piece brass bridge with integral ground contacts.

E. All receptacles shall be self-grounding with ground lug.

F. Install receptacles to clear all cabinets, equipment, etc.

G. Color of receptacles: Ivory. Color of receptacles on the emergency system: Red. Verify colors with Architect prior to ordering.

H. All 120V, 20A receptacles located, within kitchens, within 6 feet of a sink, exterior locations, elevator machine rooms, elevator pits, garages, per NFPA 70 and as located on the plans shall be ground fault circuit interrupters (GFCI) for personnel protection (Class A) with 5ma trip. Feed through GFCI receptacles or GFCI breakers may be used to protect other receptacles in the same room and on the same circuit if wired per the manufacturer's recommendations. Prior to final inspection, perform ground fault test on each protected receptacle and submit list of all receptacles tested with results to the Engineer. Label receptacles that are GFCI protected by another feed through GFCI receptacle or by GFCI breaker "GFCI protected".

I. Provide duplex receptacle on separate circuit beside each telephone terminal board location and other communications equipment requiring 120V, power.

J. All 20 amp, 125 or 250 volt non-locking receptacles in damp or wet locations should be listed as “weather resistant”.

2.03 PENDANT CORD-CONNECTOR DEVICES:

A. Description:
   1. Matching plug and receptacle body connector.

2. Body: Nylon with screw-open, cable-gripping jaws and provisions for attaching external cable grip.
3. External Cable Grip: Woven wire mesh type made of high-strength, galvanized steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.04 CORD AND PLUG SETS:

A. Description:
1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket, with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable clamping jaws. Match cord and receptacle type for connection.

2.05 TOGGLE SWITCHES:

A. Wall Switches: Wall switches in general, used to control lighting shall be quiet operating.

B. Comply with NEMA WD 1, UL 20, and FS W-S-896.

C. Switches shall be single pole, two-pole, three-way, four-way, keyed, and with pilot light as called for on the drawings. Groups of switches shall be under one gangplate. Where switches are in fire rated walls groups of switches shall be maximum of two (2) gangs under one cover plate.

D. Switches shall be as follows unless specified otherwise.

Single Pole	20 A. 120 V. / 277 V.
Two Pole	20 A. 120 V. / 277 V.
Three-Way	20 A. 120 V. / 277 V.
Four-Way	20 A. 120 V. / 277 V.
Pilot Light	20 A. 120 V. / 277 V.
Key Switch	20 A. 120 V. / 277 V.

E. When only one switch is connected to a 20 amp circuit by itself, it must be rated 20A.

F. All switches shall be self grounding w/ground lugs.

G. LIST OF ACCEPTABLE SWITCH MANUFACTURERS

Manufacturer:	P&S	Hubbell / Kellems	Leviton	Bryant	Cooper Wiring Devices
Specification Grade Switches	PS 20AC Series	HBL 1220 Series	1220 Series	4901	AH 1220 Series
Light Commercial/ Residential Grade	500-G Series	CSB 120 Series	1100-G Series	CSB120 Series	CSB120 Series
Key Switches:	PS 20AC-L Series	HBL 1220-L Series	1221-L Series	4901L	AH 1220 Series
Pilot Light Switches	PS 20AC-CPL Series	HBL 1220-PL Series	1221-PLR Series	4901PLR Series	AH 1220 PL Series

H. Pilot light switches shall be illuminated toggle switch lighted red in "on" position. Key switches shall be master keyed.

I. Color of switches: Ivory. Color of switches on the emergency system: Red. Verify colors with Architect prior to ordering.

J. Provide barriers between 277V switches and between 277V and 120V switches installed in a common outlet box.

2.06 WALL PLATES:

A. Wall plates shall be flexible (non-breakable) nylon or polycarbonate
B. Wall plates in industrial areas, gymnasiums, maintenance areas, warehouses and other high abuse areas shall be stainless steel.
C. Nylon plate color shall be Ivory unless otherwise specified. Nylon plate color for devices on the emergency system shall be Red unless otherwise specified. Verify colors prior to ordering. Nylon plate manufacturer shall be the same as the device manufacturer so that colors match.
D. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
E. Provide plates for all telephone, cable TV, communication outlets.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Installation shall be in accordance with NFPA 70, and as shown on the drawings.
B. Comply with NECA 1.
C. Switches shall be located on the latch side of all doors. If switches must be located on the hinge side of a door, they shall be located so that they are not behind the door when it is open. All questionable locations shall be brought to the Engineers/Architects attention.
D. Verify all outlet locations on the job prior to rough-in. Locations may be altered up to 6'-0" in any direction without additional cost to the Owner.
E. When conductors larger than #12 AWG are used on 15A or 20A circuits, splice #12 AWG pigtails for device connections.
F. Install ground pin up on vertically mounted receptacles and install ground pin to the right on horizontally mounted receptacles.
G. Dimmers: Do not remove cooling fins from dimmers. Space boxes as required.

3.02 FIELD QUALITY CONTROL:

A. Convenience Receptacles:
   1. Verify ground continuity.
   2. Verify correct polarity of hot and neutral conductors.
B. Hospital Grade Receptacles:
   1. In addition to above tests for convenience receptacles, test straight-blade receptacles in patient care rooms for the retention force of the grounding blade shall not be less than 4 oz. per NFPA 99.
   2. Provide test reports per NFPA 99.
   3. In addition, comply with testing requirements listed in Section “Overcurrent Protective Devices” under heading “Grounding Resistance Testing Patient Care Spaces”.

END OF SECTION 262726

SECTION 26 28 10
OVERCURRENT PROTECTIVE DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. Section includes:

1. Cartridge fuses rated 600 VAC and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor control centers.
2. Plug fuses rated 125 VAC and less for use in enclosed switches and fuseholders.
3. Spare fuse cabinets.
4. Molded Case Circuit Breakers (MCCBs)
5. Insulated Case Circuit Breakers (ICCBs)
6. Molded Case Switches

1.03 DEFINITIONS:

A. ICCB: Insulated Case Circuit Breaker

B. MCCB: Molded Case Circuit Breaker

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, and descriptions of individual components.

1. Dimensions and manufacturer's technical data on features, performance, and electrical characteristics.
2. Current and voltage ratings.
3. Short-circuit current ratings (both interrupting and withstand, as appropriate).
4. Evidence of UL listing for series rating of installed devices.

B. Operation and Maintenance Data:

1. Manufacturer's written instructions for testing, operating, and adjusting overcurrent protective devices.
2. Summary of final settings for all adjustable overcurrent protective devices.

C. Performance Testing: For each system requiring performance testing, submit a written record of the test results and include with the associated system's Operations and Maintenance Data.

1. For arc energy reduction system testing methods other than primary current injection, submit a Performance Testing Plan with the associated Product Data submittal for review and approved by the Architect/Engineer. Test results obtained from testing methods other than primary current injection will not be accepted without Architect/Engineer pre-approval.

1.05 QUALITY ASSURANCE:

A. Source Limitations: Obtain overcurrent protective devices, components, and accessories, within same product category, through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for the intended locations and application.

C. Comply with NFPA 70.

D. Comply with NEMA FU 1 for cartridge fuses.

E. Comply with UL 248-11 for plug fuses.

F. Comply with UL 489 for circuit breakers.

1.06 COORDINATION:

A. Coordinate overcurrent protective device ratings with utilization equipment nameplate limitations of maximum fuse and/or breaker size and with system short-circuit current levels.

B. Final fuse sizes for mechanical and other motor loads shall be selected by the fuse manufacturer to provide Type-2 “no damage” protection for equipment served. Contractor shall provide and install the selected fuses.

1.07 EXTRA MATERIALS:

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

1. Fuses: Equal to 10 percent of quantity of installed fuses for each size and type but no fewer than three for each size and type.

PART 2 PRODUCTS

2.01 FUSES:

A. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Mersen Electrical Power
4. Littelfuse, Inc.

B. Cartridge Fuses:

1. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
2. Fuse Classes:
   a. Class-CC: UL 248-4, time-delay, rejection type
   b. Class-J: UL 248-8, dual-element, time-delay
   c. Class-L: UL 248-10, dual-element, time-delay

C. Plug Fuses:

1. Characteristics: UL 248-11, dual-element, time-delay, Edison base.

2.02 SPARE FUSE CABINET:

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

B. Size: Adequate for storage of all spare fuses specified with 20 percent minimum extra spare capacity.

C. Finish: Gray, baked enamel.

D. Identification: Engraved nameplate to read “SPARE FUSES” in 1.5” high letters on exterior of door.

E. Fuse Pullers: Provide for each size and type of fuse, where applicable and available, from the fuse manufacturer.

2.03 MOLDED-CASE CIRCUIT BREAKERS:

A. Shall be provided as factory installed components of panelboards or switchboards, or as separately enclosed units, as specified in other Sections or on the Drawings.

B. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company
3. Siemens Infrastructure and Cities (Siemens IC)
4. Square D by Schneider Electric

C. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

D. Standard Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Line connections shall be bolt-on.
   3. Lugs: Mechanical type, suitable for the trip rating, number and size of conductors, and conductor material.
   4. Multi-pole units shall be enclosed in a single housing or be factory-assembled to operate as a single unit. They shall have a trip element for each pole, a common trip bar for all poles, and a single operator.
   5. Operating handle shall indicate ON, TRIPPED, and OFF positions.
   6. Shall be 80% rated, unless 100% rating is shown on the Drawings or is otherwise specified.
   7. Application Listing: Appropriate for application:
      a. Type SWD for switching fluorescent lighting loads.
      b. Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      c. Type HACR for feeding heating, air conditioning, and refrigeration equipment.

E. Optional Features and Accessories: Provide where indicated on the Drawings or otherwise specified.
   1. Ground-Fault Protection: Relay and trip unit with push-to-test feature.
   2. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
   3. Handle Padlocking Device: Fixed attachment, for padlocking circuit-breaker handle in off position.
   4. Shunt Trip: 120-Volt trip coil energized from separate circuit, set to trip when at least 75% of coil voltage is applied, with coil clearing contact.
   5. Auxiliary Contacts: One SPDT switch with “a” and “b” contacts; “a” contacts mimic circuit-breaker contacts; “b” contacts operate in reverse of circuit-breaker contacts.
   6. Key Interlock Kit: Externally mounted to prohibit circuit breaker operation; key shall be removable only when circuit breaker is in off position.
   7. Alarm Contacts: One SPDT switch with “a” and ‘b” contacts; “a” contacts mimic circuit breaker contacts; “b” contacts operate in reverse of circuit breaker contacts.

F. Thermal-Magnetic (or Non-Adjustable Electronic Trip) Circuit Breakers:
   1. Shall have inverse time element for low-level overloads.
   2. Shall have instantaneous magnetic trip element for short circuits.
   3. Shall have front-mounted, field-adjustable magnetic trip setting for circuit-breaker frame sizes 250 amperes and larger. Factory setting shall be LO, unless otherwise noted.

G. Adjustable Electronic Trip Circuit Breakers:
   1. Shall have RMS sensing.
   2. Shall have field replaceable rating plug and field replaceable electronic trip unit.
   3. Shall have the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long-time delay and pickup levels.
      c. Short-time delay and pickup levels.
      d. Ground-fault pick-up level, time delay, and I2t response.
         1) Ground fault functions shall not be provided on systems operating at less than 150 volts to ground unless specifically noted otherwise.

4. Shall have a digital current ammeter.
5. Shall have a trip test button to provide a means to manually trip the breaker.
6. Shall have permanently installed provisions for padlocking the breaker in the open position.
7. Field adjustable settings shall be protected by a transparent cover.
8. Shall have communications interface. For circuit breakers that require power or minimum power flow to the trip unit in order to make settings, provide portable battery power unit so settings can be made during no power or low power flow situations.

H. Current-Limiting Circuit Breakers: Frame sizes 400 amperes and smaller; shall have let-through ratings less than NEMA FU 1, RK-5.

I. Ground-Fault Circuit Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip) with self-test circuitry.

J. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

K. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-Volt, single pole configuration.

L. Circuit Breakers and/or Trip Units Rated 1200 Amp and Larger: Provide an energy-reducing maintenance switching system to temporarily reduce the instantaneous pickup setting of the circuit breaker. Provide all components as required for a fully functional system. All components shall be clearly labeled. The energy-reducing maintenance switching system shall consist of the following:

1. Energy reduction maintenance setting switch.
2. Blue status light to indicate energy-reducing maintenance system is active.

2.04 INSULATED CASE CIRCUIT BREAKERS:

A. Shall be provided as factory installed components of switchboards or switchgear, as specified in other Sections or on the Drawings.

B. General Requirements: Shall comply with UL 489, UL 891, and applicable NEMA and NEC requirements.

C. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company
3. Siemens Infrastructure and Cities (Siemens IC)
4. Square D by Schneider Electric

D. Insulated Case Circuit Breaker (ICCB) Features and Accessories:

1. Shall be a sealed, insulated-case power circuit breaker, manually operated, with interrupting capacity to meet available fault current.
2. Shall have a two-step, stored energy closing mechanism.
3. Shall have a minimum short-time (30 cycle) withstand rating of 42,000 amperes.
4. Shall be 100% rated.
5. Shall have fixed mounting, unless draw-out construction is shown on the Drawings or is otherwise specified.
6. Shall have provisions for padlocking the breaker in the open position.
7. Shall have a full function, microprocessor-based trip unit with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long-time delay and pickup levels.

c. Short-time delay and pickup levels.
d. Ground-fault pick-up level, time delay, and I2t response.
1) Ground fault functions shall not be provided on systems operating at less than 150 volts to ground unless specifically noted otherwise.

8. Shall have a trip test button to provide a means to manually trip the breaker.
9. Shall have communications interface.
10. Where indicated on the Drawings or otherwise specified, shall have an externally mounted key interlock kit to prohibit circuit breaker operation. Key shall be removable only when circuit breaker is in off position.

E. Circuit Breakers and/or Trip Units Rated 1200 Amp and Larger: Provide an energy-reducing maintenance switching system to temporarily reduce the instantaneous pickup setting of the circuit breaker. Provide all components as required for a fully functional system. All components shall be clearly labeled. The energy-reducing maintenance switching system shall consist of the following:
1. Energy reduction maintenance setting switch.
2. Blue status light to indicate energy-reducing maintenance system is active.

2.05 MOLDED-CASE SWITCHES:

A. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company
3. Siemens Infrastructure and Cities (Siemens IC)
4. Square D by Schneider Electric

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame interrupting rating.

C. Features and Accessories:
1. Standard frame sizes and number of poles.
2. Lugs: Suitable for the trip rating, number and size of conductors, and conductor material.
3. Provide the following options or accessories where indicated on the Drawings or otherwise specified:
a. Shunt Trip: 120-Volt trip coil energized from separate circuit, set to trip at 75 percent of rated voltage, with coil clearing contact.
b. Auxiliary Contacts: Two SPDT switches with “a” and “b” contacts; “a” contacts mimic circuit-breaker contacts; “b” contacts operate in reverse of circuit-breaker contacts.
c. Key Interlock Kit: Externally mounted to prohibit circuit breaker operation; key shall be removable only when circuit breaker is in off position.

PART 3 EXECUTION

3.01 EXAMINATION:

A. Examine overcurrent protective devices before installation. Reject units that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install overcurrent protective devices of sizes and with characteristics appropriate for each piece of equipment.

