PROJECT MANUAL

RENOVATIONS AND ADDITIONS TO BRANDON OAKS FISHWICK & NRC PHASES 2D & 3

FOR

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VOLUME II

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DIVISION 21 – FIRE SUPPRESSION

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SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Fire-suppression equipment and piping demolition.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Concrete bases.
10. Supports and anchorages.

1.3 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

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

1.4 QUALITY ASSURANCE

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

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

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

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

1.6 COORDINATION

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

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

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

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

2.3 JOINING MATERIALS

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

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

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

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

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

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

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

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

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

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

H. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

2.4 MECHANICAL SLEEVE SEALS

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

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

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

2.5 SLEEVES

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

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

C. 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.

2.6 ESCUTCHEONS

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

B. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

2.7 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

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

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

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors.

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

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

O. 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 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.

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

Q. Verify final equipment locations for roughing-in. Coordinate with other trades to allow adequate space for other systems.

3.2 PIPING JOINT CONSTRUCTION

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

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

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

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

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

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

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

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

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

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.

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

3.3 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

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

3.4 CONCRETE BASES

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

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

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.

3.5 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 21 05 00

SECTION 21 11 00 - FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fire-suppression piping and equipment for the following building systems:

1. Wet-pipe, fire-suppression sprinklers, including piping, valves, specialties, and automatic sprinklers throughout all areas except where noted below.

2. Existing System Modifications to NRC shall be included in the scope.

a. The existing fire service entry for NRC will remain in place and be reused.

b. Existing piping located within the areas of renovation shall be assumed to be in conflict with new work from other trades and therefore shall be replaced, however, existing piping may be retained and reused at the discretion of the contractor. Relocation and deletion of existing heads and branch pipe to accommodate the new space layout and modifications shall be included. This shall include the addition of new piping and sprinkler heads to ensure the system design meets all NFPA 13 requirements and to provide coverage of the addition and renovated areas.

c. Existing piping which is retained and reused shall be raised and / or relocated throughout all areas of work to accommodate, new partition and ceiling arrangements, new ceiling heights and installation of new piping and ductwork systems. Existing piping may be reused, added to, and modified as required where possible and when in good condition. New components shall be provided as needed to meet all NFPA 13 requirements.

d. At the completion of the project the system shall be fully compliant with NFPA 13 and shall be fully documented and provided with new hydraulic calculations for the entire system.

e. This contractor shall be responsible for visiting the project site prior to bid submittal. This contractor shall review all existing conditions and be responsible for including all products and services required to complete the scope of work outlined within this specification under this bid submittal. Change orders will not be approved for items resulting from this contractor’s lack of knowledge of an existing condition.

f. The existing dry pipe valve assembly and compressor serving NRC shall be modified, as necessary, to serve NRC Addition as well.

3. The quantity of dry-pipe valve assemblies shall be the responsibility of this contractor and shall be based on system sizing and testing requirements of NFPA 13.

4. The dry system in all new additions shall include galvanized, schedule 40 steel pipe and fittings for all piping in each dry system.
5. Install sprinklers in the center of tile.
6. Install sprinklers in the center row of each corridor.
7. Head placement shall be symmetric and coordinated with the ceiling equipment, lights, air devices and other ceiling mounted devices. The Architect and Engineer shall review the Shop Drawings and modify proposed head arrangement to meet the Architect's aesthetic requirements for the project.
8. Provide a backflow preventer, flow switch and tamper switches for the main service entry. Service entries are indicated on the plumbing drawings.
9. Provide two pressure switches and a tamper switch for each dry pipe valve assembly.
10. The system shall be designed in accordance with NFA 13.
11. All systems drains shall be routed concealed through the building structure and shall discharge onto grade or into an approved receptor. Terminations shall be painted to match the exterior wall.
12. All sprinkler heads shall be quick response type.

B. Related Sections include the following:

1. Division 28 Section "Fire Alarm Systems" for alarm devices not in this Section.

1.3 DEFINITIONS

A. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to the most current version of NFPA 13 for obtaining approval from authorities having jurisdiction and the Owner's insurance company.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Design sprinkler system according to the following and obtain approval from authorities having jurisdiction:

1. Include 10 percent margin of safety for available water flow and pressure in all calculations.
2. Include losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications: As follows:

a. Building Service Areas: Ordinary Hazard, Group 1.
b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
c. General Storage Areas: Ordinary Hazard, Group 1.
d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
e. Public Areas: Light Hazard.
f. Residential Living Areas: Light Hazard.
g. Kitchen Service Areas: Ordinary Hazard, Group 1.

4. Minimum Density for Automatic-Sprinkler Piping Design: As follows:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500- sq. ft. area.

5. Maximum Protection Area per Sprinkler:

a. According to NFPA 13 recommendations, unless otherwise indicated. Extended coverage systems shall not be included in the design of any portion of the fire protection system except the attic where approved by the jurisdictional authority.

B. Components and Installation: Capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Pipe and fitting materials and methods of joining for sprinkler piping.
2. Pipe hangers and supports.
3. Valves, including specialty valves, accessories, and devices.
4. Alarm devices. Include electrical data.
5. Air compressors. Include electrical data.
6. Fire department connections. Include type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
7. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.

B. Fire-Hydrant Flow Test Report: Flow test data must be performed within six months of project start date.

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

1. All plans and calculations shall be approved by the Owner’s insurance company prior to submission to the jurisdictional authorities and engineer.
2. Include site plan with water service size and location.

D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13.

E. Maintenance Data: Each type of sprinkler specialty to include in maintenance manuals specified in Division 01.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project for 10 years and obtained design approval and inspection approval from authorities having jurisdiction.

B. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional. Base calculations on results of fire-hydrant flow test.

C. Professional Qualifications: A professional engineer or a certified NICET Level IV Designer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent.

D. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.

E. Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

G. NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:

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

1.7 EXTRA MATERIALS

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

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Specialty Valves and Devices:

a. Central Sprinkler Corp.
b. Firematic Sprinkler Devices, Inc.
c. Globe Fire Sprinkler Corp.
d. Grinnell Corp.
e. Reliable Automatic Sprinkler Co., Inc.
f. Viking Corp.

2. Water-Flow Indicators and Supervisory Switches:

a. Gamewell Co.
b. Grinnell Corp.
c. Pittway Corp.; System Sensor Div.
d. Potter Electric Signal Co.
e. Reliable Automatic Sprinkler Co., Inc.
f. Viking Corp.

3. Sprinkler, Drain and Alarm Test Fittings:

    a. Central Sprinkler Corp.
    b. Fire-End and Croker Corp.
    c. Grinnell Corp.
    d. Victaulic Co. of America.

4. Sprinkler, Branch-Line Test Fittings:

    a. Elkhart Brass Mfg. Co., Inc.
    b. Fire-End and Croker Corp.
    c. Smith Industries, Inc.; Potter-Roemer Div.

5. Sprinkler, Inspector's Test Fittings:

    a. Fire-End and Croker Corp.
    b. G/J Innovations, Inc.
    c. Triple R Specialty of Ajax, Inc.

6. Sprinklers:

    a. Central Sprinkler Corp.
    b. Firematic Sprinkler Devices, Inc.
    c. Globe Fire Sprinkler Corp.
    d. Grinnell Corp.
    e. Reliable Automatic Sprinkler Co., Inc.
    f. Viking Corp.

7. Indicator Valves:

    a. Central Sprink, Inc.
    b. Grinnell Corp.
    c. McWane, Inc.; Kennedy Valve Div.
    d. Milwaukee Valve Co., Inc.
    e. Nibco, Inc.
    f. Victaulic Co. of America.

8. Fire-Protection-Service Valves:

    a. Central Sprink, Inc.
    b. Central Sprinkler Corp.
    c. Grinnell Corp.
    d. McWane, Inc.; Kennedy Valve Div.
    e. Nibco, Inc.
    f. Stockham Valves & Fittings, Inc.
    g. Victaulic Co. of America.

9. Mechanical Couplings for Steel Piping:

    a. Central Sprink, Inc.
    b. Ductilic, Inc.
    c. Grinnell Corp.
    d. National Fittings, Inc.
    e. Star Pipe Products, Inc.; Star Fittings Div.

f. Victaulic Co. of America.

10. Mechanical Couplings for Ductile-Iron Piping:

a. Victaulic Co. of America.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES AND TUBES

A. Ductile-Iron Pipe: AWWA C151, push-on-joint type; with cement-mortar lining and seal coat according to AWWA C104 or grooved joint and coupling system. Include rubber gasket according to AWWA C111. Must be approved for potable water service.

B. Standard-Weight Steel Pipe: ASTM A 53, ASTM A 135, or ASTM A 795; Schedule 40 in NPS 2" and smaller, and Schedule 10 in NPS 2½" and larger. Galvanized where indicated.

C. Schedule 30 Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30 or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe. (NPS 2½" and larger.) Galvanized pipe and fittings where indicated.

2.4 PIPE AND TUBE FITTINGS

A. Ductile-Iron Fittings: AWWA C110, ductile-iron or cast-iron push-on-joint type; or AWWA C153, ductile-iron, compact push-on-joint type. Include cement-mortar lining and seal coat according to AWWA C104 and rubber gaskets according to AWWA C111.

B. Cast-Iron Threaded Flanges: ASME B16.1.

C. Cast-Iron Threaded Fittings: ASME B16.4.

D. Malleable-Iron Threaded Fittings: ASME B16.3.

E. Steel, Threaded Couplings: ASTM A 865.

F. Steel Welding Fittings: ASTM A 234/A 234M, ASME B16.9, or ASME B16.11.

G. Steel Flanges and Flanged Fittings: ASME B16.5.

H. Steel, Grooved-End Fittings: UL-listed and FM-approved, ASTM A 47, malleable iron or ASTM A 536, ductile iron; with dimensions matching steel pipe and ends factory grooved according to AWWA C606. Galvanized fittings where indicated.

I. Compression type fittings including saddle style and 'U' bolt style are not approved for use.

2.5 CPVC PIPE AND FITTINGS

A. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig rated pressure at 150 deg F with plain ends. Include "Listed" and "CPVC Sprinkler Pipe" markings.

1. CPVC Fittings: UL-listed, for 175-psig rated pressure at 150 deg F socket type. Include "Listed" and "CPVC Sprinkler Fitting" markings.

a. NPS 3/4 to NPS 1-1/2 ASTM F 438 and UL 1821, Schedule 40.
b. NPS 2 to NPS 3 ASTM F 439 and UL 1821, Schedule 80.

2. Adhesive: ASTM F 493, solvent cement recommended by pipe and fitting manufacturer and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by manufacturer of pipe and fittings.

2.6 JOINING MATERIALS

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for pipe-flange gasket materials and welding filler metals.

B. Ductile-Iron, Flanged Joints: AWWA C115, ductile-iron or gray-iron pipe flanges, rubber gaskets, and steel bolts and nuts.

C. Steel, Grooved Couplings: UL 213 and AWWA C606, for steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts. Include listing for dry-pipe service for couplings for dry piping.

D. Transition Couplings: AWWA C219, sleeve type, or other manufactured fitting the same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.7 GENERAL-DUTY VALVES

A. Refer to Division 22 Section "Valves" for gate, ball, butterfly, globe, and check valves not required to be UL listed and FM approved.

2.8 FIRE-PROTECTION-SERVICE VALVES

A. General: UL listed and FM approved, with minimum 175-psig non-shock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.

B. Gate Valves, NPS 2 and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.

C. Indicating Valves, NPS 2-1/2 and Smaller: UL 1091; butterfly or ball-type, bronze body with threaded ends; and integral indicating device.

1. Indicator: Electrical 115-V ac, prewired, supervisory switch.

D. Gate Valves, NPS 2-1/2 and Larger: UL 262, iron body, bronze mounted, taper wedge, OS&Y, and rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.

E. Swing Check Valves, NPS 2 and Smaller: UL 312 or MSS SP-80, Class 150; bronze body with bronze disc and threaded ends.

F. Swing Check Valves, NPS 2-1/2 and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze-disc ring and flanged ends.

G. Split-Clapper Check Valves, NPS 4 and Larger: UL 312, cast-iron body with rubber seal, bronze-alloy discs, and stainless-steel spring and hinge pin.

2.9 SPECIALTY VALVES

A. Alarm Check Valves: UL 193, 175-psig working pressure; designed for horizontal or vertical installation, with cast-iron flanged inlet and outlet, bronze grooved seat with O-ring seals, and single-hinge pin and latch design. Include trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

1. Option: Grooved-end connections for use with keyed couplings.
2. Drip Cup Assembly: Pipe drain without valves, and separate from main drain piping.

B. Dry-Pipe Valves: UL 260; differential type; 175-psig working pressure; with cast-iron flanged inlet and outlet, bronze seat with O-ring seals, and single-hinge pin and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment. Include two pressure switches per assembly.

1. Option: Grooved-end connections for use with keyed couplings.
2. Air Compressor: 120-V ac, 60 Hz, single phase, 10 gallon tank minimum.

C. Ball Drip Valves: UL 1726, automatic drain valve, NPS 3/4, ball check device with threaded ends.

2.10 SPRINKLERS

A. Automatic Sprinklers: With heat-responsive element complying with the following:

1. UL 199, for applications except residential.

B. Sprinkler Types and Categories: Quick response style for "Ordinary" temperature classification rating shall be used in all areas unless otherwise indicated or required by application.

C. Sprinkler types, features, and options include the following:

1. Concealed ceiling sprinklers, including cover plate.
2. Pendent sprinklers.
3. Pendent, dry-type sprinklers.
4. Quick-response sprinklers.
5. Recessed sprinklers, including escutcheon.
6. Sidewall sprinklers.
7. Sidewall, dry-type sprinklers.
8. Upright sprinklers.

D. Sprinkler Finishes: White enameled and bronze.

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

1. Ceiling Mounting: White enameled steel, one piece, flat.
2. Sidewall Mounting: White enameled steel, one piece, flat.

F. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.11 SPECIALTY SPRINKLER FITTINGS

A. Specialty Fittings: UL listed and FM approved; made of steel, ductile iron, or other materials compatible with piping.

B. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

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

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

E. Sprinkler, Inspector's Test Fittings: UL-listed, cast- or ductile-iron housing; with threaded inlet and drain outlet and sight glass.

2.12 ALARM DEVICES

A. General: Types matching piping and equipment connections.

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

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

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

E. Indicator-Post Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

2.13 PRESSURE GAGES

A. Pressure Gages: UL 393, 3-1/2- to 4-1/2-inch- diameter dial with dial range of 0 to 250 psig.

2.14 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Water system modeling may be used when requested by local jurisdictional official in the absence of viable flow data.

C. Report test results promptly and in writing.

3.2 EARTHWORK

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.3 EXAMINATION

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

B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing and other conditions where piping is to be installed.

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

3.4 PIPING APPLICATIONS

A. Do not use welded joints with galvanized steel pipe.

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

C. Sprinklers: Use the following:

1. NPS 2” and smaller: Standard-weight schedule 40 steel pipe with threaded ends or plain ends or grooved ends, cast or malleable-iron threaded fittings, and threaded joints or welded fittings and welded joints or grooved end fittings and grooved joints.
2. NPS 2-1/2” to NPS 8: Standard-weight schedule 40 or schedule 10 steel pipe with plain ends, steel welding fittings, and welded joints or grooved ends, grooved end fittings and grooved joints.
3. All piping and fittings for each dry pipe system shall be hot-dip galvanized and scheduled as noted in items 1 and 2 above.

4. CPVC piping and fittings may be used for wet system branch piping of 3” and less in light hazard areas and limited area (400 sq. ft) ordinary hazard areas of coverage in place of black steel pipe. CPVC may not be used in lieu of galvanized pipe.

3.5 VALVE APPLICATIONS

A. Where specific valve types are not indicated, the following requirements apply:

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

   a. Shutoff Duty: Use gate valves.

2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13.

   a. Shutoff Duty: Use gate, ball, or butterfly valves.
   b. Throttling Duty: Use globe, ball, or butterfly valves.

3.6 JOINT CONSTRUCTION

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

B. Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.

C. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.

D. Dissimilar-Piping-Material Joints: Construct joints using adapters or couplings compatible with both piping materials. Use dielectric fittings if both piping materials are metal. Refer to Division 21 Section "Common Work Results for Fire Suppression" for dielectric fittings.

3.7 PIPING INSTALLATION

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

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

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

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

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

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

F. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13. Drains shall not be exposed in stairwells or finished areas of the facility.

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

H. Install sprinkler zone control valves, test assemblies, and drain risers in accessible locations approved by engineer and architect.

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

J. Install alarm devices in piping systems.

K. Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping.

L. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.

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

N. Galvanized piping may not be welded.

3.8 VALVE INSTALLATION

A. Refer to Division 22 Section "Valves" for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and authorities having jurisdiction.

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

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

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

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

1. Air-Pressure Maintenance Devices for Dry-Pipe Systems: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
2. Install air compressor and compressed-air supply piping. Secure compressor to floor with vibration isolators.

3.9 SPRINKLER APPLICATIONS

A. General: Use sprinklers according to the following applications:

1. Rooms without Ceilings: Upright and pendent sprinklers, as required.
2. Rooms with Suspended Ceilings: Recessed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright; pendent, dry-type; and sidewall, dry-type sprinklers labeled for use with dry systems.
5. Elevator Shafts and Pits: Dry-type sidewall with extended neck fitting to be connected to wet pipe system.
6. Sprinkler Finishes: Use sprinklers with the following finishes:

a. Upright and Pendent Sprinklers: Chrome-plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
b. Recessed and Sidewall Sprinklers: Enameled white sprinkler and white escutcheon.

3.10 SPRINKLER INSTALLATION

A. Install sprinklers in patterns indicated.

B. Install sprinklers in suspended ceilings in center of acoustical panels and tiles.

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

3.11 CONNECTIONS

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

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

C. Coordinate connection of alarm devices to fire alarm system with Fire Alarm Contractor.

D. Connect air compressor to the following piping and wiring:

1. Pressure gages and controls.
2. Electrical power system.
3. Fire alarm system devices, including low-pressure alarm.

3.12 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Division 21 Section "Common Work Results for Fire Suppression."

3.13 FIELD QUALITY CONTROL

A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.

B. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

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

3.14 CLEANING

A. Clean dirt and debris from sprinklers.

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

3.15 PROTECTION

A. Protect sprinklers from damage until Substantial Completion.

3.16 OPERATION

A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

B. Verify that air compressors and their accessories are installed and operate correctly.

C. Verify that specified tests of piping are complete.

D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

F. Drain dry-pipe sprinkler piping.

G. Pressurize and check dry-pipe sprinkler piping air-pressure maintenance devices and air compressors.

H. Fill wet-pipe sprinkler piping with water.

I. Energize circuits to electrical equipment and devices.

J. Start and run air compressors.

K. Adjust operating controls and pressure settings.

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

3.17 DEMONSTRATION

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. Schedule demonstration with Owner with at least seven days' advance notice.

END OF SECTION 21 11 00

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 230500 for Plumbing / Mechanical / Electrical Coordination.

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.

1.3 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:

1. 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-monomer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.

1.5 QUALITY ASSURANCE

A. 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 at the Contractor's expense. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 COORDINATION

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

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

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

D. Phasing: This contractor shall be responsible for all work and materials required to accommodate the phasing associated with the construction of this project. This shall include, but is not limited to, providing temporary connections, isolation valves and piping, system fill and drain-down, system re-balancing and temporary provisions for all functions of the controls system to operate. It shall also include provisions for temporary equipment to facilitate system operation throughout the phased construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 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.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

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

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

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

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

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

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

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

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

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

H. Solvent Cements for Joining Plastic Piping:

1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 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 ranges including safety factor of 1.25. Listed for use in potable water systems.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F. Gaskets listed to exceed temperature rating and pressure of system. Gaskets to be listed and meet NFS requirements.

1. Manufacturers:

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

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

1. Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.

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

2.6 SLEEVES

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

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

C. 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.

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

2.7 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. Deep-pattern type are not approved.

B. One-Piece, Cast-Brass Type:

1. Finish: Polished chrome-plated.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

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

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

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

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

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

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

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

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

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

        1) Seal space outside of sleeve fittings with grout.

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

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

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. 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.

O. 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 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.

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

Q. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

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

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.

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

3.3 PIPING CONNECTIONS

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

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions 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.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not 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.

3.5 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

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

END OF SECTION 22 05 00

SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal-bellows expansion joints.
2. Rubber expansion joints.
3. Flexible-hose expansion joints.
4. Pipe bends and loops.
5. Alignment guides and anchors.

B. Contractor is responsible for Design and Installation of Fittings, Assemblies, and Systems to facilitate expansion and contraction of all domestic water piping systems.

1.3 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

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

F. NR: Natural rubber.

1.4 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.5 SUBMITTALS

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

B. Shop Drawings: Indicating locations, style and calculations for all expansion fittings. Shop drawings and calculations shall be produced by the product manufacturer or a registered Professional Engineer. Design shall be for the entire domestic cold water and domestic hot water piping system throughout each building.

C. Welding certificates.

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

E. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.

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

a. Adsco Manufacturing, LLC.
b. Anamet, Inc.
c. Badger Industries.
d. Expansion Joint Systems, Inc.
e. Flex-Hose Co., Inc.
f. Flexicraft Industries.
g. Flex-Pression, Ltd.
h. Flex-Weld, Inc.
i. Hyspan Precision Products, Inc.
j. Metraflex, Inc.
k. Piping Technology & Products, Inc.
l. Proco Products, Inc.
m. Senior Flexonics, Inc.; Pathway Division.
n. Tozen America Corp.
o. Unaflex Inc.
p. WahlcoMetroflex.

2. Metal-Bellows Expansion Joints for Copper Piping: Multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.
3. Minimum Pressure Rating: 150 psig, unless otherwise indicated.

B. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

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

a. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Flex-Weld, Inc.

d. Garlock Sealing Technologies.
e. General Rubber Corp.
f. Mason Industries, Inc.; Mercer Rubber Co.
g. Metraflex, Inc.
h. MG Piping Products Co.
i. Proco Products, Inc.
j. Red Valve Company, Inc.
k. Senior Flexonics, Inc.; Pathway Division.
l. Tozen America Corp.
m. Unaflex Inc.
n. Vibration Mountings & Controls, Inc.

2. Spherical Type: Single or multiple spheres.

a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.

3. Material: Buna-N.
4. End Connections: Full-faced, integral, steel flanges with steel retaining rings.

C. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

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

a. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Flex-Pression, Ltd.
d. Metraflex, Inc.

2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- joint end connections.

a. NPS 2-1/2 to NPS 4: Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

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

a. Adsco Manufacturing, LLC.
b. Advanced Thermal Systems, Inc.
c. Flex-Hose Co., Inc.
d. Flexicraft Industries.
e. Flex-Weld, Inc.
f. Hyspan Precision Products, Inc.
g. Metraflex, Inc.

h. Piping Technology & Products, Inc.
i. Senior Flexonics, Inc.; Pathway Division.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Stud: Threaded, zinc-coated carbon steel.
2. Expansion Plug: Zinc-coated steel.
3. Washer and Nut: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

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

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

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion fittings and loops.

B. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. 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.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 22 05 16

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes meters and gages for mechanical systems and water meters installed outside the building.

B. Related Sections include the following:

1. Section "Water Distribution" for water meters outside the building.
2. Section "Natural Gas Distribution" for gas meters outside the building.

C. Utility Furnished Products: Water meters will be furnished to site, ready for installation.

1.3 SUBMITTALS

A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Liquid-in-Glass Thermometers:

a. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
b. Ernst Gage Co.
c. Marsh Bellofram.
d. Palmer Instruments, Inc.
e. Trerice: H. O. Trerice Co.
f. Weiss Instruments, Inc.
g. Winter's Thermogauges, Inc.