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

3.02 FUSE APPLICATIONS:

A. Cartridge Fuses:

1. Service Entrance: Class-J for up to 600 A; Class-L for over 600 A
2. Feeders: Class-J for up to 600 A; Class-L for over 600 A
3. Motor branch circuits: Class-J for up to 600 A; Class-L for over 600 A
4. Single-phase motor and other branch circuits where appropriate fuse holders are specified in other Sections: Class-CC

B. Plug Fuses:

1. Motor and other branch circuits: Edison-base type.

3.03 CIRCUIT BREAKER APPLICATIONS:

A. Refer to applicable Drawings and Specification Sections for information on types of circuit breakers to be installed in particular applications. Applicable Sections may include, but not be limited to, “Panelboards”, and “Enclosed Switches and Circuit Breakers”.

3.04 INSTALLATION:

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare fuse cabinet(s) in locations as indicated on the Drawings

3.05 IDENTIFICATION:

A. Install labels complying with requirements found on the Drawings and elsewhere in this Specification. Install labels at every fused switch and each fuse block, socket, or holder which indicate fuse replacement information

3.06 PERFORMANCE TESTING

A. Arc Energy Reduction: Arc energy reduction protection systems shall be performance tested when first installed on site by primary current injection testing or another approved method in accordance with NFPA 70. Submit a written record of this testing in accordance with paragraph SUBMITTALS.

B. Service Disconnect Ground-Fault Protection: The ground-fault protection system shall be performance tested when first installed on site by primary current injection testing in accordance with NFPA 70. Submit a written record of this testing in accordance with paragraph SUBMITTALS.

END OF SECTION 262810

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. Section includes:
   1. Fusible Switches
   2. Nonfusible Switches
   3. Shunt Trip Switches
   4. Toggle Type Switches
   5. Fustats
   6. Enclosed Circuit Breakers
   7. Enclosures

1.03 DEFINITIONS:

A. NC: Normally closed

B. NO: Normally open

1.04 SUBMITTALS:

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, factory setting, accessories, and finishes.
   1. Enclosure types and details for types other that NEMA 250, Type 1.
   2. Current and voltage ratings.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work. Include wiring diagrams for power, signal, and control wiring.

C. Operation and Maintenance Data: Include operation and maintenance data for all enclosed switches and circuit breakers in the operation and maintenance manuals. Data shall include, but not be limited to:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.05 QUALITY ASSURANCE:

A. Source Limitations: Obtain enclosed switches and circuit breakers, components, and accessories, within same product category, through one source from a single manufacturer.

B. Product Selection for Restricted Space: Drawings may indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for the intended locations and application.

D. Comply with NFPA 70.

1.06 COORDINATION:

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and requires clearances for equipment access doors and panels.

1.07 PROJECT CONDITIONS:

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions
   1. Notify Owner in writing, not fewer than five days in advance of proposed interruption of service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

PART 2 PRODUCTS

2.01 FUSIBLE SWITCHES:

A. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:
   1. Square D by Schneider Electric

B. Type GD General Duty switches are not allowed, unless specifically noted otherwise.

C. Type HD, Heavy Duty, Single Throw, 1200A and smaller: UL 98 and NEMA KS 1.
   1. Shall be horsepower rated for the load served.
   2. Shall have clips or bolt pads to accommodate the specified fuses, with rejection features to reject fuses other than those specified.
      a. Refer to Section "Overcurrent Protective Devices" for specified fuse types.
   3. Shall have an external operating handle indicating ON and OFF positions, with provisions to padlock the switch in the OFF position.
   4. Shall have a mechanical interlock to prevent the opening of the cover unless the handle is in the OFF position. This interlock shall be defeatable with a special tool to permit inspection.
   5. Shall have an equipment ground kit. Equipment ground shall be internally mounted and labeled for copper and aluminum ground conductors.
   6. Accessories: Provide where indicated on the Drawings or required to complete the intended design.
      a. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
      b. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
      c. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact arranged to activate before switch blades open.
      d. Hookstick Handle: Allows use of a hookstick to operate the handle.
      e. Service Entrance Rating: Labeled for use as service entrance equipment.

D. Other specialty switch types, such as Six Pole or Double Throw, shall be provided where indicated on the Drawings or as necessary for the equipment served, and shall meet the requirements for Type HD single throw switches above.

2.02 NONFUSIBLE SWITCHES:

A. Shall meet all requirements for FUSIBLE SWITCHES above, except that they shall not accept fuses.

2.03 SHUNT TRIP SWITCHES:

A. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:
   1. Cooper Bussmann, Inc.
   2. Eaton Electrical Inc.; Cutler-Hammer Business Unit
   3. Mersen Electrical Power.
   4. Littelfuse, Inc.

B. General Requirements: Comply with UL 50 and UL 98. Switches used in conjunction with elevators shall also comply with ASME A17.1.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class-J fuse block; padlockable handle interlocked with cover in closed position.

D. Control Circuit: 120-VAC, obtained from an integral control power transformer, with primary and secondary fusing, sized adequately to provide power to operate shunt trip, pilot lights, and indicating and control devices.

E. Standard Features:

1. Oil-tight key switch for key-to-test function.
2. Oil-tight green ON pilot light.
3. Full capacity isolated neutral lug (where specified on the Drawings or necessary to achieve the intended function).

F. Elevator Applications: Where switches are installed to serve elevator machines, provide the following accessories:

1. Mechanically interlocked auxiliary contacts that change state when switch is opened or closed.
2. Form “C” alarm contacts that change state when switch is tripped.
3. Three-pole, double-throw, fire safety and alarm relay, 24 VDC coil voltage. Verify coil voltage with fire alarm system.

2.04 TOGGLE TYPE SWITCHES:

A. Shall be installed where indicated on the Drawings or elsewhere in the Specifications.

B. Shall be 20A, 30A, 40A, or 60A, one, two, or three poles, voltage and horsepower rated for the load served.

C. Shall be provided with matching steel coverplate, with provisions for padlocking the switch in the OFF position.

D. Shall be provided with an appropriately sized mounting box where other than a standard outlet box is necessary for switch installation.

2.05 FUSTATS:

A. 120V motor loads up to 0.5 horsepower: Shall be horsepower rated and include an Edison-base fuse holder and integral toggle switch. Where located in damp or wet locations, provide weatherproof unit equal to Bussman #SSN.

B. 120V motor loads, 0.75 horsepower: Shall consist of a horsepower rated Edison-base fuse holder, with a separate horsepower rated toggle switch mounted adjacent to fuse holder.

C. 120V motor loads, 1 horsepower, or 277V motor loads: Shall consist of a horsepower and voltage rated manual motor starter switch and a horsepower and voltage rated fuse holder designed to hold a time-delay Class CC rejection-type fuse.

1. Manual motor starter switch: NEMA ICS 2, general purpose, Class A, with quick-make, quick-break toggle action, marked to indicate ON, OFF, and TRIPPED. Shall include an ambient-compensated type overload relay with inverse-time characteristics and NEMA ICS 2, Class 10 tripping characteristics. Shall have heaters and sensors in each phase, matched to nameplate full-load current of specific motor it protects and appropriately adjusted for duty cycle.

D. 120V motor loads up to 1 horsepower: Shall be Siemens “LF111N” 30A, 120V disconnect switch with Edison-base fuse holder, NEMA1 rated.

2.06 ENCLOSED CIRCUIT BREAKERS:

A. Circuit breakers shall comply with Section “Overcurrent Protective Devices”.

1. Shall be Thermal-Magnetic or Non-adjustable Electronic Trip Molded-Case for breakers less than 400 amperes, unless noted otherwise.

2. Shall be adjustable Electronic Trip Molded-Case for breakers 400 amperes and larger, unless noted otherwise.

2.07 ENCLOSURES:

A. Comply with NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50.

B. Enclosure Types: Shall be compatible with environmental conditions at installed locations, unless more stringent requirements are specified on the Drawings or elsewhere in the Specifications.

1. Indoor Dry and Clean Locations: NEMA 250, Type 1.

C. Finished Spaces: In finished spaces, enclosures shall be flush mounted unless otherwise noted.

PART 3 EXECUTION

3.01 EXAMINATION:

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the work.

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

3.02 INSTALLATION:

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated. Maximum mounting height and required working clearances shall comply with NFPA 70.

B. Install fuses in fusible devices.

1. Where fuses serve utilization equipment or motors, coordinate final fuse sizes with equipment nameplates and comply with listed minimum and maximum sizes.

2. Plug fuses installed in fustats shall be sized for 125 percent of the nameplate full load amps or running load amps.

C. Comply with NECA 1.

3.03 IDENTIFICATION:

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Label each enclosure with engraved nameplate.

3.04 ADJUSTING:

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit breaker trip ranges.

END OF SECTION 262816

SECTION 26 43 13
SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. Section includes field-mounted and factory-mounted surge protective devices for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Sections:

1. Division 26 Section “Wiring Devices” for devices with integral TVSS.

1.03 DEFINITIONS:

A. ATS: Acceptance Testing Specifications.

B. SPD: Surge Protective Device.

C. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.

D. VPR: Voltage Protection Rating.

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated. Include rated capacities; installed dimensions and operating weights; electrical characteristics, furnished specialties, and accessories.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Include wiring diagrams for power, signal, and control wiring.

C. Operation and Maintenance Data: Include operation and maintenance data for all surge protective devices in the operation and maintenance manuals.

1.05 QUALITY ASSURANCE:

A. Source Limitations: Obtain surge protective devices, components, and accessories, within same product category, through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for the intended locations and application.

C. The unit shall be UL 1449 Listed (internally mounted units shall be UL recognized) as a Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference Filter. Internally mounted units shall maintain the UL Listing of the equipment they are mounted in.

D. Comply with NFPA 70.

E. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

1.06 COORDINATION:

A. Coordinate layout and installation of surge protective devices and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate surge protective devices with Division 26 Section “Electrical Power Monitoring and Control.”

1.07 PROJECT CONDITIONS:

A. Service Conditions: Rate surge protective devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage for 480/277Y and not less than 125 percent of nominal system operating voltage for 208/120Y.

2. Operating Temperature: 30 to 150 deg F (0 to 65 deg C).

3. Humidity: 0 to 95 percent, non-condensing.
4. Altitude: Less than 12,000 feet above sea level.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions:
1. Notify Owner in writing, not fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.08 EXTRA MATERIALS:

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Replaceable Protection Modules: 1 of each size and type installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide product from one of the following list of manufacturers:
1. Square D by Schneider Electric

2.02 GENERAL REQUIREMENTS:

A. UL 1449 Listed.
B. Internally mounted within the electrical equipment unless noted otherwise.
C. Modular design with field-replaceable modules, minimum of 1 module per phase.
D. MOV's shall be individually fused per mode, with a 200-kA minimum interrupting capacity and shall be classified by the NEC as an overcurrent protection device allowing tapped device conductors from a disconnect without an overcurrent device.
E. UL 1449 minimum nominal discharge current rating of 20kA per mode.
F. Bolted compression lugs for internal wiring.
G. Integral disconnecting means if direct bussed connected.
H. Redundant suppression circuits.
I. LED indicator lights for power and protection status.
J. On board diagnostic monitoring with audible alarm, and silencing switch, to indicate when protection has failed and when failure of even one MOV has occurred.
K. Surge-event operations counter.
L. EMI/RFI filtering of -50dB @ 100kHz.

//DESIGNER NOTE: EDIT TABLES BELOW FOR SYSTEM VOLTAGES ON PROJECT.//

M. Protection Modes and UL 1449 Maximum Voltage Protection Ratings shall be as follows:

Voltage	Line-to-Neutral	Line-to-Ground	Neutral-to-Ground	Line-to-Line
120/208Y, 3 Phase, 4 Wire	700V	800V	700V	1200V
277/480Y, 3 Phase, 4 Wire	1200V	1200V	1200V	2000V

2.03 PANELBOARD SURGE PROTECTIVE DEVICES:

A. Devices shall be factory installed with direct bussed connections where possible.

B. If the manufacturer requires a disconnect, an integral disconnect switch or molded case breaker (60 amp min.) shall be provided. Submit testing to demonstrate that overcurrent devices do not open upon peak single impulse surge current test.

C. Arrangement with bussed or wire connections to phase buses, neutral bus, and ground bus. Ground and neutral buses should be relocated to minimize connection lengths. If cables are used, they shall be the lowest impedance possible. Wires shall be kept as short and straight as possible. Do not exceed manufacturer's recommended lead lengths.

D. Modifications to the panelboard shall be UL labeled as a panelboard and as a SPD. For two and three section panelboards, the SPD module shall be installed in the first section where the line connections occur.

E. Peak Single-Impulse Surge Current Rating: 150 kA per phase.

2.04 RETROFIT AND ADD-ON SURGE PROTECTIVE DEVICES:

A. Retrofit SPD's shall be used for existing panelboards and switchboards only.

B. Add-on SPD's shall be used to protect equipment that the SPD cannot be built-in (Example: Control Panels.).

C. Panel extension type is not acceptable.

D. Fed from disconnect switch or molded case breaker (60 amp min.).

1. Arrangement with wire connections to phase buses, neutral bus, and ground bus to utilize the absolute minimum cable length. Ground bus should be relocated to minimize cable lengths

2.05 CONTROL PANELS AND MISCELLANEOUS 120V. EQUIPMENT:

A. Peak Single-Impulse Surge Current Rating:40 kA per phase.

2.06 ENCLOSURES:

A. Internally mounted unless otherwise specified. Add-on devices shall comply with NEMA 250, matching the enclosure or panel being protected.

PART 3 EXECUTION

3.01 INSTALLATION OF SURGE PROTECTIVE DEVICES:

A. Install devices at service entrance on load side of main disconnect, with ground lead bonded to service entrance ground.

B. SPD equipment and devices. Upon completion the Representative shall submit a letter certifying the complete installation is per this specification and per all manufacturer's requirements and recommendations.

C. Retrofit and Add-On Surge Protective Devices:

1. Disconnect switch or molded case circuit breaker shall be located in the first section of the panelboard to be protected.

2. Cables shall have the lowest impedance possible. Locate the switch nearest to the main breaker or M.L.O. Locate the suppressor beside the switch with a close nipple connection. Connect to switch with high strand count #2 Cu. welding cables 6" preferred, (18" maximum length).

3. Do not exceed manufacturer's recommended lead lengths.

3.02 CONNECTIONS:

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

3.03 FIELD QUALITY CONTROL:

A. Testing: Perform the following field quality-control testing:

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with manufacturer's published field testing requirements.

2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

B. Manufacturer shall repair or replace malfunctioning units. Retest after repairs or replacements are made.

C. Verify that electrical wiring installation complies with this specification and manufacturer's installation requirements.

D. Do not perform insulation resistance (megger) tests of the distribution wiring equipment with the surge protective devices installed. Disconnect all wires, including neutral, before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.04 START-UP SERVICE:

A. The manufacturer shall train the Owner's maintenance personnel to adjust, operate, and maintain surge protective devices (minimum one (1) hr of field training).

1. Train Owner's maintenance personnel on procedures and schedules for maintaining suppressors.
2. Review data in maintenance manuals.
3. Contractor shall schedule training with Owner, through Architect, with at least seven days advance notice.

END OF SECTION 264313

SECTION 26 51 00
BUILDING LIGHTING

PART 1 GENERAL:

1.01 DESCRIPTION:

A. This section includes the furnishings, installation of and connection of all building lighting.

1.02 DEFINITIONS:

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

PART 2 PRODUCTS

2.01 LIGHTING FIXTURES:

A. Shall conform to the detail drawings, NEC Article 410 and UL-57.

B. Approved Manufacturers: Provide products of firms regularly engaged in the manufacturer of lighting fixtures of types and rating required, whose products have been in satisfactory use in similar service for not less than 5 years. The manufacturer of the lighting fixtures shall comply with the provisions of the appropriate code and standards. All fixtures shall be pretested before shipping.

C. UL or CSA US Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the “Standards for Safety” to UL 8750 or others as they may be applicable. A listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in the position concealing it from normal view.

D. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

E. Sheet Metal:

1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.
2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.
3. Where lighting fixture types are detailed with minimum 20 gauge (0.035 inch) housing, minimum 22 gauge (0.029 inch) housings will be acceptable provided they have strengthening embossed rib and break formations, and meet the rigidity test requirements of Fed. Spec. W-F-1662.
4. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.
5. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, and latches shall function easily by finger action without the use of tools.

F. LED Drivers shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

G. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

H. Light fixtures with louvers or light transmitting panels shall have doors with hinges, latches and safety catches to facilitate safe, convenient cleaning and relamping. Vaportight fixtures shall have pressure clamping devices in lieu of the latches.

I. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

J. Metal Finishes:

1. The manufacturer shall apply a standard finish (unless otherwise specified) over a corrosion resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking.
2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.
3. Exterior finishes shall be as shown on the drawings.

K. LED Drivers:

1. Driver shall be serviceable while the fixture is in its normally installed position, and shall not be attached to removable reflectors or wireway covers unless so specified.
2. Disconnecting Means: Each LED fixture installed in an indoor location shall have a disconnecting means either internal or external to the fixture, to disconnect simultaneously from the source of supply all conductors of the driver, including the grounded (neutral) conductor if any. The line side terminals of the disconnecting means shall be guarded. The disconnecting means shall be located so as to be accessible to qualified persons before servicing or maintaining the driver. The disconnecting means is required for new light fixtures, when an existing driver is replaced, when an existing light fixture is relocated, and when an existing light fixture is recircuited. The disconnecting means shall not be required for fixtures installed in hazardous (classified) locations or for cord-and-plug-connected fixtures.
3. All drivers shall be labeled or listed by UL or ETL. Case marking shall also indicate the required supply voltage, frequency, RMS current, current surge during starting, input watts, and power factor at the designed voltage, open circuit voltage, crest factor and efficacy.
4. Submit, simultaneously with shop drawings, a certified test report by an independent testing laboratory showing that the ballasts/drivers meet or exceed all the performance requirements in this specification.
5. LED Drivers:
    a. General Requirements: Unless otherwise indicated, features include the following:
        1) Voltage Range: +/- 10 percent of rated input.
        2) Total Harmonic Distortion Rating: ≤ 20 percent.
        3) Power Factor: ≥ 95 Percent.
        4) UL Class 2 output.
        5) Line Frequency: 60 Hz.
        6) Inrush Current: Per NEMA 410.
        7) Ambient Temperature Range: 0°C to 25°C.
        8) Maximum Case Temperature: 90°C.
        9) Sound Rating: Class A or better.
        10) Integral Short Circuit, Open Circuit, and Overload Protection: IEEE C82.41.2
        11) Electromagnetic Compliance: FCC Title 47, Park 15, Class A.

L. Provide all lighting fixtures with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor.

M. Lighting Transmitting Components for Fluorescent/LED Fixtures:

1. Shall be 100 percent virgin acrylic plastic and nominal .125 inch thick. Styrene lenses shall not be provided for any fixture.

2. Unless otherwise specified lenses and diffusers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction of the lens without distortion or cracking. At final inspection, all lens that sag or do not lay down flat and lens that sag shall be replaced by the manufacturer.

2.02 LED MODULES:

A. LED Modules:

1. LED modules shall include the following features unless otherwise indicated:

a. Comply with IES LM-79, LM-80, LM-82 and TM-21 requirements.

b. Minimum CRI 80 and color temperature [3500] K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.

c. Minimum Rated Life: IES L70 = [50,000] hours.

d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

e. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.

2. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

3. Color shift over 6,000 hours shall be <0.007 change in U'V' as demonstrates in the IES LM-80-08 testing report.

2.03 LIGHTING CONTROL EQUIPMENT:

A. See the drawings for the arrangement and method of control. Controls shall operate at 120 volt. Connect to the nearest 120 volt panel or as shown on the drawings.

B. Contactors And Relays:

1. Shall be as manufactured by Cutler-Hammer, Allen Bradley, G.E., Westinghouse or Square D by Schneider Electric. They shall be as sized on the drawings.

2. All contactors and relays shall be Tungsten rated.

2.04 EMERGENCY LIGHTING AND POWER:

A. When emergency battery power packs are optional to the specified exit signs and emergency fixtures and are not included in the model number in the light fixture schedule, the emergency battery power packs shall be included as part of the specified fixture when they are not connected to an emergency generator system. Verify on drawings.

B. Exit Signs and Other Emergency Fixtures:

1. Provide emergency battery power packs on all exit signs and emergency fixtures that are not connected to an emergency generator.

2. Batteries shall be lead calcium, pure lead, or nickel cadmium. Lead acid will not be accepted. Batteries shall be unconditionally guaranteed for 5 years with a 10 year prorated warranty from the factory. Units shall be Underwriter's Laboratory listed an labeled as an emergency unit. Batteries shall be provided as standard or as optional equipment of the same series of the specified fixtures.

3. The emergency Battery Section shall be connected on the same circuit as the light ahead of any switches or contactors controlling area lights so that emergency lighting is maintained at all times.

4. Emergency battery power packs installed in anesthetizing locations shall be capable of illuminating fixtures immediately (less than 1 second) upon loss of power.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Installation shall be in accordance with the NEC, and as shown on the drawings.

B. Align, mount and level the lighting fixtures uniformly.

C. Avoid interference with and provide clearance for equipment. Where the indicated locations for the lighting fixtures conflict with the locations for equipment, change the locations for the lighting fixtures by the minimum distances necessary as approved by the Engineer.

D. For suspended lighting fixtures, the mounting heights shall provide the clearances between the bottoms of the fixtures and the finished floors as shown on the drawings. Verify all heights with the Architect prior to mounting.

E. Lighting Fixture Supports:

1. Provide adequate support for light fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members above a suspended ceiling or to structural members within a partition (for wall mounting).
2. Maintain the fixture positions after cleaning and relamping.
3. Support the lighting fixtures without causing the ceiling or partition to deflect.
4. Hardware for recessed fluorescent/LED fixtures:
    a. For suspended ceiling systems and plaster frame construction, hardware devices such as bolts, screws or rivets shall be used to secure the fixture to the ceiling system structural members. Listed clips indentified for use with the type of ceiling framing member(s) and light fixture(s) shall also be permitted.
    b. Fixtures shall be secured to the ceiling system at not less than each of the four corners with additional support and/or connection as required to resist spreading of the support members and to safely lock the fixture into the ceiling system.
5. Hardware for surface mounting fluorescent/LED fixtures to suspended ceilings:
    a. In addition to being secured to any required outlet box, fixtures shall be bolted to a grid ceiling system at four points spaced near the corners of each fixture. The bolts shall be not less than 1/4-inch secured to channel members attached to and spanning the tops of the ceiling structural grid members. Nonturning studs may be attached to the ceiling structural grid members or spanning channels by special clips designed for the purpose, provided they lock into place and require simple tools for removal.
    b. In addition to being secured to any required outlet box, fixtures shall be bolted to a plaster ceiling at four points spaced near the corners of each fixture. Prepositioned 1/4-inch studs or threaded plaster inserts secured to ceiling structural members shall be used to bolt the fixtures to the ceiling. In lieu of the above, 1/4-inch toggle bolts may be used on new or existing ceiling provided the plaster and lath can safely support the fixtures without sagging or cracking.
6. Provide safety supports from ballast or fixture housing up to structure above for all fixtures weighing more than 15 lbs. Supports shall be chains, aircraft cable, factory or field fabricated and rated in excess of twice the weight of the fixture.

F. Provide and install new lamps for each new lighting fixture installed and for each existing lighting fixture reinstalled.

G. Contractor shall coordinate between the electrical and ceiling trades to ascertain approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed. Lay-in type fixture installed in sheet rock ceilings shall be provided with a flange and bolted to the ceiling.

H. Connection to all fixtures mounted in lay-in ceilings shall be as follows: Provide J-Box supported from structure at 12-inches above fixtures for connections. Install UL listed 3/8-inch or 1/2-inch flexible conduit whip down to each fixture. Each whip shall be field cut to length to allow fixture

to be relocated 4-foot-0-inches in any direction. Whips shall include 2 or 3 #12 Cu. THHN/THWN conductors (numbers as indicated) and a #12 ground. Fixtures supplied with UL listed whip shall be supplied with ground conductors. Tandem fluorescent fixtures shall have a factory supplied UL listed whip with conductors as required to interconnect fixtures. Length shall allow mounting fixtures 12-foot-0-inches on center in any direction.

END OF SECTION 265100

SECTION 27 05 01
COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

B. Installation of raceways, conduit sleeves etc. as required for routing of communications systems cabling shall be per specifications Section “RACEWAY SYSTEMS”.

1.02 SUMMARY:

A. The extent of the communications systems work is indicated by drawings, details, and other specification sections. Communications systems installation is hereby defined to include, but not be limited to the installation of voice, data, video, CATV, nurse call, code blue, and public address (P.A.) systems.

B. All cabling materials, cabling, jacks, patch panels, racks, etc. are specified in other sections and shall be provided by the Contractor. The Contractor shall be responsible for all testing as specified in individual specifications sections.

C. It is the intent of the Drawings and Specifications to provide a complete workable telecommunication cabling system ready for the Owner’s use. Any item not specifically shown on the Drawings or called for in the Specification, but normally required for a complete system, are to be considered a part of the contract.

1.03 SUBMITTALS:

A. Product Data: Provide submittals for each type of product specified with this section, including but not limited to cable supports, cable wraps, fire rated sleeves, etc.

B. Installer’s qualifications (including references)

C. Statement of Warranty

D. Manuals and Technical Documents

E. Record Drawings

1.04 COORDINATION:

A. The Contractor will cooperate and coordinate with the Owner, Design Team, Construction General, or Construction Manager to minimize conflict with Owner’s operations.

B. Coordinate and keep informed of all other building trades and electrical work including wires and cables, electrical boxes and fittings, and raceways to properly interface installation of systems with other work. This Contractor shall execute their work in such a manner so as not to delay or interfere in progress of other trades and delay project or Owner occupancy.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed. It is imperative that all sub-contractors coordinate with the Electrical Contractor for needed pathways, rough-in, and support. This shall minimize cable runs and maximize system performance. If not properly coordinated, the Design Team may require removal or relocation of work without additional compensation.

D. Sequence installation of communications systems cabling with other work to minimize possibility of damage and soiling during remainder of construction.

E. Contractor shall be responsible for ceiling tile replacement, wall repainting, etc. due to damage caused by installation of this equipment and cabling.

1.05 PERFORMANCE AND QUALITY ASSURANCE:

A. National Fire Protection Association:

1. NFPA 70: National Electrical Code.
2. NFPA 75: Standard for the Fire Protection of Information Technology Equipment.

B. UL LLC (UL):

1. UL 486A: Wire connectors and soldering lugs for use with copper conductors.
2. UL 1449: Transient voltage surge suppressors.
3. UL 1863: Communications - Circuit Accessories
4. UL 813: Commercial Audio Equipment

C. Telecommunications Industry Association (TIA):
1. ANSI/TIA-568-0 and addenda “Generic Telecommunications Cabling for Customer Premises”.
2. ANSI/TIA-568-1 and addenda “Commercial Building Telecommunications Cabling Standard”.
3. ANSI/TIA-568-2 and addenda “Balanced Twisted-Pair Telecommunications Cabling & Components Standard”.
4. ANSI/TIA-569: Telecommunications Pathways and Spaces.
5. ANSI/TIA-606: Administration Standard for Telecommunications Infrastructure
6. TIA-160: Sound Systems.
7. TIA-299A: Loudspeakers, Dynamic Magnetic Structures and Impedance.
8. CEA-310-E “Design Requirements for Cabinets, Panels, Racks, and sub-Racks”.
9. SE-101-A: Amplifier for Sound Equipment.
10. SE-103: Speakers for Sound Equipment.

D. Federal Communications Commission (FCC):
1. FCC Regulations, Part 15 Title 47.

E. Building Industry Consulting Service International (BICSI):
1. ANSI/BICSI 003, Building Information Modeling (BIM) Practices for Information Technology Systems
2. ANSI/BICSI 004, Information Communication Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
3. ANSI/BICSI 008, Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices
4. ANSI/BICSI N1, Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure
5. ANSI/BICSI N3, Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure
6. Telecommunications Distribution Methods Manual (TDMM)
7. Information Technology Systems Installation Methods Manual (ITSIMM)

F. Maintenance Qualifications:
1. Experienced in manufacturing equipment of the types and capacities specified for this project.
2. Equipment has a record of successful in-service performance.

G. System Manufacturers Application Warranty: The system manufacturer shall provide a total application assurance warranty per Part 3 of this section. Contractors shall be certified by the manufacturer to be an approved system installer. The manufacturer and the certified installer shall take full responsibility for a quality installation complying with all applicable standards.

H. Contractor Qualifications and Training:
1. The Contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data, voice and imaging network systems. The Contractor shall at a minimum possess the following qualifications:
a. Licenses/permits required performing telecommunications installations in the specified jurisdiction.

b. Personnel trained and certified by the proposed Cabling System Manufacturer.

c. All installation Personnel on site must be under the supervision of an individual trained and certified to install the approved manufacturers cabling System.

d. The Designer and Installers shall show proof of current certification of the proposed Cabling System Manufacturer via a current card given after attending a minimum 5- day course or a re-certification class. This card must be current and be in the possession at all times they are on the project.

e. Provide (3) previous references of the type of installation provided in this specification.

f. Personnel trained and certified in fiber optic cabling, splicing, termination and testing techniques. Personnel must have experience using a light meter and OTDR.

g. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.

h. Personnel knowledgeable in local, state, province and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.

i. Have at least (5) years successful installation experience with projects utilizing telephone, data, video and other low voltage systems and wiring similar to that required for this project to ensure system is compliant with standards.

j. Must be a Building Industry Consulting Service International (BICSI) member and have an RCDD or BICSI certified ITS Technician on staff.

k. Must possess current liability insurance certificates.

l. Established communications and electronics contractor for at least five (5) years.

m. Authorized distributor for the equipment supplied with full manufacturer's warranty privileges.

n. Maintains a fully equipped service organization capable of providing full maintenance and service of the installed system within twenty four (24) hours.

o. Maintains the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being installed.

I. Manufacturer's Instructions: Comply with all installation instructions and methods recommended or required by the manufacturer.

1.06 PROJECT SITE CONDITIONS

A. It is the intent of these specifications for the contractor to provide all material and labor required for a complete and working installation as outlined in both drawings and specifications. No additions to the contract price shall be allowed due to the failure of this contractor to properly evaluate the effect of the existing conditions on the magnitude of work to be done under this contract.

B. This contractor shall, prior to submitting a bid, visit the site and familiarize themselves with locations, project conditions, plenum space, existing systems, and other conditions that may impact their work.