2. Pressure Gages:

a. AMETEK, Inc.; U.S. Gauge Div.
b. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.

c. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
d. Ernst Gage Co.
e. Marsh Bellofram.
f. Noshok, Inc.
g. Trerice: H. O. Trerice Co.
h. Weiss Instruments, Inc.
i. WIKA Instruments Corp.
j. Winter's Thermogauges, Inc.

3. Test Plugs:

a. Flow Design, Inc.
b. MG Piping Products Co.
c. National Meter.
d. Peterson Equipment Co., Inc.
e. Sisco Manufacturing Co.
f. Trerice: H. O. Trerice Co.
g. Watts Industries, Inc.; Water Products Div.

2.2 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed are as follows:

1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
3. Hot Water: 30 to 300 deg F, with 2-degree scale divisions.

B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Description: ASTM E 1.

B. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red or blue reading, organic-liquid filled with magnifying lens.

E. Tube: Red or blue reading, mercury filled with magnifying lens.

F. Scale: Satin-faced nonreflective aluminum with permanently etched markings.

G. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.4 SEPARABLE SOCKETS

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

1. Material: Brass, for use in copper piping.
2. Material: Steel, for use in steel piping.
3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
4. Insertion Length: To extend to center of pipe.
5. Cap: Threaded, with chain permanently fastened to socket.
6. Heat-Transfer Fluid: Oil or graphite.

2.5 THERMOMETER WELLS

A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.

1. Material: Brass, for use in copper piping.
2. Material: Steel, for use in steel piping.
3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
4. Insertion Length: To extend to center of pipe.
5. Cap: Threaded, with chain permanently fastened to socket.
6. Heat-Transfer Fluid: Oil or graphite.

2.6 PRESSURE GAGES

A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.

B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch- diameter, glass lens.

C. Connector: Brass, NPS 1/4.

D. Scale: White-coated aluminum with permanently etched markings.

E. Accuracy: Grade B, plus or minus 2 percent of middle 50 percent of scale.

F. Range: Comply with the following:

1. Fluids under Pressure: Two times the operating pressure.

2.7 WATER METERS

A. Displacement-Type Water Meters:

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

a. Badger Meter, Inc.
b. Carlon Meter.

c. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
d. Schlumberger Limited; Water Services.
e. Sensus.
f. Neptune

3. Description:

a. Standard: AWWA C700.
b. Pressure Rating: 150-psig working pressure.
c. Body Design: Nutating disc; totalization meter.
d. Registration: In gallons or cubic feet as required by utility company.
e. Case: Bronze.
f. End Connections: Threaded.

B. Turbine-Type Water Meters:

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

a. Badger Meter, Inc.
b. Carlon Meter.
c. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
d. Schlumberger Limited; Water Services.
e. Sensus.
f. Neptune

3. Description:

a. Standard: AWWA C701.
b. Pressure Rating: 150-psig working pressure.
c. Body Design: Turbine; totalization meter.
d. Registration: In gallons or cubic feet as required by utility company.
e. Case: Bronze.
f. End Connections for Meters NPS 2 and Smaller: Threaded.
g. End Connections for Meters NPS 2-1/2 and Larger: Flanged.

2.8 PRESSURE-GAGE FITTINGS

A. Valves: NPS 1/4 brass or stainless-steel needle type.

B. Syphons: NPS 1/4 coil of brass tubing with threaded ends.

C. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

PART 3 - EXECUTION

3.1 GAGE INSTALLATION, GENERAL

A. Install gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions.

B. Install in the following locations and where noted on details:

1. Outlet of each water heater and storage tank.
2. Domestic Hot water recirc, line at water heater and mixing valve.
3. Domestic Hot water mixing valve outlet.

C. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1. Install with socket extending a minimum of 2 inches into fluid.
2. Fill sockets with oil or graphite and secure caps.

D. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.

1. Install with stem extending a minimum of 2 inches into fluid.
2. Fill wells with oil or graphite and secure caps.

3.3 PRESSURE-GAGE INSTALLATION

A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.

B. Install dry-type pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Building water-service entrance.

C. Install liquid-filled-type pressure gages at suction and discharge of each pump.

D. Install pressure-gage needle valve and snubber in piping to pressure gages.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install gages adjacent to machines and equipment to allow service and maintenance.

3.5 ADJUSTING AND CLEANING

A. Adjust faces of gages to proper angle for best visibility.

B. Clean windows of gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 22 05 19

SECTION 22 05 23 – GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 220500 “Common Work Results for Plumbing” applies to work of this section.

1.2 SUMMARY

A. Extent of valves required by this section is indicated on drawings and/or specified in other Division 22 sections.

B. The types of valves specified in this section shall include the following:

1. Globe valves.
2. Check valves.
3. Balancing valves.
4. Butterfly valves.
5. Drain valves.
6. Ball valves.
7. Plug valves.

C. Valves furnished as part of factory-fabricated equipment are specified as part of equipment in other Division 22 sections.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for each type of valve. Submit valve schedule showing manufacturer’s figure number, size, location, and valve features for each required valve.

B. Maintenance Data: Submit recommended maintenance data as applicable and spare parts lists for each type of valve. Include this data, product data, and shop drawings in Maintenance Manual.

1.4 QUALITY ASSURANCE

A. Provide valves of the same type by the same manufacturer throughout.

B. Provide valves with manufacturer’s name and pressure rating clearly marked on outside of body.

C. Codes and Standards:

1. Mark valves in accordance with MSS-25 “Standard Marking System for Valves, Fittings, Flanges and Unions” as well as jurisdictional code requirements.
2. For dimensions of flanged or welded and valve bodies, comply with ANSI B16.10.
3. Provide valves used in fire protection piping, which are UL-listed and FM approved.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Valves and valve construction shall be suitable for the pressure, temperature and fluid of the service. Provide proper selection as determined by Installer to comply with installation requirements. Provide end connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer’s option.

B. Unless otherwise indicated, provide valves of same size as upstream pipe size.

C. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, 6” and smaller, other than plug valves. Provide one wrench for every 10 plug valves.

D. Refer to section 221116 for CPVC valve requirements. CPVC valves shall only be installed on CPVC piping systems.

E. Acceptable Manufacturers: Subject to compliance with requirements, provide valves from one of the following:

1. Apollo
2. Crane
3. Fairbanks
4. Hammond
5. ITT Grinnell
6. Milwaukee
7. Nibco
8. Powell
9. Stockham
10. Walworth
11. Watts

2.2 GLOBE VALVES

A. Use for throttling for water services: 2 inches and smaller with inside rising stem and screwed bonnet. 2 ½ inches to 6 inches larger with rising stem, outside screw and yoke and bolted bonnet. Valves to be back-seating with adjustable packing nut and be capable for re-packing under pressure. Provide valves for throttling service with renewable metallic seats of nickel alloy or stainless steel.

2.3 CHECK VALVES – SWING TYPE

A. Use for water and low pressure general services: 2 inches and smaller with screwed bonnet; 2 ½ inches and larger with bolted bonnet. Valves to have renewable bronze seat and disc.

2.4 CHECK VALVES – NON-SLAM

A. Use on pumps with cycling control. Valves to have semi-steel body with bronze or stainless steel trim and to be of the center guide type.

2.5 BALANCING VALVES FOR FLOW MEASUREMENT

A. Calibrated ball type balancing valves with differential pressure readout ports across fixed geometry venturi orifice. Each port shall have positive schrader type connections for connection to portable pressure meter. Provide reduced port type specifically designed for low-flow conditions where flow rate is less than 2 GPM.

B. Valves shall have memory feature to allow valve to be closed for service and then reopened without affecting balanced position.

C. Where installed to insulated piping systems each valve shall be provided with insulation molded by manufacturer to permit easy access for balance and readout.

D. Acceptable Manufacturers: Subject to compliance with requirements, provide balancing valves for flow measurement of one of the following:

1. Bell & Gossett – ITT Industries
2. Flow Design Inc., Accusetter series
3. Preso Industries, B-Plus series
4. Hydronic Components, Inc., Terminator System
5. Taco, Accu-Flo
6. Griswald.

2.6 BUTTERFLY VALVES

A. Used for shut-off duty for domestic hot water, domestic cold water, and fire protection, pipe sizes 4 inches and larger. Butterfly valves shall be of the lug body style, duct-tile iron, with lugs drilled and tapped and have drip tight shutoff capabilities in either direction up to maximum system working pressure. Butterfly valves shall be capable of closing tight after long periods of inactivity. Flanges to be through drilled to ANSI Standards.

B. Valves shall be furnished with self-lubricated bronze bearings. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion.

C. Seats shall be of the reinforced resilient type (or retained seat on high performance valves) and shall also act as a body liner to prevent flow from contacting the body casting. Resilient seats shall have flange sealing lips to provide a positive seal without use of flanges gaskets.

D. Seats shall be Nordel suitable for use with water to 240 degrees F. Shafts shall be one piece and shall be of Type 416 stainless steel. Shafts shall be finish ground and polished to minimize bearing and shaft seal wear. Shafts of 8 inches and larger valves shall have a non-adjustable thrust collar.

E. Discs shall be aluminum bronze. The disc-to-shaft connections shall be type 316 stainless steel. Pins, shaft and disc of valves shall be individually machined and completely interchangeable.

F. On manually operated valves, latch lock levers shall provide automatic, positive latching in the open, closed or eight intermediate positions. These levers shall allow locking in any position with a standard padlock. Infinite position levers shall allow manual throttling and locking in any position from open to close.

G. Manually actuated valves 8 inches and larger shall be operated using a cast iron housed hand-wheel actuator with chainwheel. Units to have adjustable open and closed position stops with provision to prevent accidental adjustment changes. Operating shafts to be supported axially and radially at input end by permanently lubricated bronze thrust and sleeve bearings.

2.7 DRAIN VALVES

A. Provide drain valves with threaded ends for hose connections at drain points, at main shutoff valves, low points of piping systems, bases of vertical risers, and at equipment. Drain valves on the potable water system shall have permanently attached vacuum breakers on the hose thread connection.

B. Brass ball valve with cap with chain, ¾ inch hose thread.

2.8 BALL VALVES

A. Ball Valves shall be used for shutoff service for domestic water for pipe sizes up to 2½ inches.

B. 1½” and Smaller: 125 psi steam, 400 psi WOG, bronze body, full port, 316 st/st ball and stem, bronze trim, 2 piece construction, TFE seats and seals.

C. 2” and larger: 150 psi steam, 600 psi WOG, bronze body, full port, 316 st/st ball and stem, 2 piece body, TFE seats with bronze trim.

D. Provide extended stem as required to accommodate piping insulation as specified elsewhere.

2.9 PLUG VALVES

A. 2” and Smaller: 150 psi, bronze body, straightaway pattern, square head, threaded ends.

B. 2½” and Larger: 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.

C. Provide one plug cock wrench for every ten (10) plug cocks sized 2 inches and smaller. Provide each plug cock 2½ inches and larger with a wrench with set screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Except as otherwise indicated, comply with the following requirements:

1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible for operation, maintenance and re-packing, and so that separate support can be provided when necessary.
2. Install isolation valves on equipment so that valve and piping do not interfere with equipment removal or maintenance. Install unions or flanges on equipment side of valves unless valve is flanged type.
3. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
4. Install with operating clearance for handle and stem.
5. Provide valves of a design permitting packing while open and under pressure.
6. Provide all valves 8 inches and larger having a rating of over 150 lbs. with a 1 inch by-pass valve of same pressure rating.
7. Furnish and install other hand valves, check valves, cocks, etc., as required for the complete and proper valving of the entire installation.
8. Install on all branches and mains serving 3 or more fixtures.

B. Insulation: Where piping is insulated, install extended-stem valves, arranged in proper manner to receive insulation. Insulation cut away to receive standard stems is not acceptable.

C. Mechanical Actuators: Install mechanical actuators with chain operators where indicated. Extend chains to about 5’ above floor and hook to clips to clear aisle passage.