C. Whenever renovating, remodeling, relocating existing equipment/head ends, or extending existing systems are in the contract, it is imperative that the contractor locate these systems, assess these systems, locate pathways, and coordinate needs with electrical contractor during time of bid. Elevations, grades, and locations shall be accounted for.

D. Install work in locations shown on drawings to the level of these specifications unless project prevented by project conditions and previously approved with project design team.

1.07 EQUIPMENT AND MATERIALS:

A. Contractor shall install communications systems per the system manufacturer recommendations or requirements or as otherwise specified on the drawings or elsewhere in the specifications.

1. The Manufacturers and Products specified in this document are to be used. No substitutions of components specifically referenced will be allowed without approval prior to bid.

2. All products and materials shall be new, clean, free of defects and free of damage and corrosion.
3. All products installed will meet or exceed the minimum performance requirement as listed in the technical specification of this document and its corresponding addendums.

1.08 SUPPORT AND WARRANTY:

A. Applications Supported:
1. Existing and future applications supported for a channel model warranty include those approved by the Institute of Electronic and Electrical Engineers (IEEE), the Asynchronous Transfer Mode (ATM) Forum, the American National Standards Institute (ANSI) or the International Organization of Standards (ISO) that specify compatibility with the cable referenced herein. Additional applications that are covered by this warranty include all future applications developed for the specified structured cabling system.

B. Basic Warranty:
1. Either a basic link or channel model configuration may be applied to the horizontal and/or backbone sub-systems of the structured cabling system. Applications assurance is only applied to a channel model configuration.

C. Applications Assurance Warranty:
1. A fifteen (15) year warranty shall be provided for an end-to-end channel model installation which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement.

D. Product Warranty:
1. The manufacturer of passive telecommunications equipment used in a manner not associated with the Systems Warranty must have a minimum five (5) year Component Warranty on its entire product. The Products Warranty covers the components against defects in material or workmanship under normal and proper use.

1.09 WORKMANSHIP:

A. All work shall be done in a workman like fashion of the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

B. No substitution of product or services will be accepted without prior approval from both the Owner and the Manufacturer providing the Application warranty.

1.10 DELIVERY, STORAGE, AND HANDLING:

A. Delivery: Deliver communications system equipment and components in factory-fabricated containers or wrappings, which properly protect equipment from damage.

B. Storage: Store communications system equipment and components in original packaging. Store inside in a well-ventilated space protected from weather, moisture, soiling, humidity, extreme temperatures, and vandalism. Protection against vandalism will be at the Contractor's expense. Storage recommendations by manufacturer shall be followed.

C. Handling: Handle communications system equipment and components carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.11 AS-BUILT DRAWINGS:

A. Show on black line prints in red ink all communications cable system jack identification numbers, actual cable routing paths, as well as all changes from original plans made during the installation. Separate As-Built drawings shall be provided for each communications system installed. Return the "as-built" red lined drawings, specifications, and addenda, as set forth in the General conditions, to the Architect/Engineer upon completion of the project.

PART 2 PRODUCTS

2.01 RACEWAYS

A. All communications cabling shall be installed in raceway systems when located in concealed, non-accessible locations. In general, raceways are required for outlets in walls up to above accessible ceilings, above non accessible ceilings, all wall penetrations etc. Provide bushings at all raceway terminations. Fire stop and fire seal all penetrations of fire rated walls.

B. Refer to section “RACEWAY SYSTEMS”.

2.02 LABELS:

A. Labels shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969 and the latest addition of ANSI/TIA-606.

B. All labels shall be preprinted, or computer printed type. Handwritten labels are not acceptable.

C. Labels shall have a design life equal to or greater than that of the labeled component.

D. Labels shall be industrial, extra strength adhesive, laminated label that will resist scuff/scratch, heat, cold, water, UV, corrosive, and chemical environments.

E. Labels shall have a split backing for easy removal.

PART 3 EXECUTION

3.01 REQUIREMENTS FOR COMMUNICATIONS SYSTEMS INSTALLATION:

A. General: Examine areas and conditions under which communications cabling systems are to be installed. Notify the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

B. Cable Pathways:

1. Refer to section “RACEWAY SYSTEMS”.
2. The number of cables placed in a pathway shall not exceed manufacturer specifications, nor shall the geometric shape of a cable be affected.
3. All cables above accessible ceilings shall be supported by cable trays and/or j-hooks located approximately 6” above lay-in ceilings below all mechanical and other electrical equipment.

C. Horizontal Cable Routing:

1. All horizontal cables, regardless of media type, shall not exceed 295 ft (90 m) in total length from the telecommunications outlets in the work area to the horizontal cross connect. This does not include the allowable distances for equipment cords and patch cords as listed below.
2. The length of patch cords in the telecommunications room/closet shall not exceed 16 ft (4.9 m) and equipment cords in the work area shall not exceed 16 ft (4.9 m) unless used in conjunction with a multi-user telecommunications outlet assembly (MUTOA).
3. Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.
    a. Minimum conduit bend radius shall not be less than 6 times the diameter for 2” conduit and smaller.
    b. Minimum conduit bend radius shall not be less than 10 times the diameter for conduits larger than 2”.
4. Cables shall be supported by means that are structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 4 ft apart.
5. The installation of telecommunications cabling installed in grounded metallic conduit shall maintain a 12 inch minimum distance from all sources of Electrical Magnetic Interference (EMI), such as; fans, motors, fluorescent fixtures, transformers, etc. Cabling installed in cable tray or j-hooks shall maintain a 24 inch minimum distance from all sources of EMI. All cables shall maintain a 48 inch minimum distance from transformers. Engineer shall be notified in advance if these clearances cannot be met.

6. The installation of telecommunications cabling shall maintain a minimum clearance of 10 ft from power cables in excess of 480 Vrms. No telecommunications cross-connects shall be physically located within 20 ft (6 m) of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms. Engineer shall be notified in advance if these clearances cannot be met.
7. Cables shall be run using a star topology from the telecommunications room serving that floor to every individual telecommunications outlet.
8. The Contractor shall observe the bending radius and pulling strength requirements of the 4-pair UTP and fiber optic cable during handling and installation.
   a. Pulling force on 4-pair UTP cable shall not exceed 25lb/f.
   b. Pulling force on 2 or 4-strand optical fiber shall not exceed 50lb/f.
9. Each run of UTP cable shall not contain splices between the horizontal portion of the cross-connect in the telecommunication room and the telecommunications outlet.
10. In the telecommunications room where cable trays or cable racking are used, the contractor shall provide appropriate means of cable management such as hook and loop cable managers to create a neat appearance and practical installation.
11. Continuous conduit runs installed by the contractor should not exceed 100 ft (30.5 m) or contain more than two (2) 90-degree bends without utilizing appropriately sized pull boxes.
12. All horizontal pathways shall be installed and grounded to meet applicable local and national building and electrical codes.
13. The number of horizontal cables placed in a cable support or pathway shall not exceed manufacturer's recommendations and shall not cause a change in the geometric shape of the cables.
14. Maximum conduit pathway capacity shall not exceed a 40% fill. Perimeter and furniture fill shall be limited to 60% fill for moves, adds and changes.
15. Horizontal distribution cables shall not be exposed in the work area or other locations with public access.
16. Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted as close as possible to 6 in (15 cm) above the ceiling grid supporting the tiles.
17. **All cables in exposed or open ceilings shall be routed in conduit.**

D. Work Area Termination:
   1. All UTP cables wired to the telecommunications outlet/connector shall have 4-pairs terminated in eight-position eight conductor (8P8C) modular outlets in the work area. All pairs shall be terminated.
   2. The telecommunications outlet/connector shall be securely mounted.
   3. The height of the telecommunications faceplates shall be to applicable codes and regulations, and/or the same height of nearby electrical faceplates.
   4. Provide specialized outlets for the specific systems furniture manufacturer. Outlets must be fully compatible. Verify systems furniture manufacturer with Architect or Owner.

E. Tightening: Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors.

F. Bend Radius:
   1. The maximum cable bend radii shall not exceed manufacturer's specifications.
   2. In spaces with UTP cable terminations, the maximum bend radius for 4-pair cables shall not exceed four times the outside diameter of the cable. The maximum bend radius for multi-pair cables shall not exceed ten times the outside diameter of the cable. Manufacturer specifications shall be followed if more stringent.

3. During the actual installation, bend radius on 4-pair cables shall not exceed eight times the outside diameter of the cable and multi-pair cables shall not exceed ten times the outside diameter of the cable. Manufacturer specifications shall be followed if more stringent.
4. The bend radius of 2 or 4-strand optical fiber cable shall be 1" (2.5 cm) minimum under no load and 2" (5 cm) minimum under load. Manufacturer specifications shall be followed if more stringent.

G. Slack:
1. In the work area, a minimum of 12 in (30 cm) shall be left for UTP cables. A minimum of 3 ft (1 m) shall be left for fiber cables.
2. In telecommunications room/closets a minimum of 10 ft (3 m) of slack shall be left for all fiber cables and a minimum of 3 ft (1 m) of slack shall be left for all UTP cables. This slack must be neatly managed on trays or other support types.

H. Wiring Methods
1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
   a. Install plenum rated cable in environmental air spaces, including plenum ceilings.
2. Bundle, lace and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.02 ADJUSTING AND CLEANING:

A. Cleaning: Clean all equipment and components of dirt and construction debris upon completion of installation. Remove scrap cable components off site as required.

B. Touch-up: Touch-up scratched or marred enclosure surfaces to match original finishes.

C. Protection: Protect installed equipment, cabling and components from damage during remainder of construction period.

3.03 LABELING:

A. Labeling shall consist of lettering or numbering as required by Owner to coordinate with existing labeling schemes. Contractor to coordinate exact labeling scheme of cables with Owner.

B. Documentation of labeling shall be in accordance with the latest edition of TIA-606.

C. Telecommunication Spaces:
1. Labels shall be affixed at the entry to all telecommunications rooms and spaces (Includes entrance facilities, communication equipment rooms, communication equipment spaces and work areas).
2. Adhesive laminated type labels shall be used for all communications space labeling.
3. Affix labels to entrance doors and inside the room so that the label is visible by those working in the room – coordinate with owner.

D. Pathways:
1. Pathways shall be marked at each endpoint and at all intermediate pull or junction boxes. In the case of partitioned pathways (i.e., innerduct) each partition shall have a unique identifier.
2. Label pathways using the recommended identifiers shown in the latest edition of ANSI/TIA-606.
3. Pathway labels shall be laminated adhesive type labels.

E. Cables:
1. Horizontal and backbone cables shall be marked within 12" of each endpoint using laminated labels with identifier repeating itself a minimum of four times on label for easy identification from all viewing angles. Marking directly on the cable is not permitted.
2. Any cable installed in conduit shall be labeled at all intermediate pull or junction boxes.
3. Label cables using the appropriate horizontal line identifier.

4. No cabling identifier will duplicate any previous, active cable identifier.

F. Faceplates:
1. A unique identifier shall be marked on each faceplate to identify it as connecting hardware.
2. Each port in the faceplate shall be labeled with its identifier.
3. For faceplates that use clear plastic cover strips, insert an 'unpeeled' label with backing intact.
4. For faceplates without clear plastic cover strips, laminated adhesive type labels shall be affixed to the faceplate. Marking directly on the faceplates is not permitted.

G. Racks, Panels, Blocks:
1. A unique identifier shall be marked on each piece of connecting hardware to identify it as connecting hardware.
2. Patch panels shall be labeled with an identifier and all individual ports shall be labeled with an identifier.
3. Patch panels ports may be labeled with adhesive type laminated labels or ‘unpeeled’ labels with backing intact if the panel has a clear label strip.
4. Each cable termination position on blocks shall be labeled with number designators.
5. Use adhesive laminated type labels for all block labels. Marking directly on the block is not permitted.

3.04 RECORDS:

A. All records shall be created by the installation contractor and turned over at the completion of work. The format shall be computer based. Both soft copies and hard copies shall be included as part of the As-Built package. The minimum requirements include:
1. Cable records must contain the identifier, cable type, and termination positions at both ends, splice information as well as any damaged pairs/conductors.
2. Connecting hardware and connecting hardware position records must contain the identifier, type, damaged position numbers, and references to the cable identifier attached to it.
3. Test documentation on all cable types shall be included as part of the As-built package.

3.05 DOCUMENTATION/AS-BUILTS/RECORDS:

A. All cables shall be labeled in accordance with the Owner’s labeling standards.

B. No cabling identifiers shall duplicate any previous active cable identifier.

C. All documentation, such as, As-Builts and records shall be kept on file by the Certified Installer for the entire term of the warranty.

D. As-built drawing shall be supplied by the contractor showing the locations of and identifiers for all components.

3.06 REMOVAL OF EXISTING CABLE:

A. Existing communications systems cable that is not terminated at both ends at a connector or other equipment shall be completely and entirely removed unless identified for future use with a tag.

END OF SECTION 270501

SECTION 27 12 00
COMMUNICATIONS INFRASTRUCTURE CABLING

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. Section Includes:

1. UTP cabling.
2. Cable connecting hardware, patch panels, and cross-connects.

1.03 DEFINITIONS:

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. NRTL: Nationally recognized testing laboratories.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

K. VoIP: Voice over internet protocol.

1.04 PERFORMANCE AND QUALITY ASSURANCE:

A. Installer Qualifications: See section “COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS”.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

1.05 HORIZONTAL CABLING DESCRIPTION:

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the work area telecommunications outlet/connector and the horizontal cross-connect located in the telecommunications room/closet. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. Comply with the latest versions of ANSI/TIA-568.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Horizontal cabling shall be connected to a telecommunications room/closet located on the same floor as the work area being served, unless otherwise allowed on the plans.
5. If telecommunications closets are shown on the plans to serve multiple floors, provide separate racks to serve each floor shown.

B. If work areas are not sufficiently designed on the plans, a work area shall be approximately 100 sq. ft. (9.3 sq. m), and shall include the components that extend from the telecommunications outlet/connectors to the station equipment.

C. A minimum of two horizontal cables shall be routed to each work area.

D. The maximum allowable horizontal cable length is 295 feet (90 m) for all cable types. This maximum allowable length does not include an allowance for equipment cords to the workstation equipment or an allowance for patch cords in the horizontal cross-connect.

1.06 SUBMITTALS:

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

B. Shop Drawings:

1. Submit labeling convention for approval by Owner prior to installation. See section “COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS” for additional labeling information.
2. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
3. System Labeling Schedules: Electronic copy of labeling schedules, in software or format selected by Owner.
4. Cabling administration drawings and printouts.

C. Qualification Data: Refer to Section “COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS”.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.07 DELIVERY, STORAGE AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.09 COORDINATION:

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

PART 2 PRODUCTS

2.01 PATHWAYS

A. Refer to Section “COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS” and section “RACEWAY SYSTEMS”.

2.02 UTP CABLE:

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

1. General Cable/Panduit (Pan/Gen)

B. Compliance and Listings:

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with the latest edition of ANSI/TIA-568.1.
3. Comply with the latest edition of ANSI/TIA-568.2 for performance specifications.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications, General Purpose: Type CM or CMG.
   b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
   c. Communications, Riser Rated: Type CMR, complying with UL 1666.
   d. Communications, Limited Purpose: Type CMX.

C. Horizontal UTP Cabling:
   1. 100-ohm, 4-pair UTP, color as noted on plans.
   2. All cables and parts shall be plenum rated unless otherwise noted on the drawings.

2.03 UTP CABLE HARDWARE:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Superior Essex/Ortronics
   2. CommScope
   3. Belden
   4. Berk-Tek/Leviton
   5. General Cable/Panduit (Pan/Gen)
   6. Panduit/Panduit
   7. Or Engineer Approved Equal

B. General Requirements for Cable Connecting Hardware: Comply with the latest edition of ANSI/TIA-568.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables. Panels shall have the following characteristics:
   1. Be sized to fit a standard, 19-inch rack, or be capable of mounting to a wall.
   2. Be made of black anodized aluminum in 24- and 48- port configurations.
   3. Have cutouts supporting UTP.
   4. Have cutouts, which allow terminated jacks to pass through the panel for easy rearrangement.
   5. Have changeable ports, which are removed from the front of the panel to allow custom configuration or modification to the panel.
   6. Have port identification numbers provided on both the front and rear of the panel.
   7. Have mounting slots compatible with CEA-310-E “Design Requirements for Cabinets, Panels, Racks, and Sub-Racks”.
   8. Allow modular insert to accept 110-style patch plugs as a means of termination.

D. Jacks and Jack Assemblies: Modular, color-coded, 8P8C eight-position modular receptacle units with integral IDC-type terminals. Jacks and jack assemblies shall have the following characteristics:
   1. Be available in black, white, gray, ivory, light ivory, blue, green, and yellow.
   2. Accommodate a minimum of two 8-position / 8-conductor modular jacks.
   3. Utilize RJ-45 connectors, category to match cabling. Jack shall match performance of the cable.
   4. Termination shall be accomplished with a single conductor impact tool.
   5. Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.

6. Have rear protective strain relief caps with side or rear entry, which can be installed onto cable before or after termination.
7. Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit.
8. Have 45 degree angled design available with angled shroud to protect connection and help control bend radius.
9. Provide universal application / multi-vendor support.
10. Support industry standards for T568A or T568B wiring options.

2.04 UTP CABLE PATCH CORDS

A. Patch Cords: Factory-made, pre-connectorized, 4-pair cables in lengths as directed by Owner. Jacket color shall be as directed by Owner.

1. Modular Patch Cords: All modular plugs shall be equipped with a matching Cat. 6 or **Cat. 6A** patch cord as required.
   a. Patch cords shall be backwards compatible with lower performing categories.
   b. Modular plugs shall exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro-inches minimum of gold plating over nickel contacts.
   c. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure category performance. Patch cords shall have latch guards to protect against snagging.
   d. Patch cords shall be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants and shall exhibit PSNEXT performance.

2.05 OPTICAL FIBER CABLE PATCH CORDS

A. Patch Cords: Factory-made, cable type to match terminated fiber.

B. Provide patch cords in lengths as directed by Owner. Jacket color and connector types shall be as directed by Owner.

C. Provide patch cords for every fiber termination.

PART 3 EXECUTION

3.01 CABLE ROUTING:

A. Refer to Section “COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS”.

3.02 WIRING METHODS:

A. Refer to Section “COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS”.

3.03 FIRESTOPPING:

A. Refer to Section “RACEWAY SYSTEMS”.

3.04 LABELING:

A. Refer to Section “COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS”.

3.05 FIELD QUALITY CONTROL:

A. Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with the latest edition of ANSI/TIA-568.2.
2. Visually confirm category, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment, patch cords, and labeling of all components.
4. End-to-end cabling will be considered defective if it does not pass tests and inspections.
5. Prepare inspection reports.

B. General Testing:

1. Cables shall be tested after installation is complete with an approved tester and delivered in electronic format for the engineer to review. No hand written test shall be excepted. If for any reason a drop count was removed from an existing location or after the initial test was done, all cables associated to this drop location shall be retested. The cost of retesting is the responsibility of the cabling contractor and shall be included at time of bid. The field testing device shall be recalibrated every 12 months or as required by the manufacturer.
2. Prepare test reports.

C. UTP Performance Tests:

1. Test Equipment Parameters:
   a. All UTP field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of the testing.
   b. Auto test settings provided in the field tester, for testing the installed cabling, shall be set to the default parameters.
   c. Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.
   d. All field testing shall be performed with an approved level IIe or III UTP field test device.
2. Tests for each outlet. Perform the following tests according to the latest edition of ANSI/TIA-568.2:
   a. Wire map.
   b. Length (physical vs. electrical, and length requirements).
   c. Insertion loss.
   d. Near-end crosstalk (NEXT) loss.
   e. Power sum near-end crosstalk (PSNEXT) loss.
   f. Equal-level far-end crosstalk (ELFEXT).
   g. Power sum equal-level far-end crosstalk (PSELFEXT).
   h. Return loss.
   i. Propagation delay.
   j. Delay skew.
3. All installed channels shall perform equal to or better than the minimum requirements as specified in the latest edition of ANSI/TIA-568.2.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report and submitted to the Owner.

E. Remove and replace cabling, at no cost to the Owner, where test results indicate that they do not comply with specified requirements.

END OF SECTION 271200

SECTION 27 51 16
PUBLIC ADDRESS (70-VOLT PAGING SYSTEM)

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SYSTEM DESCRIPTION:

A. Public Address System for Voice.

B. Features:

1. One-way Paging.
2. Telephone interface.
3. Amplifiers.
4. Speakers.

1.03 SUBMITTALS:

A. Shop Drawings. Indicate a "One-Line" diagram schematic to include electrical characteristics and connection requirements, Layout of equipment (new and existing), racks, cabinets, field wiring to input devices such as microphones or telephones from an interface, amplifiers, and speakers.

B. Test reports and/or manufacturer certificates to confirm estimated amplifier drawl and speaker tap settings meet or exceed specified requirements.

C. Product data cutsheets on all equipment, components, accessories, wire and speakers.

1.04 QUALIFICATIONS:

A. Authorized distributor/installer of specified or approved equal manufacturer and have a minimum of 3 years experience with the system.

PART 2 PRODUCTS

2.01 MANUFACTURERS (AMPLIFIERS):

A. Bogan.

2.02 SPEAKERS:

A. See Schedule on Drawings for all speaker types.

B. See zoning chart on drawings for further information on wiring intent.

2.03 WIRE AND CABLE:

A. Manufacturers:

1. General Cable.
2. Essex.
3. Southwire.
4. Belden.
5. Penn.

2.04 INPUT SOURCES:

A. Telephone Interface Modules:

1. VoIP.

PART 3 EXECUTION

3.01 INSTALLATION:

A. System shall have enough amplifiers for a complete and working system.

B. Coordinate with zoning schedule and verify with owner prior to installation.

C. Install in accordance to manufacturers' recommendations.

D. Splice cable only at accessible and documented locations. Use paging only junction boxes or terminal block locations.

E. When using cable shields or drains, shields must be continuous. Join at all splice locations and only connect speaker shields at equipment grounds and only at amplifier locations.

F. Paging speaker wire shall be in its own J-hook or pathway. Input circuits shall be separated from output circuits.

G. Only use recommended fittings and connectors.

H. Ground and bond all equipment (and circuits.

I. Use of plenum jacketed cable only.

J. Extension of existing system:

1. Add amplifiers as required for the extension of the existing system. Maintain a complete and working system.
2. Coordinate connections and accessories need for the expansion of the existing zone or system.
3. Connect to existing hospital public address system. Existing amplifier locations are noted on drawings.

3.02 FIELD QUALITY CONTROL:

A. Field inspection and testing shall be provided.

B. Measure and record sound power levels, tap settings, and pressure levels above ambient at time of commissioning the system and submit as part of the operations and maintenance manuals and test reports for the engineer and owner.

END OF SECTION 275116

SECTION 27 53 14
WIRELESS SYNCHRONIZED CLOCK SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section includes all transmitters, cables, clocks, licenses, batteries, and accessories required for a complete GPS, wireless synchronized clock system.

B. The clock system uses transmissions from Global Positioning System (GPS) satellites to synchronize the battery powered system clocks to the exact second. The system shall consist of a GPS receiver, a wireless transmitter and an unlimited number of wireless system clocks.

1.02 APPROVED MANUFACTURERS:

A. Sapling, Inc.; 1-888-809-6063.

PART 2 PRODUCTS

2.01 SATELLITE TRANSMITTER (REPEATER):

A. When required due to facility size, a satellite transmitter and receiver shall be provided to extend the signal range. The requirements for the satellite transmitter are similar to those for the master transmitter. Provide RS232 cable to connect the satellite receiver to the satellite transmitter.

2.02 ANALOG CLOCKS:

A. 12” Diameter - Provide a 12” diameter analog clock with a polycarbonate frame and lenses. The clock shall be powered by two alkaline D-cell batteries with a 5 year expected life. Provide single or double faced clocks as shown on the drawings.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Install transmitter in equipment room. Mount on shelf or rack provided by manufacturer.

B. Secure clocks to wall using tamperproof methods.

3.02 START UP:

A. Provide start up services including synchronizing all clocks on-site verification of wireless transmission to all locations of the building. Provide additional satellite receivers and transmitters as required.

3.03 WARRANTY:

A. Provide a one year manufacturer’s warranty for parts and labor for the complete system.

B. Provide customer support for the life of the system.

END OF SECTION 275314

SECTION 28 13 00
ACCESS CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This specification details the supply, installation, and commissioning of a complete Integrated Security Management System (ISMS). The system shall follow local and international codes, standards, and meet the technical and performance criteria in this document.

B. The system is to be supplied with all equipment, hardware, software, cabling, and ancillary devices as required to provide an ISMS complete and functional in all respects. The bidders are to familiarize themselves with all matters related to the requirements and to account for such in the price as part of their proposal response.

C. All security systems components not specifically included in this specification shall be fully integrated with this ISMS. The ISMS shall be written so that all security modules (access control, alarm monitoring, ID or credential management, visitor management, asset management, and digital video management) can be developed and work on a unified platform.

D. Utilize and open architecture where all data must reside on a single database and must be accessible in real time to an ISMS workstation or web-based client connection to a network. The system shall be configurable to support all current market databases.

E. The ISMS shall support an unlimited number of access control readers, unlimited number of inputs or outputs, unlimited number of client workstations, and unlimited number of card holders.

1.02 GENERAL REQUIREMENTS

A. The drawing and specifications indicate the intent and direction for the installation. Devices shall be connected to the building's existing LenelS2 OnGuard access control system. Devices and locations are shown diagrammatically and shall be verified with architectural elevations, other trades, door types, door hardware specifications, and with design team for operation prior to completing the work associated with the installation.

B. All work shall be performed in strict accordance with all applicable laws, ordinances, codes of local, state, and federal governments, or authorities having lawful jurisdiction. It is required that the contractor confirm and verify all requirements prior to doing work.

C. The contractor shall furnish all required material, labor, and other associated accessories or tools needed to facilitate the complete installation of the system specified herein.

D. Qualified personnel, utilizing state-of-the-art equipment, current part numbers, and installation techniques required to complete the work without damage to equipment, cables, associated items, or facility.

E. All materials shall be installed in accordance with the manufacturer's specified recommendations and practices.

1.03 SUBMITTALS

A. Shop drawings that consist of, Materials list, electrical characteristics, connection requirements, rating capabilities, operating characteristics, accessories, and system wiring diagrams.

1.04 QUALITY ASSURANCE

A. Manufacturer of system shall have a minimum of five (5) years experience of successful manufacture and installation of systems equivalent in scope and function to the system(s) proposed herein.

B. Installation contractor shall be certified to install service and maintain the system by the system manufacturer.

C. The contractor shall be a factory authorized and local service organization for the manufacturer of the ISMS.

1.05 WARRANTY AND SUPPORT

A. Hardware warranties shall be provided by the original manufacturer of the specific hardware device or component for a minimum of five (5) years, including advanced replacement.

B. Manufacturer shall offer a supplemental software support program to include software updates and upgrades, which, if exercised, extends the hardware warranty up to ten (10) years, including advanced replacement.

C. Hardware warranty for non-display credential readers shall be a lifetime warranty, including advanced replacement.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. LenelS2

2.02 INTEGRATED SECURITY MANAGEMENT SYSTEM FIELD HARDWARE:

A. The ISMS shall be equipped with the access control field hardware required to receive alarms and administer all access granted or denied decisions. This shall include but not be limited to intelligent system controllers (ISC), reader controllers, general purpose input/output panels, and general-purpose door controllers. All field hardware must be designed to meet UL294 requirements. The ISMS must be able to receive device serial numbers from all field hardware, excluding card readers, biometric readers, and keypads.

B. Ethernet Access Controllers.

1. The Ethernet access controller shall be one of recent technology, based on micro processing, and shall be compatible with a reader for proximity tag cards. It shall be capable of storing numerous events in a stand-alone operation and be capable of transmitting this information to a management system when the network is reconnected.
2. The Ethernet access controller shall incorporate a web browser interface server for administration of the controller through a standard or common browser. This page shall closely emulate the feature rich client host software used to administer the system.
3. Memory for the Ethernet access controller shall be flash based and nonvolatile. If power to the controller is lost, upon restoration of power, the unit shall retain all information contained at the time of power loss including card holder database, system configuration, and event transaction history.
4. The Ethernet access controller shall be modular and include terminations for wiring to other electronic modules.
5. The Ethernet access controller shall provide encryption at both the system level and main level.
6. The following information shall be set in access from each controller by way of Ethernet communication:
    a. IP Address.
    b. Protocol for signing addresses: DHCP or static.
    c. Serial number.
    d. Ability to enable or disable web mode.
    e. Ability to provide verification/validation of a security key.
7. Ethernet access controller shall incorporate support for peer-to-peer communication between Ethernet access controllers.
8. Ethernet access controller shall be equipped with an input/output port allowing communication with a network switch. If one of the Ethernet access controllers shall lose power, it shall not affect the operation of all other access controllers.
9. The Ethernet access controllers shall have the ability to acquire alarms, trigger integration events, validate credentials, and send commands to doors as required.
10. The Ethernet Controller shall be placed in a 2-gang box housing, recesses, or surface mounted, in proximity of the door(s) it is associated with (within the zone) and shall be secured with a tamper resistant screw.

11. The wiring shall not exceed networking requirements of 100 meters (328ft) between switch and Ethernet Controller. The VDC voltage for the POE Ethernet switch shall not exceed 48 VDC to maintain appropriate power to the controller.
12. An optional power source, such as an external power supply, of 24 VDC, (1A) shall be available to each Ethernet controller.
13. Address confirmation of each controller shall occur automatically without the use of DIP switches.
14. The controller shall be able to integrate two card readers allowing for timed "hard" and "soft" anti-passback. Using peer-to-peer communications, the controller shall not require server communications for the anti-passback option to fully operate.
15. An infrared tamper switch shall be integrated in each controller to prevent unauthorized manipulation of the equipment.
16. LED displays shall indicate the status of the input and output points directly on the controllers to facilitate local, visual diagnostics.
17. Each Ethernet controller shall have input points, output points, integrated warning buzzer, external power supply outputs, and intelligent proximity card reader with or without keypads.
18. Ethernet controllers shall be capable to fulfill the following power requirements to the following connected devices:
    a. 12 VDC (250 mA) to each card reader.
    b. 12 VDC (450 mA) for a lock using an open collector relay.
19. The controller shall electronically protect output points against overloads.
20. The security contractor shall define the quantity of Ethernet controllers for the building to be controlled and shall ensure that the quantity conforms to the actual needs.
21. The input points shall be either normally closed (N.C.) or normally open (N.O.) programmable and shall accept optional end-of-line supervision.
22. The two external power outputs shall provide a 250mA at 12VDC, be regulated, and have an electronic overload protection.