D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

F. Installation of Check Valves:

1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.
2. Wafer Check Valves: Install between 2 flanges in horizontal or vertical position, position for proper direction of flow.
3. Lift Check Valves: Install in piping line with stem vertically upward, position for proper direction of flow.

3.2 ADJUSTING AND CLEANING

A. Valve Adjust: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division 22.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer’s touch-up paint.

END OF SECTION 22 05 23

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes hangers and supports for mechanical system piping and equipment.

B. Related Sections include the following:

1. Division 21 Sections on fire-suppression piping for fire-suppression pipe hangers.
2. Division 23 Section "Vibration Controls and Seismic Restraints for Mechanical Piping and Equipment" for vibration isolation and seismic restraint devices.

1.3 DEFINITIONS

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

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

C. Design seismic restraint hangers and supports for piping and equipment only when required by jurisdictional authority.

D. Design and obtain approval from authorities having jurisdiction for seismic restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

1.6 QUALITY ASSURANCE

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

B. Engineering Responsibility: Design and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent. All supports shall meet the seismic zone design criteria for the region.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Pipe Hangers:

a. AAA Technology and Specialties Co., Inc.
b. B-Line Systems, Inc.
c. Carpenter & Patterson, Inc.
d. Empire Tool & Manufacturing Co., Inc.
e. Globe Pipe Hanger Products, Inc.
f. Grinnell Corp.
g. GS Metals Corp.
h. Michigan Hanger Co., Inc.
i. National Pipe Hanger Corp.
j. PHD Manufacturing, Inc.
k. PHS Industries, Inc.
l. Piping Technology & Products, Inc.

2. Channel Support Systems:

a. B-Line Systems, Inc.
b. Grinnell Corp.; Power-Strut Unit.
c. GS Metals Corp.
d. Michigan Hanger Co., Inc.; O-Strut Div.
e. National Pipe Hanger Corp.
f. Thomas & Betts Corp.
g. Unistrut Corp.
h. Wesanco, Inc.

3. Thermal-Hanger Shield Inserts:

a. Carpenter & Patterson, Inc.
b. Michigan Hanger Co., Inc.
c. PHS Industries, Inc.
d. Pipe Shields, Inc.

e. Rilco Manufacturing Co., Inc.
f. Value Engineered Products, Inc.

2.2 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.

1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.

1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.

1. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
2. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
4. For Clevis or Band Hanger: Insert and shield cover over lower 180 degrees of pipe.
5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
2. Properties: Nonstaining, noncorrosive, and nongaseous.
3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

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

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

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

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8. Copper pipe rings shall be used on copper pipe. Painted steel pipe rings are not approved for use.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

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

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

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

1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23): For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

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

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

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

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
3. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
4. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
5. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

6. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
7. 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.

3.2 HANGER AND SUPPORT INSTALLATION

A. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment. Support of piping systems shall be distributed across the roof and floor structural systems. Alternate hanger locations when multiple pipes are supported in one area to ensure single structural members are not independently bearing the weight of multiple pipes in any one area.

B. Coordinate and follow mechanical support building attachment requirements of manufacturer.

C. Regardless of the type of construction (i.e., concrete, concrete-deck-steel, concrete plank, wood or other variations) take particular care to support main lines and large and heavy pipes in an approved manner, including the furnishing and installation of supplementary steel, if required. Supplementary steel shall be mill-rolled sections. Submit shop drawings, indicating support methods, point loadings to the building structure and hanger locations for review.

D. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

E. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.

    1. Field assemble and install according to manufacturer's written instructions.

F. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.

    1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
    2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

G. Install building attachments to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.

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

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

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

K. Insulated Piping: Comply with the following:

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 according to ASME B31.9.

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

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

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

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

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

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

5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

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

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

3.6 PAINTING

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

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

B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section "Painting."

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

END OF SECTION 22 05 29

SECTION 22 05 48 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Housed spring mounts.
5. Elastomeric hangers.
6. Spring hangers.
7. Spring hangers with vertical-limit stops.
8. Pipe riser resilient supports.
9. Resilient pipe guides.
10. Restraining braces and cables.

1.3 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.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

B. Welding certificates.

C. Qualification Data: For professional engineer and testing agency.

D. Field quality-control test reports.

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

PART 2 - PRODUCTS

2.1 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. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Spring Hangers: 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.

F. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- 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 and for equal resistance in all directions.

G. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- 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.

2.2 FACTORY FINISHES

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

PART 3 - EXECUTION

3.1 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.

3.2 APPLICATIONS

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

B. Include spring isolators on first 5 hangers on inlet and discharge pipe of circulator pumps and on inlet and outlet of water softener.

C. Refer to drawings for additional requirements.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of joists, or at structural members as required by the structural engineer. Coordinate all attachments with manufacturer of structural system to ensure proper anchorage and support.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

END OF SECTION 22 05 48

SECTION 22 05 53 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This Section includes the following mechanical identification materials and their installation:

1. Access panel and door markers.
2. Pipe markers.
3. Valve tags.
4. Valve schedules.
5. Warning tags.

1.2 SUBMITTALS

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

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

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.4 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Access Panel and Door Markers: 1/16-inch thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

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

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

C. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

D. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch thick brass.
2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.4 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size 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. Provide in plastic sleeves located in 3-ring binder.

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
2. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
3. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

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

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.3 VALVE-TAG INSTALLATION

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

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:

a. Domestic Water: 1-1/2 inches.
b. Fire Protection: 1-1/2 inches.
c. Natural Gas: 1-1/2 inches.

2. Valve-Tag Color:

a. Domestic Cold Water: White.
b. Domestic Hot Water: Green.
c. Fire Protection: Red.
d. Natural Gas: Orange.

3. Letter Color:

a. Domestic Cold Water: Black.
b. Domestic Hot Water: White.
c. Fire Protection: White.
d. Natural Gas: Black.

3.4 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule in plastic slip sheets located in the 3-ring binder.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.6 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.7 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 22 05 53

SECTION 22 07 00 – PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Division 07 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe insulation shields and protection saddles.

1.3 SUBMITTALS

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

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for insulation application.

1.7 SCHEDULING

A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Mineral-Fiber Insulation:

   a. CertainTeed Manson.
   b. Knauf FiberGlass GmbH.
   c. Owens-Corning Fiberglas Corp.
   d. Schuller International, Inc.

2. Flexible Elastomeric Thermal Insulation:

   a. Armstrong World Industries, Inc.
   b. Rubatex Corp.

3. Calcium Silicate Insulation:

   a. Owens-Corning Fiberglas Corp.
   b. Pabco.
   c. Schuller International, Inc.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket. U.L. 25/50 fire/smoke rating compliant.
2. Insulation shall have a maximum k value of 0.27 Btu per inch/h–sqft-deg F.

3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:

   a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
   b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.

4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.

B. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
3. Insulation shall have a maximum k value of 0.27 Btu per inch/h–sqft-deg F.

C. Calcium Silicate Insulation: Preformed pipe sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

D. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

A. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC. U.L. 25/50 smoke/fire rating compliant.

1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
2. Adhesive: As recommended by insulation material manufacturer.

2.4 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Apply multiple layers of insulation with longitudinal and end seams staggered.

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

G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

H. Keep insulation materials dry during application and finishing.

I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

J. Apply insulation with the least number of joints practical.

K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.

1. Apply insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.

4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

P. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

Q. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

R. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.

1. Firestopping and fire-resistive joint sealers are specified in Division 07 Section "Firestopping".

S. Floor Penetrations: Apply insulation continuously through floor assembly.

1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
2. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
3. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

4. Hanger and piping support assemblies shall be installed on the exterior surface of the insulation with insulation shields on domestic cold water piping. Hangers and piping supports shall not penetrate the insulation jacket.

B. Apply insulation to flanges as follows:

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

C. Apply insulation to fittings and elbows as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.
4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1. Apply mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.6 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors.
2. Vibration-control devices.
3. Fire-suppression piping.
4. Chrome-plated pipes and fittings, unless potential for personnel injury.
5. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.7 FIELD QUALITY CONTROL

A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:

1. Inspect fittings and valves randomly selected by Engineer.
2. Remove fitting covers from 20 elbows or 1 percent of elbows, whichever is less, for various pipe sizes.
3. Remove fitting covers from 20 valves or 1 percent of valves, whichever is less, for various pipe sizes.

B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.8 INSULATION APPLICATION SCHEDULE, GENERAL

A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.11 INSULATION APPLICATION SCHEDULE

A. Insulate the following piping systems with material and thickness as scheduled below:

Insulation Thickness In Inches for Pipe Sizes In Inches									
Interior Piping Service	Material	1" and less	1¼" to 1.5"	2 " to 4"	5" to 6"	8" and larger	Notes	Vapor Barrier Yes/No	Exterior Pipe Jacket Type PVC/ ALUM
Domestic Hot Water & Hot Water Recirculation	Jacketed Fiberglass	1	1	1	1	1	1, 2	No	-
Domestic Cold Water	Jacketed Fiberglass	½	½	½	½	½	1, 2	Yes	-

Notes:

1. Where a rigid insulation is required because the piping is expected to be exposed to impact or abuse, use calcium silicate pipe insulation with thickness to maintain the R-value of the specified thickness schedule.
2. Plumbing Insulation Omitted: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping, fire protection piping, and pre-insulated equipment. All other portions of system shall be fully insulated.

END OF SECTION 22 07 00

SECTION 22 07 50 - EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes blanket, board, and block insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Division 23 Section "Duct Insulation" for insulation materials and application for ducts and plenums.
2. Division 22 Section "Pipe Insulation" for insulation for piping systems.

1.3 SUBMITTALS

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

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

1.4 QUALITY ASSURANCE

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

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate clearance requirements with equipment Installer for insulation application.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Flexible Elastomeric Thermal Insulation:

a. Armstrong World Industries, Inc.
b. Rubatex Corp.

2.2 INSULATION MATERIALS

A. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.3 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of equipment.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each equipment system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either the wet or dry state.

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

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Keep insulation materials dry during application and finishing.

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

H. Apply insulation with the least number of joints practical.

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

J. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

K. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

L. Insulate the following indoor equipment:

1. Domestic hot-water storage tanks and expansion tanks, not factory insulated.

M. Omit insulation from the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INDOOR TANK AND VESSEL INSULATION APPLICATION

A. Flexible Elastomeric Thermal Insulation Applications for Tanks and Vessels: Apply insulation over entire surface of tanks and vessels according to the manufacturer's written instructions.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.5 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.6 FIELD QUALITY CONTROL

A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:

1. Inspect pumps and tanks randomly selected by Architect.
2. Replace/repair damaged insulation sections where tears, abrasions or punctures are visible.

B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

3.7 EQUIPMENT APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

3.8 INDOOR TANK AND VESSEL INSULATION APPLICATION SCHEDULE

A. Equipment: Domestic hot-water storage tanks and expansion tanks, not factory insulated.

1. Operating Temperature: 55 to 140 deg F.
2. Insulation Material: Flexible elastomeric.
3. Insulation Thickness: Two 1” layers.
4. Finish: Manufacturer’s protective coating.

END OF SECTION 22 07 50

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes domestic water piping from locations indicated to fixtures and equipment inside the building.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and fittings.
2. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1. Combined Fire-Protection and Domestic Water Service Piping: 200 psig.
2. Domestic Water Distribution Piping: 125 psig.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Water Samples: Specified in "Cleaning" Article in Part 3.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances," and NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for combined fire-protection and domestic water service piping to building.

C. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 DUCTILE-IRON PIPING

A. Piping for fire-suppression applications shall be listed for fire-protection service.

1. Refer to Section 21 11 00 for ductile iron combination service piping materials.

2.3 COPPER TUBING

A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

a. Copper-Tubing, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

2.4 CPVC PIPING

A. CTS FlowGuard Gold CPVC domestic water piping and fittings listed in accordance with ASTM D2846 for sizes ½” through 2.

B. Corzan CPVC SDR 11 (Schedule 80) CPVC domestic water piping and fittings listed in accordance with ASTM F441, ASTM F437; ASTM F439 and ASTM F493 – solvent for sizes: 2-1/2”.

2.5 VALVES

A. Refer to Division 22 Section "General Duty Valves for Plumbing Piping" for bronze and cast-iron, general-duty valves.

B. Refer to Division 22 Section "Domestic Water Piping Specialties" for balancing and drain valves.

C. CPVC Non-Union Ball Valves:

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

a. American Valve, Inc.
b. Legend Valve.
c. NIBCO Inc.
d. Spears Manufacturing Company.
e. Thermoplastic Valves Inc.

2. Description:

a. Standard: MSS SP-122.
b. Pressure Rating and Temperature: 150 psig
c. Body Material: CPVC.
d. Body Design: Non-union type.
e. End Connections: Socket or threaded.
f. Ball: CPVC; full or reduced port.
g. Seals: PTFE or EPDM-rubber O-rings.
h. Handle: Tee shaped.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

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 may be used on aboveground piping, unless otherwise indicated.

C. Underground Combined Fire-Protection and Domestic Water Service Piping: Provide piping listed for fire-protection service and complying with NSF 61. Use the piping materials listed in Section 21 11 00.

D. Above Ground Domestic Water Piping: Use the following piping materials for each size range:

1. **Cold Water Systems and 110 degree Hot Water and 110 degree Hot Water Recirculating Systems, sizes: ½" through 2": Option 1:** Hard copper tube, Type L;

copper pressure fittings; and soldered joints. Grooved ends; copper grooved-end fittings; and grooved joints or Pro-Press fittings may be used in lieu of soldered joints.

2. **Cold Water Systems and 110 degree Hot Water and 110 degree Hot Water Recirculating systems, sizes ½" through 2": Option 2:** CPVC pipe and fittings.

3. **Cold Water Systems and 110 degree Hot Water and 110 degree Hot Water Recirculating Systems, sizes: 2-1/2" and larger:** Hard copper tube, Type L; copper pressure fittings; and soldered joints. Grooved ends; copper grooved-end fittings; and grooved joints or Pro-Press fittings may be used in lieu of soldered joints.

4. **140 degree Hot Water and 140 degree Hot Water Recirculating Systems, All Sizes:** Hard copper tube, Type L; copper pressure fittings; and soldered joints. Grooved ends; copper grooved-end fittings; and grooved joints or Pro-Press fittings may be used in lieu of soldered joints.

5. **All piping in mechanical rooms, receiving rooms, storage rooms and in exposed locations, All Sizes:** Hard copper tube, Type L; copper pressure fittings; and soldered joints. Grooved ends; copper grooved-end fittings; and grooved joints or Pro-Press fittings may be used in lieu of soldered joints.

E. Underground Domestic Water Piping NPS 4 and Smaller: Soft copper tube, Type K; continuous pipe. All joints to occur above floor slab.

3.3 VALVE APPLICATIONS

A. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use bronze full port ball valves for piping NPS 3 and smaller. Use cast-iron butterfly valves or full port ball valves for piping NPS 4 and larger.
2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves with vacuum breaker.
5. Refer to Section 220523 for valve specifications.

3.4 PIPING INSTALLATION

A. Refer to Division 33 Section for site water distribution and service piping.

B. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping installation.

C. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.

D. Install underground ductile-iron piping according to AWWA C600, and AWWA M41, and NFPA 24. Install buried piping inside building between wall and floor penetrations and connection to water service piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

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

F. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to

make installation watertight. Refer to Division 22 Section "Common Work Results for Plumbing" for sleeves and mechanical sleeve seals.

G. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 22 Section "Common Work Results for Plumbing" for wall penetration systems.

H. Install shutoff valve, hose-end drain valve, strainer and pressure gage on the domestic water service. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages, and to Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

I. Install aboveground domestic water piping level and plumb.

J. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

K. Perform the following steps before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings, and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use.

L. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

M. Check plumbing specialties and verify proper settings, adjustments, and operation.

N. Energize pumps and verify proper operation.

O. Extended-tee and drilled fittings with brazed joints are not approved for use.

P. All piping shall be installed and tested in accordance with piping manufacturer and code requirements. Compensation for expansion and contraction shall be provided in the installation. Shock absorbers shall be provided at each quick closing valve and air chambers shall be provided according to manufacturer requirements. Rough-ins for individual fixture connections shall be secured and rigid at each wall penetration.

Q. All CPVC piping shall be installed and tested in accordance with piping manufacturer and code requirements. Compensation for expansion and contraction shall be provided in the installation. Shock absorbers shall be provided at each quick closing valve and air chambers shall be provided according to manufacturer requirements. Rough-ins for individual fixture connections shall be secured and rigid at each wall penetration.

R. Install hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.

S. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

3.5 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

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

3.6 VALVE INSTALLATION

A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment. Use ball valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.

B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

C. 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. Install stop-and-waste drain valves where indicated.

D. Install calibrated balancing valves in each hot-water circulation return branch. Set calibrated balancing valves partly open to restrict but not stop flow. Refer to Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves. Balancing Valves shall be sized for low flows from 0.5 to 15 gpm.

3.7 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 22 Section "Vibration and Seismic Controls Plumbing Piping and Equipment" for seismic-restraint devices.

B. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:

   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:

      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

E. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

F. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

G. Install supports for vertical copper tubing every 10 feet.

3.8 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 service piping with shutoff valve, and extend and connect to the following:

1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
2. 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:

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 for final inspection by 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 test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping 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 domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.10 ADJUSTING

A. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

1. Adjust calibrated balancing valves to flows indicated.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 22 11 16

SECTION 22 11 19 – PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following plumbing specialties:

1. Backflow preventers.
2. Water regulators.
3. Balancing valves.
4. Domestic water mixing valves.
5. Strainers.
6. Key-operation hydrants.
7. Wheel-handle wall hydrants.
8. Drain valves.
9. Miscellaneous piping specialties.
10. Flashing materials.
11. Cleanouts.
12. Floor drains.
13. Grease Interceptors.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for water meters, thermometers, and pressure gages.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic piping materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. PE: Polyethylene plastic.
3. PUR: Polyurethane plastic.
4. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

1. Domestic Water Piping: 125 psig.
2. Sanitary Waste and Vent Piping: 10-foot head of water.

3. Storm Drainage Piping: 10-foot head of water.

1.5 SUBMITTALS

A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:

1. Backflow preventers and water regulators.
2. Balancing valves, water filters, and strainers.
3. Domestic water mixing valves.
4. Water hammer arresters.
5. Drain valves, hose bibbs, and hydrants.
6. Washer-supply outlets.
7. Cleanouts, floor drains and roof drains.
8. Vent terminals and roof flashing assemblies.
9. Grease interceptors.
10. Cleanout carpet marker sample.

B. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:

1. Backflow preventers and water regulators.
2. Thermostatic water mixing valves.
3. Hydrants.
4. Grease interceptors.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

C. 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.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping.
2. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Manufacturers:

1. Cla-Val Co.
2. CMB Industries, Inc.; Febco Backflow Preventers.
3. Conbraco Industries, Inc.
4. FLOMATIC Corp.
5. IMI Cash Valve.
6. Mueller Co.; Hersey Meters Div.
7. Watts Industries, Inc.; Water Products Div.
8. Zurn Industries, Inc.; Wilkins Div.

B. General: ASSE standard, backflow preventers.

1. NPS 2 and Smaller: Bronze body with threaded ends.
2. NPS 2-1/2 and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.

a. Interior Lining: AWWA C550 or FDA-approved, epoxy coating for backflow preventers having cast-iron or steel body.

3. Interior Components: Corrosion-resistant materials.
4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
5. Strainer: On inlet.

C. Pipe-Applied, Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.

D. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

E. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves.

1. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

F. Double-Check Backflow Prevention Assemblies: ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves.

1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

G. Antisiphon-Pressure-Type Vacuum Breakers: ASSE 1020, suitable for continuous pressure application. Include shutoff valves, spring-loaded check valve, spring-loaded floating disc, test cocks, and atmospheric vent.

1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

H. Hose-Connection Backflow Preventers: ASSE 1052, suitable for at least 3-gpm flow and applications with up to 10-foot head of water back pressure. Include two check valves;

intermediate atmospheric vent; and non-removable, ASME B1.20.7, garden-hose threads on outlet.

2.2 WATER REGULATORS

A. Manufacturers:

1. Armstrong-Yoshitake, Inc.
2. Cashco, Inc.
3. Cla-Val Co.
4. Conbraco Industries, Inc.
5. FLOMATIC Corp.
6. IMI Cash Valve.
7. Watts Industries, Inc.; Water Products Div.
8. Zurn Industries, Inc.; Wilkins Div.

B. General: ASSE 1003, water regulators, rated for initial working pressure of 150 psig minimum. Include integral factory-installed or separate field-installed, Y-pattern strainer.

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

a. General-Duty Service: Single-seated, direct operated, unless otherwise indicated.
b. Booster Heater Water Supply: Single-seated, direct operated with integral bypass.

2. NPS 2-1/2 and Larger: Bronze or cast-iron body with flanged ends. Include AWWA C550 or FDA-approved, interior epoxy coating for regulators with cast-iron body.
3. Interior Components: Corrosion-resistant materials.

2.3 BALANCING VALVES

A. Calibrated Balancing Valves: Adjustable, with two readout ports and memory setting indicator. Include manufacturer's standard hoses, fittings, valves, differential pressure meter, and carrying case.

1. Model: Bell & Gossett “RF” – Low Flow Applications:
2. Manufacturers:

a. Armstrong Pumps, Inc.
b. Armstrong-Yoshitake, Inc.
c. ITT Industries; Bell & Gossett Div.
d. Taco, Inc.
e. Tour & Andersson, Inc.
f. Watts Industries, Inc.; Water Products Div.

3. NPS 2 and Smaller: Bronze body with brass ball, adjustment knob, calibrated nameplate, and threaded or solder-joint ends.

2.4 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Domestic Hot Water Mixing Valve Assembly

1. Acceptable Manufacturer

    a. Armstrong “The Brain”

2. Electronically Operated Valve

    a. Three-way mixing valve to proportionally mix hot and cold water, die cast aluminum or brass housing, synthetic diaphragm, cadmium plated spring, Teflon-Asbestos packing ring, ball bearing spring and adjustment, stem lubricator, bronze trim and guided valve plugs. Integrated temperature controller – 120V with low voltage control wiring, transformer and NEMA 4X enclosure.
    b. Factory mounted and assembled to enameled steel frame.
    c. Union Connections.
    d. Accuracy: +/- 2 deg F at min and max flow conditions.
    e. BAS interface shall be provided.

B. Primary, Thermostatic, Water Mixing Valves

1. Acceptable Manufacturers

    a. Lawler Manufacturing Company, Inc.
    b. Powers; a division of Watts Water Technologies, Inc.
    c. Holby
    d. Symmons
    e. Speakman

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Cabinet-type, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Union end stop and check inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 110 deg F.
9. Tempered-Water Design Flow Rate: 24 gpm.
10. Selected Valve Flow Rate at 45-psig Pressure Drop: 80 gpm.
11. Pressure Drop at Design Flow Rate: 3 psig.
12. Valve Finish: Rough bronze.
13. Piping Finish: Copper.
14. Cabinet: Factory fabricated, stainless steel, for surface mounting and with hinged, stainless steel door.

2.5 STRAINERS

A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.

1. Pressure Rating: 125-psig minimum steam working pressure, unless otherwise indicated.
2. NPS 2 and Smaller: Bronze body, with female threaded ends.
3. NPS 2-1/2 and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.
4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.

a. Drain: Field-installed, hose-end drain valve.

5. T-Pattern Strainers: Malleable-iron or ductile-iron body with grooved ends; access end cap with drain plug and access coupling with rubber gasket.
6. Basket Strainers: Bolted flange or clamp cover, and basket with lift-out handle.

a. Type: Simplex with one basket.
b. Drain: Field-installed, hose-end drain valve.