C. ISMS Authentication Hardware:
1. Contactless smartcard reader - multi-technology, mobile ready standalone credential readers:
    a. HID signo keypad reader 20k mullion mounted.
    b. HID signo keypad reader 40k single-gang mounted.
    c. Refer to drawings for locations and quantities. Verify with architectural specification section 087100.

2.03 ELECTRICAL POWER REQUIREMENTS

A. System Power: The ISMS system shall operate using standard 120 Volts AC power.

B. Battery Backup: A rechargeable 12VDC, gel-type, LED acid battery backup shall be provided for all intelligent system controllers, reader controllers, and general purpose I/O panels.

C. Provide a centralized power supply for all electronic locking hardware with the exception of all electrified panic bar locations. Coordinate power supply quantities as specified in division 087100.
1. Altronix
2. ESC
3. Engineer approved equal.

PART 3 EXECUTION

3.01 EXAMINATION:

A. Submission of proposal confirms that the contract documents and site conditions are accepted without qualifications unless exceptions are specifically noted.

B. The site shall be visited on a regular basis to appraise the ongoing process of all other trades and contracts. Make allowances for all ongoing work and coordinate the requirements of this contract in a timely, coordinated manner.

C. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting the performance of the ISMS system. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SYSTEM INTEGRATION:

A. Integrate electronic security system with the following systems and equipment:

1. Video surveillance.

3.03 INSTALLATION:

A. Install system in accordance with manufacturer's installation instructions. The following conditions are applicable.

1. In order to ensure a complete, functional system for bidding purposes, where information is not available from the owner upon request, the worst-case conditions shall be assumed.
2. Interfaces shall be coordinated with the owner’s representative, where appropriate.
3. All necessary back boxes, connectors, supports, conduit, cable, and wire shall be furnished and installed to provide a complete and reliable system installation. Exact location of all devices and wiring shall be presented to the owner for approval in advance the any installation.

B. The contractor shall install system components, devices, and appliances, in accordance with the manufacturer's instructions, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Control signal, communications, and data transmission line-grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Provide mounting hardware as required.

C. All inputs shall be protected against surges included on device wiring. Outputs shall be protected against surges induced on control and device wiring, installed outdoors. All communication equipment shall be protected against surges induced on any communication circuit. All cables and conductors, which serve as communication circuits, from security console to filed equipment, and between field equipment, shall have surge protection circuits installed at each end.

D. Connect each field device with owner's data network as required. Coordinate each connection type and requirement with structured cabling contractor.

E. Wiring method: Install wiring in metal raceways, except in accessible spaces and in interior hollow gypsum board partitions where cable may be used. Minimum conduit size shall be 1/2-inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

3.04 CABLE:

A. The access control system contractor shall install manufacturer approved low-voltage cable. All low voltage electrical cable that is installed as part of the access control system shall be plenum-rated cable.

3.05 TESTING AND CERTIFICATION:

A. This contractor shall demonstrate the functionality of the system upon completion of installation, documenting the result of all tests and providing these results to the owner. The system shall be tested in accordance with the following:

1. This contractor shall conduct a complete inspection and test of all installed equipment. This includes testing and verifying connection to equipment of other divisions.
2. This contractor shall provide staff to test all devices and all operational features of the system and testing must be witnessed by the owner’s representative and the authority

having jurisdiction. The contractor shall provide two-way radio communications to assist in the testing. The owner's representative, prior to acceptance, must witness all testing.

B. The testing and certification shall take place as follows:
   1. System shall be tested in conjunction with the manufacturer's representative.
   2. All deficiencies noted in the above test shall be corrected.
   3. Test results shall be submitted to the consultant or owner's representative.
   4. System test witnessed by the owner's representative and correction of any deficiencies noted.
   5. The owner's representative shall sign off and accept the system.
   6. System tests shall be witnessed by the authority having jurisdiction and any deficiencies that are noted shall be corrected.
   7. A letter of certification shall be provided to indicate that all tests have been performed and all devices are operational, with proper sign-off from the owner and authority having jurisdiction.

3.06 DEMONSTRATION

A. The contractor shall conduct training courses for personnel designated by the owner. Training shall cover all facets of maintenance and operation of the integrated security management system. The training shall be oriented to the specific system being installed under this contract.

B. Training manuals shall be delivered for each trainee with two additional copies delivered for archiving at the project site. These manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The contractor shall furnish audio/visual equipment and other training materials and supplies as necessary.

C. Where the contractor presents portions of the course by audio/visual material, copies of the presentation material shall be delivered to the owner on the same media as used during the training session. Up to four (4) hours of training shall be provided for the base contract, with a minimum of two (2) hours per shift if necessary.

END OF SECTION 281300

SECTION 28 23 00
VIDEO SURVEILLANCE SYSTEM

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION:

A. The Digital Video Management System (DVMS) shall be a hardware-based solution with preloaded software designed for a fully scalable installation that may consist of multiple sites, and therefore, utilization of multiple Network Video Recorders (NVR's) to run the deployment.

B. The Preloaded Software shall be quick and easy to set up, navigate, and manage. The solution shall use system configurations wizards and have functionality to program and direct the hardware. The system shall be compatible with multiple different vendor's cameras.

C. The software solution shall allow for an unlimited ability to add unlimited cameras and all systems connected with software. The software shall also be writable to manage, work with, and coordinate triggers to other security systems, such as, access control and burglar systems.

D. A single site shall consist of a dedicated video recording server, a management application, an image server, a database server, an optional event server, and an optional dedicated remote server.

E. In addition to the NVR, the preloaded software shall have the ability to store video and multiple hard drives, direct attached storage, network attached storage, network storage devices, and so on.

F. The software shall have an alarm management function that shall make it possible to manage all alarms generated by all components attached to the system including, but not limited to:

1. Internal system related events such as motion, archiving issues, and SNMP.
2. External integrated events such as video analytics, access-controlled doors held open too long, or an invalid card read event.

1.02 GENERAL REQUIREMENTS:

A. The drawing and specifications indicate the intent and direction for the installation. Devices and locations are shown diagrammatically and shall be verified with architectural elevations, other trades, door types, door hardware specifications, and with design team for operation prior to completing the work associated with the installation.

B. All work shall be performed in strict accordance with all applicable laws, ordinances, codes of local, state, and federal governments, or authorities having lawful jurisdiction. It is required that the contractor confirm and verify all requirements prior to doing work.

C. The contractor shall furnish all required material, labor, and other associated accessories or tools needed to facilitate the complete installation of the system specified herein.

D. Qualified personnel, utilizing state-of-the-art equipment, current part numbers, and installation techniques required to complete the work without damage to equipment, cables, associated items, or facility.

E. All materials shall be installed in accordance with the manufacturer's specified recommendations and practices.

1.03 SUBMITTALS:

A. Shop drawings that consist of Materials list, electrical characteristics, connection requirements, media transfer, server calculations, camera settings, and system wiring diagrams.

B. Product data sheet showing all equipment, devices, accessories, mounts, electrical characteristics, and connection diagrams.

C. Manufacturers installation instructions: Indicate application conditions and limitations of use stipulated herein by product testing agencies. Include storage, handling, protection, examination, preparation, installation, and startup of the product.

D. Calculations for days of retention and camera settings.

E. Programming and coordination or interface with other systems. Include mapping and page layout. Include all information regarding ties to other systems.

1.04 PRODUCT DOCUMENTATION AND RECORD DOCUMENTS:

A. Record the actual locations and routing of cameras and cabling.

B. Record patch panel and network port address for each camera.

C. Record IP address, MAC address, and camera log in information.

D. Record and turn over a copy of the DVMS configuration files, log-in information, and system documentation.

E. Owner shall get a copy of all training videos and help files to navigate, search, export and retrieve information and use of the DVMS system.

1.05 QUALIFICATIONS:

A. Authorized distributor and installer of the specified manufacturer with service facilities within 150 miles of the project site and have at least 3 years of experience installing the product.

1.06 MAINTENANCE SERVICE:

A. Installing contractor shall provide service and maintenance of the product to the Owner free of charge for 1 year after substantial completion which should include, trip charges, software updates, firmware updates, scene adjustment, and DVMS navigation support.

B. Contractors shall also include information of System Service agreements, costs, fees, and updates for the Owner for 5 years as a line item to evaluate cost.

PART 2 PRODUCTS

2.01 DVMS SYSTEM:

A. Connect to existing DVMS System.

1. Built-in.

2.02 IP CAMERAS:

A. Manufacturers:

1. Axis.

B. Refer to Camera Schedule on plans for basis of design.

2.03 ETHERNET NETWORK:

A. Contract provided network.

1. See Specifications Section 271200 for infrastructure cabling requirements. Division 27 contractor shall provide all cabling unless otherwise noted.

2. Coordinate Network IP, POE switch requirements, port quantities, VLAN, and network security requirements with owner prior to installation.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Install system in accordance with manufacturer's instructions. The following conditions are applicable:

1. In order to ensure a complete, functional system, for bidding purposes, where information is not available from the owner on request, or clarified during the addendum process, the worst-case condition shall be assumed.

2. Interfaces (not specifically called out) shall be coordinated with owner at time of programming, when applicable.

3. All necessary back-boxes, pull-boxes, weatherproof accessories, connectors, supports, conduit, cable, and wire, and accessories shall be furnished to provide a complete and reliable, working system installation. The exact location of devices shall be presented to the owner in advance of any installation and heights coordinated with the design team and architectural elevations.

B. The contractor shall install all system components in accordance with manufacturers recommended instructions. The contractor shall provide all necessary interconnections, services, programming, and final adjustments required to meet the Owner's expectations and as designed on the plans. Grounding loops and precautions for surges into the data communications systems shall be required to minimize system operation errors. Provide all mounting brackets and hardware required at each installation point.

C. All inputs shall be protected including device wiring. Outputs shall be protected against surges induced or transmitted to other system integrations. All equipment shall be properly protected from internal and external noise, surges, or communication transmission errors.

D. Connect each field device to the owner's data network as required. Coordinate each connection point with electrical and data contractors.

E. Install all wiring in raceways allowable by the specifications herein. Minimum conduit shall be 1/2" for single data use. Smooth wall raceway only allowed for data cable to prevent damage to the jacket.

3.02 INTERFACE WITH OTHER PRODUCTS:

A. The DVMS shall interface with security access control system.

3.03 ADJUSTING:

A. All Cameras shall be in focus and adjusted for changing light conditions throughout the day. Final scene adjustments shall be approved by Owner. Final placement shall be approved by Owner and design team prior to installation.

3.04 TESTING AND CERTIFICATION:

A. The testing and certification of the system shall take place as follows.

1. System shall be tested in conjunction with an Owner's Representative and or member from the engineering staff.
2. All deficiencies noted in the above walk-through shall be corrected.
3. Test results shall be submitted for final sign off to Owner and Consultant.
4. Final remedies and scene adjustments must be witnessed by the Owner prior to final sign off.
5. A letter of certification shall be administered providing all tests that were performed, confirmation that all devices are labeled and operational, and owner has signed off on the system.

3.05 DEMONSTRATION:

A. The Contractor shall conduct a demonstration of the full functionality of the system upon completion of installation. Contractor shall provide training for personnel designated by the owner. Training shall cover how to access all functionality of the system, maintenance, operation, and access to the Security management system that includes all integrations.

B. Training manuals, recorded training sessions, and other trainee information shall be handed to the owner and archived on site.

C. Contractor shall account for 4 hours of training and presentation within his bid contract.

D. Training shall include but not limited to:

1. Log into the system in all various ways.
2. Add/Remove Users.
3. Add/Remove Cameras.
4. Viewing live and recorded cameras.

5. Exporting recorded footage.
6. Basic server functions and operations.
7. Basic viewer client functions and operations.
8. Demonstration of basic search functions and features, analytics, and integration features.

END OF SECTION 282300

SECTION 28 46 21
ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section of the specifications includes the furnishing, installation, and connection of a solid-state, low voltage, modular, hardwire, supervised fire alarm system to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm indicating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified. The setting of all addressable devices shall be performed by the manufacturer. The fire alarm system shall consist of all necessary hardware, equipment, and software programming to perform one-way supervised automatic voice alarm operations. Voice evacuation signaling shall be installed as described in this section.

B. Equipment and devices shall be compatible with the existing fire alarm system.

C. Fire Alarm systems shall comply with requirements of NFPA 70, 72, (including appendices) 90A, 101 for local building systems except as modified and supplemented by this specification. This is a performance specification. The devices shown on the drawings indicate design intent and shall be the minimum provided. Provide all other devices as required by other governing laws, codes, standards, and local inspectors.

D. The Electrical Contractor shall prepare design drawings (including plans showing device locations and riser diagram), calculations, documents, and catalogs cut sheets on all components and submit as shop drawings for approval. The system designer shall be identified on the system design documents. The system designer and installer shall provide evidence of their qualifications and/or certifications when required by the AHJ or engineer of record. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculations, and single-line connection diagram.

1. The system supplier shall submit fire alarm system drawings and calculations sealed by a licensed professional engineer for approval. After approval, shop drawings to be submitted to the State Fire Marshal for approval.

1.02 CONTROL PANELS:

A. Connect to existing fire alarm control panel. Provide additional components if required.

B. Audio/visual signals shall only sound upon any alarm within the building served.

1.03 POST CONTRACT MAINTENANCE:

A. Complete maintenance and inspection service for the new fire alarm system devices and components shall be provided, by a factory trained authorized representative of the manufacturer of the major equipment, for a period of two (2) years after acceptance of the installation by the engineer.

B. Maintenance and inspection service shall be performed by factory trained authorized representatives of the major equipment manufacturer. Service availability shall be within 150 miles.

C. Maintenance service shall include the following:

1. Inspection:
   a. Inspect all equipment per NFPA 72 prior to final acceptance by Owner and at six (6) month intervals.
   b. Testing, cleaning, adjusting, repairing, and replacing of all components as necessary, to keep the system in reliable condition and proper working order.
   c. Submit a company contact and proposed schedule for inspection and testing through the remainder of the two-year period.

d. Submit a list of recurring inspection and maintenance items required following the two-year period.

e. Furnishing all tools, test instruments, cleaning materials and parts required.

f. Battery and charger maintenance shall be included.

2. Emergency Service:

a. Normal and overtime emergency call-back service shall consist of responding to calls via telephone within one (1) hour of notification of system trouble.

b. Overtime emergency call-back service shall be limited to minor adjustments and repairs to affect the integrity of the system.

c. Non-operational system situations and associated on-site service shall be provided within 24 hours of notification.

D. Install access panels approved by the architect for all devices located in non-accessible spaces. Panels shall be flush locking type with a fire rating equal to the ceiling system.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by Underwriters Laboratories, Inc., and Factory Mutual Research Corporation. The authorized representative of the manufacturer of the major equipment such as control panel, annunciator, transmitters, and initiating devices, shall install and be responsible for satisfactory total system operation and its certification. Manufacturer shall provide NICET certified personnel to test equipment.

B. Approved Manufacturers: Siemens Infrastructure and Cities (Siemens IC).

2.02 WIRING:

A. Conduit and Wire Sections RACEWAY SYSTEMS and LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES shall apply:

1. This contractor shall furnish and install all wiring, conduit, junction boxes and outlet boxes required for the installation of a complete system. All wiring shall be installed in red colored metallic conduit; wiring shall be color coded throughout and shall test free and clear of opens, grounds and shorts between conductors. All wiring shall be #18 gauge or minimum size as determined by the manufacturer, copper, with the exception of audio and visual alarm devices which shall have #14 gauge copper. All wiring shall have a minimum insulation rating of 300V. All equipment shall be grounded with an approved earth ground wire being supplied at the control panel. All wiring shall be in conformance with Article 760 of the National Electric Code. Audible and visual devices shall be capable of being controlled individually.