2.6 KEY-OPERATION HYDRANTS

A. Manufacturers:

1. Josam Co.
2. Smith, Jay R. Mfg. Co.
3. Tyler Pipe; Wade Div.
4. Watts Industries, Inc.; Drainage Products Div.
5. Woodford Manufacturing Co.
6. Zurn Industries, Inc.; Jonespec Div.
7. Zurn Industries, Inc.; Specification Drainage Operation.

B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.

1. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.
2. Outlet: ASME B1.20.7, garden-hose threads.
3. Operating Keys: One with each key-operation hydrant.

C. Nonfreeze Exposed-Outlet Wall Hydrants: ASSE 1019, self-drainable with integral nonremovable hose-connection vacuum breaker, casing and operating rod to match wall thickness, projecting outlet, and wall clamp.

1. Classification: Automatic draining with hose removed or with hose attached and nozzle closed.
2. Nozzle and Wall Plate Finish: As scheduled.

D. Nonfreeze Concealed-Outlet Wall Hydrants: ASSE 1019, self-drainable with flush-mounting box with cover, integral nonremovable hose-connection vacuum breaker, casing and operating rod to match wall thickness, concealed outlet, and wall clamp.

1. Classification: Automatic draining with hose removed or with hose attached and nozzle closed.
2. Box and Cover Finish: As scheduled.

2.7 WHEEL-HANDLE WALL HYDRANTS

A. Manufacturers:

1. Mansfield Plumbing Products, Inc.
2. NIBCO INC.
3. Sioux Chief Manufacturing Co., Inc.
4. Watts Industries, Inc.; Water Products Div.
5. Woodford Manufacturing Co.

6. Zurn Industries, Inc.; Jonespec Div.

B. Description: Frost-proof design similar to ASME A112.21.3M, for wall mounting with wheel-handle operation, NPS 1/2 or NPS 3/4 threaded or solder-joint inlet, casing and operating rod to match wall thickness, and projecting outlet with ASME B1.20.7 garden-hose threads on outlet. Include wall clamp; integral vacuum breaker or nonremovable, drainable hose-connection vacuum breaker complying with ASSE 1011; and garden-hose threads complying with ASME B1.20.7 on outlet.

2.8 DRAIN VALVES

A. Hose-End Drain Valves: MSS SP-110, NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.

1. Inlet: Threaded or solder joint.
2. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.

B. Stop-and-Waste Drain Valves: MSS SP-110, ball valve, rated for 200-psig minimum CWP or MSS SP-80, Class 125, gate valve; ASTM B 62 bronze body, with NPS 1/8 side drain outlet and cap.

2.9 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, piston type with pressurized metal-tube cushioning chamber. Sizes indicated are based on ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

1. Manufacturers:

a. Amtrol, Inc.
b. Josam Co.
c. Precision Plumbing Products, Inc.
d. Sioux Chief Manufacturing Co., Inc.
e. Watts Industries, Inc.; Drainage Products Div.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

B. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 1/2 or NPS 3/4 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral, nonremovable, drainable hose-connection vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.

1. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
2. Operation for Equipment Rooms: Wheel handle or operating key.
3. Include operating key with each operating-key hose bibb.
4. Include integral wall flange with each chrome- or nickel-plated hose bibb.

C. Air Vents: Float type for automatic air venting.

1. Bolted Construction: Bronze body with replaceable, corrosion-resistant metal float and stainless-steel mechanism and seat; threaded NPS 1/2 minimum inlet; 125-psig minimum pressure rating at 140 deg F; and threaded vent outlet.

D. Roof Flashing Assemblies: Refer to Division 07 specifications.

E. Open Drains: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting, joined with ASTM C 564, rubber gaskets.

F. Deep-Seal Traps: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap seal primer valve connection.

1. NPS 2: 4-inch- minimum water seal.
2. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

G. Floor-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.

H. Fixed Air-Gap Fittings: Manufactured cast-iron or bronze drainage fitting with semiopen top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.

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

J. Expansion Joints: ASME A112.21.2M, assembly with cast-iron body with bronze sleeve, packing gland, and packing; of size and end types corresponding to connected piping.

2.10 CLEANOUTS

A. Cleanouts: Comply with ASME A112.36.2M.

1. Manufacturers:

a. Josam Co.
a. Smith, Jay R. Mfg. Co.
b. Tyler Pipe, Wade Div.
c. Wade.
d. Watts Industries, Inc., Drainage Products Div.
e. Zurn Industries, Inc., Jonespec Div.
f. Zurn Industries, Inc., Specification Drainage Operation.

B. General: Cleanouts shall be provided with a bronze plug. Floor cleanouts in wet locations to be furnished with flashing clamp device and set in the center of a 24” x 24” flashing pan except for slab on grade or grade cleanout applications.

C. Floor Cleanouts (F.C.O.): All exposed F.C.O. to have satin finish bronze tops unless otherwise noted. Carpet markers shall be provided either by the cleanout manufacturer or by a third party manufacturer and shall be of satin bronze finish. Submit carpet marker samples for review.

Floor Surface		Slab on Grade	Upper Floor w/Occupied Spaces Below
1.	Finished concrete	56020-15-22	56020-15-22-41
2.	Tiled	56020-12-15-22	56020-12-15-22-41
3.	Terrazzo	56020-13-15-22	56020-13-15-41-22
4.	Carpet	56020-14-15-22	56020-14-15-22-41
5.	Use Josam 56030 series cleanouts with modifications listed above, for spigot or no hub type connections.		
6.	All cleanouts located in carpeted area shall be installed flush with the concrete topping to allow for carpet installation. Install marker in cleanout cover.		

D. Wall Cleanouts (W.C.O.)

1. Provide at base of all sanitary and storm stacks.
2. For pipe spaces and walls without access:

    a. Josam 58890-17 (use tapped C.O. tee)
    b. The wall cleanout cover plate is to match wall finish. Apply wallpaper to match walls that are papered. Apply paint to match walls that are painted.

E. Cleanout Plugs (CO)

1. For accessible pipe spaces and exposed sewer piping (end of main, heel, wyes, etc.)

    a. Josam 5840 plug with tapped spigot no hub or hub type.

F. Grade Cleanout (GCO)

1. Provide cast iron riser to grade with concrete base under riser wye, and 12 x 12 x 8” thick concrete pad at grade with cleanout centered in pad.
2. Josam 56040-5-15-22

2.11 FLOOR DRAINS AND FLOOR SINKS

A. Floor Drains and Floor Sinks: Comply with ASME A112.21.1M.

1. Manufacturers:

    a. Josam Co.
    b. Josam Co., Blucher-Josam Div.
    c. Smith, Jay R. Mfg. Co.
    d. Tyler Pipe, Wade Div.
    e. Wade.
    f. Watts Industries, Inc., Drainage Products Div.
    g. Zurn Industries, Inc., Jonespec Div.
    h. Zurn Industries, Inc., Specification Drainage Operation.

2. Body Material: Cast iron.
3. Seepage Flange: Required.
4. Clamping Device: Required.
5. Outlet: As schedule for all floor sinks.
6. Exposed Surfaces and Interior Lining: Acid-resistant enamel.
7. Top or Strainer Material: Nickel bronze.
8. Top Shape: As scheduled.
9. Top Loading Classification: As scheduled.
10. Interior Coating: Acid resistant (floor sinks only).
11. Provide Trap Guard insert on all floor drains.

2.12 Cast-Iron or Steel Grease Interceptors:

A. Standard: PDI G101 and ASME A112.14.3, for intercepting and retaining FOG from food-preparation wastewater.
1. Manufacturers:

a. Josam Co.
b. Smith, Jay R. Mfg. Co.
c. MIFAB, Inc
d. Watts Industries, Inc., Drainage Products Div.
e. Zurn Industries, Inc.

2. PDI Seal: Required for units up to 50-gpm (3.15-L/s) flow rate and 100-lb (45.4-kg) grease retention by PDI G101.
3. Body Material: Cast iron or steel.
4. Interior Lining: Corrosion-resistant enamel.
5. Exterior Coating: Corrosion-resistant enamel.
6. Body Extension: As required.
7. Number of Compartments: One.
8. Inlet and Outlet Pipe Size: 4 inch NPS.
9. End Connections: Flanged, Hub or Threaded.
10. Cleanout: Integral or field installed on outlet.
11. Trapped Outlet Required: Integral.
12. Vent Pipe Size: 2 inch NPS.
13. Mounting: Above floor, Recessed in acid-resistant, coated steel frame and cradle or Recessed, flush with floor.
14. Flow-Control Fitting: Required.
15. Operation: Manual cleaning or Semiautomatic, manual drawoff.

2.13 Individual-Fixture, Water Tempering Valves

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

a. Holby
b. Lawler Manufacturing Company, Inc.
c. Powers; a division of Watts Water Technologies, Inc.
d. Symmons
e. Speakman

2. Standard: ASSE 1070, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.

4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 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 in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.

D. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.

F. Install trap seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

G. Install expansion joints on vertical risers, stacks, and conductors.

H. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 80 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

I. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.

J. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping. All covers shall be finished to match the wall material in exposed public locations.

K. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

L. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.

M. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

N. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

O. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

P. Fasten recessed-type plumbing specialties to reinforcement built into walls.

Q. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty ball, butterfly, check, gate, and globe valves.

R. Install air vents at piping high points. Include ball, gate, or globe valve inlet.

S. 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.

T. Install interceptors, including trapping, venting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor unless otherwise indicated.

2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

U. Set interceptors level and plumb.

3.3 CONNECTIONS

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

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

C. Connect plumbing specialties to piping specified in other Division 22 Sections.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

C. Protect sanitary waste interceptors from damage during construction period.

D. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain all equipment. Refer to Division 01 Section.

END OF SECTION 22 11 19

SECTION 22 11 23 – DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pumps for the building potable-water systems.

B. Related Sections include the following:

1. Division 26 Sections for power-supply wiring, field-installed disconnects, electrical devices, and motor controllers.

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities of selected models; shipping, installed, and operating weights; furnished specialties; and accessories for each type and size of pump specified. Indicate pumps' operating point on curves.

B. Maintenance Data: For each pump specified to include in maintenance manuals specified in Division 01.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of pumps through one source from a single manufacturer.

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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

PART 2 - PRODUCTS

2.1 PUMPS, GENERAL

A. Description: Factory-assembled and -tested, single-stage, centrifugal pump units; complying with UL 778; suitable for potable-water service; with all-bronze or stainless-steel construction and components in contact with water made of corrosion-resistant materials.

B. Motors: Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment" with built-in thermal-overload protection appropriate for motor size and duty.

C. End Connections for NPS 2 and Smaller: Threaded. Pumps available only with flanged ends may be furnished with threaded companion flanges.

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

E. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles.

2.2 CIRCULATORS

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

1. In-Line Circulators:

a. Armstrong Pumps, Inc.
b. ITT Fluid Technology Corp.; ITT Bell & Gossett Div.
c. Patterson Pumps
d. Peerless Pumps

B. Description: Horizontal in-line circulator, rated for 125-psig minimum working pressure and minimum continuous water temperature of 225 deg F.

1. Construction: Radially split, all-bronze construction.
2. Impeller: ASTM B 36/B 36M, rolled brass; or ASTM B 584, cast bronze; overhung, single suction, and keyed to shaft.
3. Seal: Mechanical.
4. Shaft and Sleeve: Steel shaft, with oil-lubricated copper sleeve.
5. Pump Bearings: Oil-lubricated, bronze-journal or thrust type.
6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
7. Motor: Single speed, with oil-lubricated bearings, unless otherwise indicated; and resiliently mounted to pump casing.

a. Motor Size: For motors larger than 1/2 hp, select motor size that will not overload through full range of pump performance curve.
b. Provide combination starter-disconnect for each pump.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water distribution piping to verify actual locations of connections before pump installation.

3.2 INSTALLATION

A. Install pumps according to manufacturer's written instructions and with access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

B. Support pumps and piping so weight of piping is not supported by pumps.

C. Suspend horizontal in-line pumps independent of piping. Use continuous-thread hanger rods and vibration isolation hangers of sufficient size to support pump weight. Fabricate brackets or supports as required. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for materials.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Connect water distribution piping to pumps. Install suction and discharge pipe equal to or greater than size of pump nozzles.
2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General Duty Valves for Plumbing Piping" for general-duty valves and Division 22 Section "Plumbing Specialties" for strainers.
3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and gage connectors.

B. Electrical wiring and connections are specified in Division 26 Sections.

C. Ground equipment.

1. 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.

3.4 OPERATION

A. Check suction piping connections for tightness.

B. Clean strainers on suction piping.

C. Controls: Set for manual starting and stopping operation.

D. Final Checks before Starting: Perform the following preventive maintenance operations:

1. Lubricate oil-lubricated-type bearings.

2. Verify that pump is free to rotate by hand and that pump for handling hot liquids is free to rotate with pump hot and cold. Do not operate pump if it is bound or drags, until cause of trouble is determined and corrected.
3. Verify that pump controls are correct for required application.

E. Starting procedure for pumps is as follows:

1. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
2. Open circulating line valve if pump should not be operated against dead shutoff.
3. Start motor.
4. Open discharge valve slowly.
5. Check general mechanical operation of pump and motor.
6. Close circulating line valve once there is sufficient flow through pump to prevent overheating.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.

B. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."

END OF SECTION 22 11 23

SECTION 22 11 24 - FACILITY NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fuel gas piping, specialties, and accessories within the building.

1.3 PROJECT CONDITIONS

A. Gas System Pressure: Pressure range. 0.5 psig to 2 psig.

B. Design values of fuel gas supplied for these systems are as follows:

1. Nominal Heating Value: 1000 Btu/cu. ft..
2. Nominal Specific Gravity: 0.65.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
2. Pressure regulators. Include pressure rating, capacity, and settings of selected models.

B. Maintenance Data: For natural gas specialties and accessories to include in maintenance manuals specified in Division 01.

1.5 QUALITY ASSURANCE

A. ANSI Standard: Comply with ANSI Z223.1, "National Fuel Gas Code."

B. FM Standard: Provide components listed in FM's "Fire Protection Approval Guide" if specified to be FM approved.

C. IAS Standard: Provide components listed in IAS's "Directory of A. G. A. and C. G. A Certified Appliances and Accessories" if specified to be IAS listed.

D. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.7 COORDINATION

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect and Owner not less than seven days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Appliance Connector Valves:

a. American Valve.
b. B&K Industries, Inc.
c. Brass Craft Manufacturing Co.
d. Conbraco Industries, Inc.; Apollo Div.
e. Frey: John M. Frey Co.
f. Jomar International, Ltd.
g. Key Gas Components, Inc.
h. Legend Valve and Fitting, Inc.
i. McDonald: A. Y. McDonald Mfg. Co.
j. Mueller Co.; Mueller Gas Products Div.
k. State Metals, Inc.
l. Watts Industries, Inc.; Water Products Div.

2. Gas Valves, NPS 2 and Smaller:

a. BMI Canada, Inc.
b. Crane Valves.
c. Flow Control Equipment, Inc.
d. Grinnell Corp.
e. Honeywell, Inc.
f. Jomar International, Ltd.
g. Kitz Corp. of America.
h. Legend Valve and Fitting, Inc.
i. McDonald: A. Y. McDonald Mfg. Co.
j. Milwaukee Valve Co., Inc.
k. Mueller Co.; Mueller Gas Products Div.
l. Nibco, Inc.
m. Red-White Valve Corp.
n. Watts Industries, Inc.; Water Products Div.

3. Plug Valves, NPS 2-1/2 and Larger:

   a. Flow Control Equipment, Inc.
   b. Milliken Valve Co., Inc.
   c. Nordstrom Valves, Inc.
   d. Olson Technologies, Inc.; Homestead Valve Div.
   e. Walworth Co.

4. Automatic Gas Valves:

   a. ASCO General Controls.
   b. ASCOLECTRIC, Ltd.
   c. Automatic Switch Co.
   d. Eaton Corp.; Controls Div.
   e. Eclipse Combustion, Inc.
   f. GPS Gas Protection Systems, Inc.
   g. Honeywell, Inc.
   h. Johnson Controls, Inc.

5. Line Pressure Regulators:

   a. American Meter Co.
   b. Donkin: Bryan Donkin RMG Canada, Ltd.
   c. Eclipse Combustion, Inc.
   d. Equimeter, Inc.
   e. Fisher Controls International, Inc.
   f. Maxitrol Co.
   g. National Meter.
   h. Richards Industries, Inc.; Jordan Valve Div.
   i. Schlumberger Industries; Gas Div.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

A. Steel Pipe: ASTM A 53; Type E or S; Grade B; Schedule 40; black.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
4. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
5. Joint Compound and Tape: Suitable for natural gas.
6. Steel Flanges and Flanged Fittings: ASME B16.5.
7. Gasket Material: Thickness, material, and type suitable for natural gas.

B. Transition Fittings: Type, material, and end connections to match piping being joined.

C. Common Joining Materials: Refer to Division 23 Section "Common Work Results for HVAC" for joining materials not in this Section.

D. Below grade pipe shall be UL and AGA listed P.E. pipe matching the serving utility company specifications.

2.4 SPECIALTY VALVES

A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.

D. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.

E. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

F. Automatic Gas Valves: ANSI Z21.21, with electrical operator for actuation by appliance automatic shutoff device.

2.5 PRESSURE REGULATORS

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.

1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
3. Line Pressure Regulators: ANSI Z21.80 with 10-psig inlet pressure rating, unless otherwise indicated.
4. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping. Extend to exterior of building above roof line. Size as required by regulator manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

B. Comply with ANSI Z223.1, "Prevention of Accidental Ignition" Paragraph.

3.2 PIPING APPLICATIONS

A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.

B. Fuel Gas Piping, 0.5 to 5 psig : Use the following:

1. NPS 3/4 and NPS 1: Steel pipe, malleable-iron threaded fittings, and threaded joints.
2. NPS 1-1/4 to NPS 2: Steel pipe, malleable-iron threaded fittings, and threaded joints.
3. NPS 2-1/2 to NPS 4: Steel pipe, steel welding fittings, and welded joints.
4. Larger Than NPS 4: Steel pipe, steel welding fittings, and welded joints.

C. Below grade pipe shall be UL and AGA listed P.E. pipe matching the serving utility company specifications.

3.3 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.

B. Piping Line Valves, NPS 2 and Smaller: Gas valve.

C. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.

3.4 PIPING INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping installation requirements.

B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.

    a. Exception: Tubing passing through partitions or walls.

3. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.
4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

    a. Exception: Accessible above-ceiling space specified above.

C. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

D. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

E. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

F. Connect branch piping from top or side of horizontal piping.

G. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

H. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

I. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.

J. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere at roof. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

K. Provide pressure regulator at building entry as indicated on construction drawings.

3.5 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.

B. Use materials suitable for fuel gas.

1. Brazed Joints: Make with brazing alloy with melting point greater than 1000 deg F. Brazing alloys containing phosphorus are prohibited.

3.6 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for pipe hanger and support devices.

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.7 CONNECTIONS

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

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

C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.8 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.

B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

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

D. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.

E. Verify correct pressure settings for pressure regulators.

F. Verify that specified piping tests are complete.

3.9 ADJUSTING

A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 22 11 24

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes soil and waste, sanitary drainage and vent piping inside the building and to locations indicated.

B. Related Sections include the following:

1. Division 22 Section "Domestic Water Piping Specialties" for soil, waste, and vent piping systems specialties.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic and rubber piping materials:

1. EPDM: Ethylene-propylene-diene terpolymer.
2. NBR: Acrylonitrile-butadiene rubber.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 QUALITY ASSURANCE

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

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 CAST-IRON SOIL PIPING

A. Hub-and-Spigot Pipe and Fittings: ASTM A 74, Service Extra-Heavy class.

1. Gaskets: ASTM C 564, rubber.

B. Hubless Pipe and Fittings: ASTM A 888 or CISPI 301.

1. Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral, center pipe stop.

a. Heavy-Duty, Type 304, Stainless-Steel Couplings: To be used on all systems unless noted otherwise ASTM A 666, Type 304, stainless-steel shield; stainless-steel bands; and sleeve.

1) NPS 1-1/2 to NPS 4: 3-inch wide shield with 4 bands.
2) NPS 5 to NPS 10: 4-inch wide shield with 6 bands.

b. Compact, Stainless-Steel Couplings: Acceptable for use on vent piping only. CISPI 310 with ASTM A 167, Type 301, or ASTM A 666, Type 301, stainless-steel corrugated shield; stainless-steel bands; and sleeve.

1) NPS 1-1/2 to NPS 4: 2-1/8-inch wide shield with 2 bands.
2) NPS 5 and NPS 6: 3-inch wide shield with 4 bands.
3) NPS 8 and NPS 10: 4-inch wide shield with 4 bands.

2.3 COPPER TUBING

A. Used for indirect waste systems only.

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

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

C. Hard Copper Tube: ASTM B 88, Type M, water tube, drawn temper.

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

2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.4 PVC PIPING

A. PVC Pipe: ASTM D 2665 schedule 40, solid-wall drain, waste, and vent.

B. PVC Special Fittings: ASTM F 409, drainage-pattern tube and tubular fittings with ends as required for application.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground pressure piping, unless otherwise indicated.

C. Aboveground, Soil, Waste, and Vent Piping: Use the following piping materials for each size range:

1. NPS ¾" to NPS 2": Indirect waste piping only: Copper DWV tube, copper drainage fittings, and soldered joints.
2. NPS 1-1/2" to NPS 10: All piping in return air plenums: Hubless, cast-iron soil piping and the following:
    a. Couplings: Heavy-duty, Type 304, stainless steel (4 and 6 band). (All waste piping.)
    b. Couplings: Compact, stainless steel (2 and 4 band). (Vent piping only.)
3. NPS 1-1/2" to NPS 10: All Waste and Vent Piping not located in return air plenums: Schedule 40 DWV, solid-wall, PVC.

D. Underground, Soil, Waste, and Vent Piping: Use the following piping materials for each size range:
1. NPS 1-1/2" to NPS 10: All Waste Piping in the Kitchen receiving high temperature waste and grease laden waste up to the grease interceptor inlet: Hubless, cast-iron soil piping with Heavy-duty, Type 304, stainless steel couplings. (4 and 6 band).
2. All other Areas: Schedule 40 DWV, solid-wall, PVC.

E. Condensate Drain Piping: Schedule 40 PVC. (Type "M" copper if located in a return air plenum).

3.3 PIPING INSTALLATION

A. Refer to Division 02 Section "Sanitary Sewerage" for Project-site sanitary sewer piping.

B. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping installation.

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 22 Section "Common Work Results for Plumbing" for sleeves and mechanical sleeve seals.

E. 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."

F. 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 2 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.

G. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

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

1. Building Sanitary Drain (Minimum slopes): 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

I. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

J. Install underground soil and waste drainage piping according to ASTM D 2321.

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

L. Install backwater valves with access enclosures where required by jurisdictional requirements or where indicated on drawings.

M. Install building traps at each sewer exit point of each facility when required by local jurisdiction. Locate out of public walkways.

N. Refer to Trenching and Backfilling requirements in other sections of this Specification.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
2. Hubless Joints: Make with rubber gasket and sleeve or clamp.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 VALVE INSTALLATION

A. Refer to Division 22 Section "General Duty Valves for Plumbing Piping" for general-duty valves.

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Use gate or full-port ball valve for piping NPS 2 and smaller.
2. Use gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, downstream from shutoff valve, on each sump pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

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

B. Connect soil and waste piping to exterior sanitary sewer 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. Refer to Division 22 Section "Plumbing Fixtures."
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. Refer to Division 22 Section "Domestic Water Piping Specialties."
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

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

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 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.

END OF SECTION 22 13 16

SECTION 22 31 00 – DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes water softeners and accessories for water-supply systems.

B. Related Sections include the following:

1. Division 22 Section "Pipe Insulation" for softener-piping insulation.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. FRP: Fiberglass-reinforced plastic resin.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; ion-exchange resins; salt purity and form; furnished specialties; and accessories.