2. Contractor and equipment supplier shall jointly provide a proposed riser diagram for the fire alarm system indicating all devices, equipment, and wiring with the submittals prior to construction. If changes are made during construction a corrected riser diagram shall be submitted with the operating and maintenance manuals upon project completion. Riser diagram shall use symbols as shown on the drawings and shall have room numbers adjacent to all devices. All wiring shall be in conduit.

3. Wires in junction boxes and cabinets shall be permanently tagged and identified with metal or phenolic tags attached by nylon ties.

4. Where partial evacuation or relocation is used, all fire alarm wiring routed outside of the evacuation signaling zone it serves, shall have a minimum pathway survivability level of 2 per NFPA 72. The following methods can be used to meet NFPA 72 Pathway Survivability Level 2 requirements:

a. CI Cable (not in conduit):

1) Cable shall be 2-hour fire-rated circuit integrity (CI) cable UL Listed for installation without conduit.

2) Cable shall be installed and supported per manufacturers and UL requirements.

b. CIC Cable (CI cables in conduit):

1) Cable shall be 2-hour fire rated cable system (electrical protective system). Cable shall be UL Listed for installation in steel conduit system.

2) Conduit supports shall be located a maximum of 5'-0" on center.

3) System shall be installed and supported per manufacturer's and UL requirements.

B. Terminal Boxes, Junction Boxes and Cabinets:

1. Shall be galvanized steel and in accordance with UL.
2. Paint box and cover red and identify with letters of white paint stenciled as "Fire Alarm System" in accordance with Section PAINTING.
3. Junction boxes shall have a volume 40 percent greater than required by the NEC. Minimum sized wire shall be considered as 14 AWG for calculation purposes.
4. Terminal cabinets shall have identified pressure type terminal strips, and shall be located at the base of each riser as shown on the drawings.

C. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted.

D. Audible indicating devices and visual indicating devices shall be capable of being controlled individually.

2.03 FIRE ALARM CONTROL PANEL:

A. Function:

1. Operate as a supervised, positive noninterfering successive alarm system. Each power source shall also be supervised from the other source for loss of power.
2. Supervise all signal initiating circuits, alarm indicating circuits, alarm transmitter trip circuits, and sprinkler and standpipe valves.
3. Detect the operation of any signal initiating device and the area of the alarm condition, and operate all alarm and designated auxiliary devices.
4. Visually and audible annunciate any trouble condition such as main power failure, ground or system wiring derangement, and sprinkler system and standpipe valve off-normal position.

B. Power Supply:

1. The control panel shall derive its normal power from a 120 volt, 60 Hz supply. Standby power shall be provided by a 24 volt DC battery as hereinafter specified. The normal power shall be transformed, rectified, coordinated, and interfaced with the standby battery and charger.
2. The door holder power shall be arranged so that momentary or sustained loss of main operating power shall not cause the release of any door for a minimum of 15 seconds. This may be accomplished by floating the door holders across the battery supply or by other approved means accomplishing the same function.
3. Power supply for smoke detectors shall be taken from the fire alarm control panel.
4. Provide protectors to protect the fire alarm equipment from damage due to lightning or voltage and current transients.
5. Provide additional power supplies as required.

C. Circuit Arrangement:

1. Provide means whereby any device or signal circuit may be disconnected from the system. Removing any initiation or alarm circuit shall leave the remainder of the system in normal operating condition, and light an individual trouble lamp which shall remain lighted until the circuit is restored to normal operating condition.

2. Arrange circuits so that if an open circuit occurs in the signal coil, it shall not prevent other audible signals on the same circuit from sounding.
3. Each circuit shall be individually fused.

D. Circuit Supervision:
1. Each alarm initiating circuit, alarm indicating circuit, and local energy transmitter trip circuit, and sprinkler and standpipe valve circuit shall be supervised against the occurrence of a break or ground fault condition in the field wiring. These conditions shall cause a trouble signal to sound in the control panel until manually silenced by an off switch.
2. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall also be supervised for off-normal position. Valve supervision shall indicate where the valve is located. Closing a valve shall sound a supervisory signal in the control panel until silenced by an off switch. Valve operation shall not cause an alarm signal.

E. Trouble signals:
1. Arrange the trouble circuit for ring back operation to prevent switch disarrangement during normal supervisory condition. Automatic reset arrangement is acceptable in lieu of ring back operation.
2. System trouble switch off and on lamps shall be visible through the control panel door.

F. Interfaces:
1. One communication port compatible for voice evacuation interface.

G. Sound System Interface:
1. Fire alarm system shall be provided with a set of dry contacts to signal each public address/sound system in the building to override these systems to “off” prior to broadcasting a voice evacuation signal in the building.

2.04 BATTERY AND CHARGER:

A. Battery:
1. Shall be 24-volt nominal.
2. Battery shall have sufficient capacity to power the fire alarm system for not less than four hours plus fifteen minutes of alarm to an end voltage of 1.14 volts per cell, upon a normal AC power failure. System load shall include the power required by the electromagnetic door holders for a minimum of fifteen seconds.
3. Battery racks shall be steel with an alkali-resistant finish.
4. Battery calculations shall include a 20 percent safety margin to the calculated amp hour rating.
5. Provide additional battery capacity as required.

B. Battery Charger:
1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120-volt, 60 hertz source.
2. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.
3. A trouble condition shall actuate the fire alarm trouble signal.
4. Charger shall have automatic AC line voltage regulation, automatic current-limiting features, and adjustable voltage controls.

2.05 RECORD DOCUMENTS:

A. System Record Documents Enclosure:
1. Provide red fire alarm System Record Documents (SRD) enclosure equal to Space Age Electronics, Inc. SRD ACE-11.
2. Mount SRD adjacent to the fire alarm control panel or other AHJ approved location.

B. Location Charts:

1. Print with easily readable, uppercase type, minimum 3/16-inch size letters.
2. Laminate or mount under plexiglass in a neat frame, and install adjacent to the fire alarm control panel. Six additional unframed charts shall be delivered to the Owner.

2.06 AUDIO/VISUAL FIRE ALARM SIGNAL DEVICES:

A. Shall be electrical supervised, selectable single stroke or vibrating, chime type, flush mounted at 80" AFF per ADA. Audio devices shall use the ANSI S3.41 Three-Pulse Temporal Code Standard Evacuation Signal.

B. Unless otherwise shown on the drawings, shall have a nominal rating of 87 dB at ten feet.

C. Mount on removable adapter plates on conduit boxes.

D. Provide surface mounted box adapter for surface mounted devices in finished spaces.

E. Audio signals located outdoors shall be weatherproof type with metal housing and protective grille.

F. Each signal circuit (audio or visual) shall have a minimum of twenty percent spare capacity.

G. Visual Signal: Shall be integral with the audio signal and shall have clear dome. Lettering on housing to read "FIRE" and be visible from all viewing directions. Lettering shall be white for red appliances and red for white appliances. Dome to be high impact non-yellowing plastic. Lamps shall be low voltage type for flashing service with a xenon flasher that meets ADA and UL 1971 requirements. Lamp circuits shall be supervised.

H. Provide all additional devices as required to meet all codes, inspector's requirements and ADA.

I. Strobes shall be synchronized.

J. Strobes shall be located per NFPA 72.

K. Strobe intensity shall be per the following:

Minimum Required Light Output, Candela (cd) (Effective Intensity) Wall Mounted Visual Signal			
Maximum Room Size	One Light Per Room (cd)	Two Lights per Room (Located On Opposite Walls) (cd)	Four Lights per Room (One Light per Wall) (cd)
20' x 20'	15	-	-
30' x 30'	34	15	-
40' x 40'	60	30	15
50' x 50'	94	60	30
60' x 60'	135	95	30
70' x 70'	184	95	60
80' x 80'	240	135	60
90' x 90'	304	185	95
100' x 100'	375	240	95

Minimum Required Output, Candela (cd) (Effective Intensity) Ceiling Mounted Visual Signal		
Maximum Room Size	Maximum Lens Height	Minimum Required Light Output, One Light
20' x 20'	10'	15
30' x 30'	10'	30
40' x 40'	10'	60
50' x 50'	10'	95
70' x 70'	10'	185
20' x 20'	20'	30
30' x 30'	20'	45
50' x 50'	20'	95
70' x 70'	20'	185
20' x 20'	30'	55
30' x 30'	30'	75
50' x 50'	30'	95
70' x 70'	30'	185

L. Voice/Tone Notification Appliances (Speakers):
   1. Speakers shall comply with UL 1480.
   2. Speakers for Voice Notification: Locate speakers for voice evacuation to provide the intelligibility requirements of the “Notification Appliances” and “Emergency Communications Systems” chapters of NFPA 72.
   3. Mounting:
      a. Backboxes shall be per manufacturer’s recommendations.
      b. Speakers shall be flush mounted in spaces with ceilings and surface mounted to structure in spaces without ceilings. Provide tile bridge as required.
   4. Speaker shall be U.L. Listed for use in fire protective signaling systems.
   5. Speakers shall operate on a standard 25V RMS or 70.7V RMS. If using 70V system, Contractor to verify installation requirements with the authority having jurisdiction.
   6. Transformers shall be factory installed and tested.
   7. Speakers shall be a 4” moisture-proof cone with a frequency response of 400-4000 Hz.
   8. Speakers shall produce a minimum UL rated sound pressure level of 84dBA at 10 feet.
   9. Metal baffle shall be white.Verify color prior to ordering.

M. Audio Power Amplifiers:
   1. Amplifiers shall comply with UL 1711 “Amplifiers for Fire Protective Signaling Systems”.
   2. Amplifiers shall be furnished with a self-contained power supply, transformer, and amplifier monitor circuits.
   3. Amplifiers shall provide a 25V RMS or 70.7V RMS output. If using 70V system, Contractor to verify installation requirements with the authority having jurisdiction.
   4. Provide sufficient amplification to operate all system speakers simultaneously plus 20 percent spare capacity.
   5. Provide at least one backup amplifier capable of automatically replacing any failed amplifier. Amplifiers shall automatically transfer to backup units, on primary equipment failure. Test switches on the amplifiers shall be provided to test and observe amplifier backup switchover.

2.07 ADDRESSABLE MANUAL STATIONS:

A. Furnish and install a double action, non-coded, manual fire alarm station, flush mounted.

B. This station shall be connected to a remote interface monitor module as required, for addressable operation. Each module will have an engraved nameplate, acceptable to the engineer, with the same name setup in programming.

C. To operate the station you must push the face panel and manually pull down which in turn activates the associated remote interface monitor module. The face panel locks in the down position providing a positive indication that the station has been operated. The station can be reset to the normal position by the use of a special reset key.

D. The station shall be constructed of a die cast metal or fire retardant polycarbonate, finished in red enamel with raised white lettering. The station shall be jam-proof and shall be surface or semi-flush mountable. The station shall offer a break rod feature which shall not be necessary for station operation.

2.08 SMOKE/HEAT DETECTORS:

A. Addressable Ceiling Smoke Detectors:
   1. Furnish and install as indicated a ceiling mounted photoelectric detector. This detector shall be environmentally compensated, and calibrated and adjusted for sensitivity at the manufacturer's factory to U.L. Standard 268 (Nominal 2.3% per foot smoke obscuration level). Each detector shall utilize solid state components and be equipped with a fully regulated LED light source for long life reliability and an insect screen to minimize nuisance alarms. The detector shall provide a multiple pulse coincidence circuit to minimize false

alarms from transient smoke conditions. When the alarm threshold value is exceeded for the first time, the detector shall go into alarm only after at least 2 more consecutive sample pulses have exceeded the alarm threshold values. The detector shall be able to transmit obscuration information to FACP. Detector shall have environmental compensation circuits and shall maintain constant sensitivity even when maintenance required messages are produced.

2. Either the detector head itself or the detector base shall use magnetic (switchless), binary dipswitches, or rotary decimal (hexadecimal) switches for the assignment of its individual address number when it is being field programmed. It shall also have a data communication line/alarm (flashing/steady) LED and terminals for making data communication line circuit connections. The detector/base assembly shall draw its power from the fire alarm control panel via the data communication line. The detector/base shall flash its LED, to assure communication, as it is being polled for status from the fire alarm control panel and shall report alarm or trouble status changes to it.
3. Outlet boxes for detectors shall be flush mounted. Each detector will have a label to coordinate with control panel description, acceptable to the engineer, with the same name setup in programming.
4. Smoke detectors shall not be located within 36” of any air diffuser or sprinkler head.
5. Provide a remote alarm indicator for each detector located in a concealed location or located where the detector's alarm indicator is not readily visible. Flush mount the remote alarm indicator in the ceiling near the detector.

B. Addressable Duct Mounted Smoke Detectors:

1. Furnish and install photoelectric type, duct mounted smoke detectors at all supply and return ducts, all fire/smoke dampers, where indicated on the drawings, and where required by code. Duct mounted detectors shall operate similar to ceiling smoke detectors and are to be equipped with suitable duct housings from the manufacturer. Sampling tubes are to be sized according to the actual duct they are placed across in the facility. The detector housing shall have a local test capability and status indicator LED, and provisions for connecting a remote status indicator LED. The detector shall be able to transmit obscuration information to FACP.
2. Duct mounted smoke detectors shall be UL listed for their intended use and shall be compatible with the Fire alarm equipment installed. Sampling tubes shall extend across the entire width of the duct and be secured properly on each end.
3. Each detector and duct housing shall be self-compensating for the effects of air velocity (from 500 to 3,000 feet per minute), temperature, humidity, and atmospheric pressure. It shall not be necessary to field adjust the sensitivity to compensate for the above effects.
4. Each detector shall be a 2-wire or 4-wire, 24 VDC type duct smoke detector utilizing solid state components. Detectors providing integral relay initiation shall be 4-wire type detectors. Each detector shall be listed for U.L. Standard 268A.
5. The 24 VDC power to the duct detectors and the number of duct detectors on each 24 VDC power loop is completely dependent on the alarm current of the duct detector and the fused capacity of the supervised power loop and these requirements shall be designated and shown on the fire alarm submittal.
6. All duct mounted smoke detectors shall be installed in accordance with the standards and requirements set out in NFPA 90A, Installation of Air Conditioning and Ventilating Systems. The Installing contractor will be responsible for installing any additional duct mounted smoke detectors that are needed to meet the latest requirements of NFPA 90A.
7. Provide a remote alarm indicator for each duct smoke detector. For duct smoke detectors in supply and return ducts of mechanical equipment, locate remote alarm indicators at mechanical unit mounted at 46” AFF. For duct smoke detectors at fire/smoke dampers, locate remote alarm indicators as close as possible to duct detectors locations, flush mounted in ceiling.

C. Addressable Heat Detectors:

1. Furnish and install heat detectors flush mounted as indicated on the drawings. Detectors shall be combination rate-of-rise and fixed temperature. Each detector shall utilize solid state components and the activation of the rate-of-rise or fixed temperature alarm functions shall be capable of being reset from the fire alarm control panel.
2. Either the detector head itself or the detector base shall use magnetic (switchless), binary dipswitches, or rotary decimal (hexadecimal) switches for the assignment of its individual address number when it is being field programmed. It shall also have a data communication line/alarm (flashing/steady) LED and terminals for making data communication line circuit connections. The detector/base assembly shall draw its power from the fire alarm control panel via the data communication line. The detector/base shall flash its LED, to assure communication, as it is being polled for status from the fire alarm control panel and shall report alarm or trouble status changes to it.
3. Outlet boxes for detectors shall be flush mounted. Each detector will have a label to coordinate with control panel description, acceptable to the Engineer, with the same name setup in programming.

2.09 AIR HANDLING UNIT SHUT DOWN RELAYS:

A. 24 VDC operation, mounted in surface cabinet. These relays shall be controlled and powered from the fire alarm control panel and must be supervised. Contacts shall be 2P D.T. rated at 2 amps resistive 28 VDC/120VAC.

2.10 ELECTROMAGNETIC DOOR HOLDERS:

A. Provide as part of the fire alarm system individual door holders at all locations as shown on the drawings. Any additional door holders that are specified under Section BUILDERS HARDWARE shall be connected and coordinated into the fire alarm system as specified in this section.

B. Operation shall be by 24 volt DC supplied from the fire alarm control panel. Coordinate door holders as to voltage, ampere drain, and voltage drop with the battery, battery charger, wiring, and fire alarm system for the operation specified.

C. A maximum of eight door holders shall be provided for each circuit with its own fuses, disconnect switch and pilot light.

D. Associated relay control circuits shall be electrically supervised.

E. Smoke detectors shall not be incorporated as an integral part of door holders, but are functionally associated as hereinafter specified.

F. Provide master control switches with pilot light, for maintaining power to door holders during fire alarm tests. A switch shall be located at the fire alarm control panel.

2.11 WATERFLOW SWITCHES:

A. Waterflow switches shall be cane type waterflow detectors with adjustable retard feature and two sets of single-pole, double-throw (SPDT) alarm contacts to be supplied. Remote interface monitor modules will be installed to monitor each individual waterflow switch which is shown on the fire alarm bid document drawings. These modules shall be flush or surface mounted to the wall at an appropriate location below the waterflow switch itself, so that maintenance personnel can readily view the supervisory LED on the module. They will be mounted at the same height as manual stations. Each module shall have an engraved nameplate, acceptable to the Specifying Engineer, with the same custom alphanumeric message setup in programming on this nameplate.

2.12 ANNUNCIATOR:

A. Where shown on the plans provide and install a serial LCD annunciator. LCD display shall consist of two backlit lines with 40 characters per line. The annunciator(s) shall have a black finish with beige enamel trim. The annunciator shall communicate to the control panel over one twisted, shielded pair of wire and operating power shall be 24 VDC provided by (2) #14's and shall be fused at the control panel. Annunciator(s) shall mount on a 6-gang electrical box furnished by the Electrical Contractor. The serial annunciator shall provide a common alarm and trouble circuit consisting of:

1. Control push-button switches for alarm silence, trouble silence, system reset, and manual evacuation duplicating the control panel switches. A key “enable” switch shall be provided to activate or deactivate the control switches.
2. Tone Alert: Duplicates the control panel tone alert during alarm and trouble conditions.
3. Shall display the time, date, and “system is normal” label when there are no alarms, troubles, or supervisory conditions present in the system.
4. Display shall provide clear English language information as to the point status (alarm, trouble, etc.), type of alarm (smoke detector, pull station, etc.), number of alarms, supervisory conditions, and troubles in the system, and a custom location label.

2.13 GRAPHIC ANNUNCIATOR:

A. Graphic annunciator panel shall be with anodized aluminum frame, full color polyester film, glare free front lens, aluminum backplate, LED. (Light Emitting Diodes) indicators showing exact locations of zones and or devices.

B. Annunciator shall be U.L. listed, with lamp test feature, powered from the Fire Alarm Control Panel. Size with floor plan positioned correctly for the wall on which it is mounted. Door shall have key lock and LED indicators shall be protected from tampering. Engineer to provide final approval and background color prior to manufacture.

2.14 NOTIFICATION APPLIANCE CONTROL (NAC) PANELS:

A. Notification appliance control panels shall be provided as required by the system supplier.

B. Units shall be UL 864 listed for power limited operation.

C. Power supplies shall support a full 8 amps of notification power even if the battery is in a degraded mode and only AC power is connected.

D. The unit shall incorporate a built-in battery charger with automatic switchover to battery back-up in the event of AC power failure.

E. Horn and strobe circuits shall be synchronized.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Installation shall be in accordance with the NEC, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. Install smoke detector heads not more than two weeks prior to final inspection. Test the detectors in place. Cleaning detectors at the time of final inspection is the contractor’s responsibility.

C. Field verify location of area smoke detectors and heat detectors. Do not locate within 36-inches of a HVAC diffuser (supply or return), in a direct air flow, within 36-inches of a sprinkler head, or within 36-inches of the tip of a ceiling fan blade. Smoke detectors for door release shall be located on the centerline of the door and a maximum of 5 feet from the door. The minimum distance from the door is the depth of the wall section above the door, but not less than 12”. Provide smoke detectors at all fire alarm control equipment (fire alarm control panels, NAC panels, etc.)

D. Duct smoke detectors should be located in the area between 6 and 10 duct equivalent diameters of straight, uninterrupted run. Duct smoke detectors for fire/smoke dampers should be located between the last inlet or outlet upstream of the damper and the first inlet or outlet downstream of the damper. Coordinate location of duct detectors with humidifier dispersion grids as required.

E. Fan shutdown relay wiring shall be located within 3 feet of the fan controls and the wiring to the relay shall be monitored. Fan shutdown relay shall be wired to shutdown to the fan, not the temperature controls controller.

F. All fire alarm control equipment (fire alarm control panels, NAC panels, etc.) shall be connected to emergency power if the building or structure has an emergency power distribution system.

3.02 TYPICAL OPERATION:

A. Normal System Operation: Actuation of any manual station, smoke detector, or water flow switch shall cause the following operations to occur, unless otherwise specified:

1. Operate the audible/visual signals in the building. Audible devices shall be temporal coded.
2. Transmit a separate alarm/trouble signal, via phone line to a central monitoring agency.
3. Duct type smoke detectors and waterflow switches shall, in addition to the above, perform the functions specified in the mechanical specifications or shown on the mechanical drawings.
4. Operation of any sprinkler and standpipe valve supervisory switch shall cause the system to go into trouble condition.
   a. It shall not cause the system to go into alarm condition.
   b. It shall not prevent any flow switch from actuating an alarm.
5. Provide duct detectors in both the supply and return air ducts for air handling equipment, fan coil units; and make-up air unit, 2000 CFM or larger. Provide fan shut down relays to shut down AHU's, make-up air units, relief fans, exhaust fans and fan coil units.
6. The alarm activation of any elevator lobby smoke detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled according to the following sequence:
   a. If the alarmed detector is on any floor other than the main level of egress, the elevator cabs shall be recalled to the main level of egress.
   b. If the alarmed detector is on the main egress level, the elevator cabs shall be recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.
   c. If the alarmed detector is in any elevator equipment room or elevator shaft, the elevator cabs shall be recalled to the main level of egress.

B. System Supervision: System supervision shall include the following conditions:
1. Loss of operating or standby power.
2. A signal ground or open circuit in alarm initiating circuits, alarm indicating circuits, and auxiliarized transmitter trip circuits, and sprinkler and standpipe valve circuits. Each circuit shall have its own supervisory devices.
3. Off-normal position of sprinkler and standpipe valves.
4. Battery and battery charger shall have supervision as specified elsewhere in this section.

C. Trouble Signals:
1. Derangement of any of the above supervised conditions shall be visually and audible annunciated at the fire alarm control panel. Each circuit shall have individual visual annunciation.
2. Operation of the sprinkler and standpipe valves towards the closed position shall cause a supervisory signal.
3. Trouble signals shall be retransmitted, via an individual auxiliarized transmitter, to remote locations.

D. One-Way Voice Communication:
1. The system shall incorporate one-way voice communication and tone generating capabilities.
2. Voice evacuation message shall be preceded and followed by a minimum of two cycles of the emergency evacuation signal.
   a. Standard emergency evacuation signal shall consist of a three pulse temporal pattern in accordance with NFPA 72.
3. A central audio control module shall be provided for the necessary alarm message/tone generation, main and remote microphone connections, music inputs, and mixer/pre-amplifier circuits. Dual alarm channels shall permit simultaneous transmission of different announcements to different zones or floors automatically. Continuous circuit supervision shall be provided along with specific information as to the type of failure should a problem

occur. Audio control module shall provide up to 30 minutes of message memory for digitally stored messaged.

4. An audio control switch module shall be furnished to provide manual access to audio operations for authorized personnel. The module shall include an “All Circuits” switch, “Aux Tone 1” switch, “Aux Tone 2” switch, tone generator stop switch, and “Audio Trouble Reset” switch. These switches and associated LED indicators shall be supervised for disarrangement or failure.
5. A handheld, push to talk microphone shall be provided, recessed within a protective panel mounted enclosure. The microphone shall be a noise canceling communication type and shall be equipped with a five foot coiled cable. An LED indicator shall be provided to indicate the microphone push to talk button has been pressed and speaker circuits are ready for transmission. The microphone connection shall be supervised. Activation of manual voice microphone shall automatically silence any existing alarm tones/messages.
6. Total building evacuation shall be provided to allow to activation of all speakers by means of an “All Circuit” switch.

3.03 TESTS:

A. Provide the service of a competent, NICET certified, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the engineer.

B. When the systems have been completed and prior to the scheduling of the final inspection, furnish testing equipment and perform the following tests in the presence of the engineer. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm system meets all contract requirements. After the system has passed the test and been approved by the engineer, the contractor may request a final inspection. Final acceptance of system will not be made until retested at final inspection.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
2. Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
3. Run water through all flow switches. Drain the water by hose to the nearest drain. Check to verify whether all codes are coming in clearly and correctly. Check time delay on water flow switches to assure that water surges do not trip transmitters. (Submit a report listing all water flow switch operations and the delay time in seconds.)
4. Open fire alarm station circuits to see if trouble signal actuates.
5. Open audible signal circuits to see if the trouble signal actuates.
6. Ground fire alarm station circuits and verify response of trouble signals.
7. Ground audible signal circuits and verify response of trouble signals.
8. Check transmission of all fire alarm devices.
9. Check installation, supervision, operation and sensitivity of smoke detectors to ascertain that they will avoid false alarm signals and will function as specified. See Article SMOKE DETECTORS.
10. Upon completion of Fire Alarm System Testing, submit to engineer one (1) copy of Testing and Inspection Report signed off as 100 percent functioning by the System Supplier and the Electrical contractor. Bind one (1) additional copy in each of the operation and maintenance manuals. A record of completion document, as described in NFPA 72, shall be stored at the fire alarm control panel or other approved location by the AHJ. When not stored at the fire alarm control panel the location of this document shall be identified at the fire alarm control panel. If documents are stored in a separate enclosure or cabinet it shall be prominently labeled “Fire Alarm Documents”. Other documents required to be located at the fire alarm control panel include:

a. Owner's manual and manufacturers published instructions covering all system equipment.
b. Record drawings.
c. For software based systems, record copy of the site specific software.
d. Written sequence of operation.

3.04 FINAL INSPECTION:

A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall perform the tests in Article TESTS. In addition the representative shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of the Owners Representative.

3.05 INSTRUCTION:

A. Furnish the services of a competent instructor for not less than two four-hour periods for instructing personnel in the operation and maintenance of the system, on the dates requested by the Engineer.

END OF SECTION 284621

SECTION 28 55 00
RF SURVEY FOR EMERGENCY RESPONDER RADIO ANTENNA/REPEATER BDA SYSTEM

PART 1 GENERAL

1.01 SUMMARY:

A. The purpose of this specification is to establish the requirements and standards for initial survey for public safety radio signal strength per NFPA and IFC.

B. Survey should be performed after the building is substantially completed, and prior to start of installation of electrical wiring.

C. Conduct a survey using a RF Spectrum Analyzer, a calibrated, system-compatible radio or another suitable instrument with traceable certificate of calibration to analyze the RF signal strength of Emergency Responder Radio Signal into the building and determine if amplification of the signal is required. Both inbound and outbound signal strength shall be determined, measured, calculated and documented as required by code.

D. Result(s) of this survey shall indicate if an Emergency Radio System (BDA) is required for this facility. **If so, Contractor shall provide and install per AHJ requirements.**

1.02 SURVEY CRITERIA IF REQUIRED:

A. The required Public Safety Radio Signal Level inside the Owner's facility must be determined per code, ordinance or AHJ.

B. Survey shall be performed by an FCC licensed technician holding a current GROL license.

1.03 REGULATIONS:

A. Codes, regulations and standards referenced in the Section are:

1. NFPA 1 – The National Fire Code (including Annex O from 2009).
2. NFPA 70 – The National Electrical Code.
3. IFC 510- Emergency Responder Radio Coverage.
4. NFPA 101, Life Safety Code, the Ohio Building Code, and Local Code and Building Authority requirements.
5. NFPA 72 National Fire Alarm Code.
6. FCC 47 CFR Private Land Mobile Radio.
7. 90.219 Services-Use of Signal Boosters.
8. ICC International Fire Code, Code and Commentary.
9. Local or State Promulgated Fire Code.
10. ADA "Americans with Disabilities Act".
11. FCC's OET 65 Standards "Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".
12. FCC Rules Part 22, Part 90 and Part 101.
13. NFPA 1221 2016 Edition.
14. International Building Code 2012 / 2015 / 2018 15. UL 2524.

1.04 DEFINITIONS:

A. Definitions:

1. Bi-Directional Amplifier BDA: Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station and in the downlink from the base station to subscriber devices for enhanced signals and improved coverage.
2. Emergency Responder Radio Coverage System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services, or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.

3. FCC: Federal Communications Commission.
4. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
5. Public Safety/First Responder: Public Safety or First Responder agencies that are charged with the responsibility of responding to emergency situations. These include, but are not limited to law enforcement departments, fire departments, and emergency medical companies.
6. RSSI: Received signal strength indicator RSSI is a measurement of the power present in a received radio signal.
7. BER: Bit Error Rate is the number of bit errors per unit time.
8. GROL- FCC General Radio Operators License.
9. ERRCES- Emergency Responder Radio Coverage Enhancement System.
10. DAS-Distributed Antenna System.

1.05 SURVEY SUBMITTALS:

A. Submit testing data for each level of the building.
   1. A RF measurement drawing of each floor of the building which indicates relative RF field strength for each frequency band of interest must be submitted to the AHJ.
   2. The drawing should clearly indicate the areas that have passed or failed based on the above parameters.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TESTING PROCEDURES:

A. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the -95dBm nominal signal at 100%.

B. Spectrum Analyzer or Calibrated Handheld Radio shall be used as basis for signal measurements or other method as approved by AHJ.

C. Testing should be based on a minimum of 20 grid locations per floor OR maximum of 1600 SQ ft. areas if the floor exceeds 32,000 Sq. Ft. Also, testing should include all critical areas per NFPA. See 1.02 of this specification and NFPA 72 2013 or NFPA 1221 2016. OR per any method determined by the AHJ, local code or ordinance.

D. A minimum signal strength of -95 dBm shall be provided throughout the coverage area for both uplink and downlink by the Local Fire Department.
   1. RSSI measurement only.

END OF SECTION 285500