B. Certificates of Shop Inspection and Data Reports: For softener tanks, as required by ASME Boiler and Pressure Vessel Code.

C. Manufacturer's Field Service Reports: As specified in this Section.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: For water softeners to include in maintenance manuals specified in Division 01.

F. Warranties: Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water softeners and are based on the specific system indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 01 Section "Substitutions."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period. Include coverage for the following:

1. Attrition loss of resin not to exceed 3 percent per year.
2. Resin not to be washed out of system during service run or backwashing period.
3. Effluent turbidity not to be greater and color not to be darker than incoming water.
4. Underdrain system, gravel, and resin not to become fouled, with turbidity or by dirt, rust, or scale from softener equipment or soft water, while operating according to manufacturer's written operating instructions.

C. Warranty Period: Not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Commercial/Industrial Water Softeners:

a. Aquion Partners, L. P.; RainSoft Water Treatment Systems Div.
b. Culligan International Co.
c. EcoWater Systems, Inc.
d. Marlo of Racine, Inc.
e. United States Filter Corp.
f. Water King, Inc.

2.2 COMMERCIAL WATER SOFTENERS

A. Description: Factory-assembled, pressure-type, commercial water softener rated for high temperature use. Incoming water temperature of 150 degrees F continuous operation.

B. Configuration: Duplex unit with two softener tanks and one brine tank.

C. NSF Compliance: NSF 44, "Cation Exchange Water Softeners," and NSF 61, "Drinking Water System Components--Health Effects."

D. Softener Tanks: Fiberglass pressure-vessel quality material specifically listed and tested for temperature use. Alternate tank materials will be reviewed by engineer prior to bid to determine acceptance. Include hydrostatic test at minimum of one and one-half times pressure rating and the following:

1. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels."
2. Pressure Rating: 125 psig minimum.
3. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.
4. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
5. Handholes: 4 inches round or 4 by 6 inches elliptical, in top head and lower sidewall of tanks 30 inches and smaller in diameter.
6. Support Legs or Skirt: Constructed of structural steel, welded to tank bottom.
7. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
8. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.

E. Controls: Fully automatic; factory mounted on units and factory-wired cycle controls. Include the following:

1. Adjustable duration of various regeneration steps.
2. Push-button start and complete manual operation.
3. Electric time clock and switch for fully automatic operation, adjustable to limit regeneration to specific hours of the day. Regeneration based on actual metered use.
4. Sequence of Operation: Program multiport pilot-control valve to automatically pressure actuate main operating valve through steps of regeneration and return to service. Include the following:

    a. Pointer on pilot-control valve to indicate cycle of operation.
    b. Means of manual operation of pilot-control valve if power fails.
    c. Regeneration of one tank to occur in off-peak hours so that one tank is always on-line.

5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

    a. Slow opening and closing, nonslam operation.
    b. Diaphragm guiding on full perimeter from fully open to fully closed.
    c. Isolated dissimilar metals within valve.
    d. Self-adjusting, internal, automatic brine injector that will draw brine and rinse at constant rate independent of pressure.
    e. Sampling cocks for soft water.
    f. Special tools are not required for service.

6. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.

F. Brine Tank: Combination brine and brine measuring. Include section with salt platform and screen for dry-salt storage and section for brine.

1. Construction: Fabricated from 3/16-inch- thick fiberglass or 3/8-inch- thick molded PE. Include plastic cover.
2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill. Include brine tubing and fittings.
3. Size: Sufficient for at least eight regenerations at full salting.

G. Include the following factory-installed accessories:

1. Piping, valves, drains, and pressure gages.
2. Sampling cocks.
3. Main-operating-valve position indicators.
4. Water meter.

2.3 CHEMICALS

A. Ion-Exchange Resin: High-capacity, sulfonated polystyrene that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Include capacity to 30,000 grains of calcium carbonate hardness/cu. ft. of resin when regenerated with 15 lb of salt.

1. Salt for Brine-Tank Applications: Fill with K-life potassium based product.

2.4 WATER TESTING SETS

A. Water-Hardness Testing Set: Manufacturer's standard testing apparatus and chemicals with testing procedure instructions and metal container suitable for wall mounting.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated for equipment. Refer to Division 03 Section "Cast-in-Place Concrete" and Division 22 Section "Common Work Requirements for Plumbing."

3.2 WATER SOFTENER INSTALLATION

A. Install water softener equipment on concrete bases, level and plumb, according to manufacturer's written instructions, layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing servicing are accessible.

B. Anchor tanks and floor-mounting accessories to substrate.

C. Install restraints for tanks and floor-mounting accessories and anchor to substrate.

D. Install pressure gages on raw-water inlet and soft-water outlet piping of each water softener tank. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

E. Install water testing sets near each water softener and mount on wall.

3.3 CONNECTIONS

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

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

C. Make piping connections to dissimilar-metal water piping with dielectric fittings. Refer to Division 23 Section "Common Work Requirements for Plumbing" for dielectric fittings.

D. Install drains as indirect wastes to spill into open drains or over floor drains.

E. Install brine lines and fittings furnished by manufacturer but not specified to be factory mounted.

F. Install electrical connections for power, controls, and devices. Electrical power wiring, devices, and connections are specified in Division 26 Sections.

G. Ground equipment.

1. 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.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field assembly of components and installation of water softeners, including piping and electrical connections. Report results in writing.

1. Leak Tests: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:

1. ASTM D 859, "Test Method for Silica in Water."
2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
3. ASTM D 1068, "Test Methods for Iron in Water."
4. ASTM D 1126, "Test Method for Hardness in Water."
5. ASTM D 1129, "Terminology Relating to Water."
6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.5 OPERATION

A. Engage a factory-authorized service representative to perform startup service.

B. Perform the following final checks before startup:

1. Water Piping Systems: Verify that tests have been completed.
2. Load Softener Tank.
3. Load Brine Tank.

C. Energize circuits.

D. Adjust operating controls.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining units.
2. Review data in maintenance manuals. Refer to Division 01 Section "Contract Closeout."
3. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
4. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION 22 31 00

SECTION 22 35 00 - DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for domestic water systems:

1. Gas-fired, tankless, domestic-water heaters
2. Large-capacity, storage tanks.
3. Compression tanks.
4. Accessories.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.

1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted water heater.

B. Maintenance Data: For tank to include in maintenance manuals specified in Division 01.

C. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of tank through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of tank and are based on specific units indicated. Other manufacturers' products complying with requirements may be considered. Refer to Section 220500 and Division 01 Section "Substitutions."

C. ASME Compliance: Fabricate and label hot-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 01.

D. ASHRAE Standard: Comply with performance efficiencies prescribed in ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

1.5 WARRANTY

A. Warranty Period:

1. Eight year Heat Exchanger and five year parts from date of Substantial Completion (Tankless Water Heater).
2. Twenty years from date of Substantial Completion (Storage Tank).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. Gas-fired, tankless, domestic-water heaters

a. Navien, Inc.
b. Rinnai Corporation
c. A.O. Smith Corporation
d. Bosch Thermotechnology

2. Large-Capacity, Storage Tanks:

a. Adamson Global Technology Corp.
b. Cemline Corp.
c. Patterson-Kelley Co.
d. PVI Industries, Inc.
e. Weben-Jarco, Inc.
f. Hubbell

3. Compression Tanks:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Smith: A. O. Smith; Aqua-Air Div.
d. State Industries.
e. Taco, Inc.
f. Wessels Co.
g. Zurn Industries, Inc.; Wilkins Div.

2.2 GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS

A. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.

B. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.

C. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water.

1. Tappings: ASME B1.20.1 pipe thread.
2. Pressure Rating: 150 psig.
3. Heat Exchanger: Stainless steel.
4. Insulation: Comply with ASHRAE/IES 90.1.
5. Jacket: Metal, with enameled finish, or plastic.
6. Burner: For use with tankless, domestic-water heaters and natural-gas fuel.
7. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
8. Temperature Control: An internal circuit board that monitors the inlet and outlet temperatures with installed thermistors, sensing and controlling flow rate to set point temperature with air-fuel ration controls in order to maintain thermal combustion efficiency.
9. Safety Features: Flame sensor system, high limit sensors, overheat prevention device, freeze protection mode and fan rotation detector.
10. Unit shall be capable of multi-system (Cascade) application up to 16 units by connecting the units using cable-only connections.
11. Unit shall include internal circulation pump and 0.5 gallon buffer tank.

D. Support: Bracket for wall mounting.

E. Capacity and Characteristics:

1. Flow Rate: 4.5 gpm at 85 deg F temperature rise.
2. Temperature Setting: 140 deg F.
3. Fuel Gas Input: 199,900 BTU/H.

4. Electrical Characteristics:

a. Volts: 120 V.
b. Phase: Single.
c. Hertz: 60 Hz.

5. Minimum Vent Diameter: 3 inches.

2.3 LARGE-CAPACITY, STORAGE TANKS

A. Description: Commercial, storage, indirect-fired tank for heating water.

B. Storage-Tank-Shell Orientation: Vertical. Include fabricated-steel legs with baseplates or steel skirt.

C. Storage-Tank-Shell Construction: ASME-code steel with 150-psig working-pressure rating. Include nozzle and head for access manhole.

1. Manhole: 20” diameter (min.) in storage-tank-shell front wall.
2. Tapings: Factory fabricated of 316 ST/ST for piping connections, relief valve, pressure gage, thermometer, blowdown, vent, anode rods, and controls as required. Attach tapings to tank shell before testing and labeling. All tapings shall be in locations as indicated on drawing details.

a. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1, pipe threads.

b. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

3. Insulation: Field applied. Two layers of 1” Armstrong sheet applied, self-adhering Armaflex Insulation.
4. Interior Finish: Cement lining (Pre-Krete Co.) complying with NSF 61, barrier materials for potable-water tank linings designed for use with softened water between 2 to 3 grains of hardness. Extend finish into and through tank fittings and outlets.
5. Exterior Finish: Manufacturer's standard, unless otherwise indicated.
6. Anode Rods: Factory installed magnesium.

D. Temperature Control: Adjustable immersion thermostat, mounted in storage-tank-shell at midpoint of tank, unless other arrangement is indicated. Refer to Section 230900 for controls.

2.4 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: According to the following:

1. Gas Water Heaters: ANSI Z21.22, combination temperature and pressure relief valve.

B. Gas Shutoff Valves: ANSI Z21.15, manually operated. Furnish for installation in piping.

C. Gas Pressure Regulators: ANSI Z21.18, appliance type, factory or field installed. Include pressure rating, capacity, and pressure differential required for water heater and gas supply.

D. Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.

E. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that is capable of isolating each water heater and of providing balanced flow through each water heater.

F. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE 90.1 or ASHRAE 90.2.

G. Provide water heater with manufacturer’s exhaust muffler/silencer on outlet if available.

2.5 COMPRESSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

B. Construction: ASME 150-psig working-pressure rating.

C. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.

D. Tank Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

E. Tank Exterior Finish: Manufacturer's standard, unless otherwise indicated.

F. Air-Charging Valve: Factory installed.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated. Refer to Division 03 Section "Cast-in-Place Concrete" and Division 22 Section "Common Work Results for Plumbing."

3.2 INSTALLATION

A. Install water heaters, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 48 inches above floor on wall bracket.

C. Install and connect gas water heaters according to NFPA 54.

1. Install vent piping from gas-train pressure regulators and valves to outside of building where required. Terminate vent piping with brass-screened vent cap fitting. Do not combine vents except with approval of authorities having jurisdiction.

D. Install water heater drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Plumbing Specialties" for drain valves.

E. Install thermometers on water heater inlet and outlet piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

1. Exception: Omit thermometers for the following:

a. Household, water heater inlet and outlet piping.

F. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves and Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

G. Fill water heaters with water.

H. Charge compression tanks with air.

I. Install tanks on concrete bases, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

J. Install temperature and pressure relief valves in top portion of storage tank shells. Use relief valves with sensing elements that extend into shells. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.

K. Install tank drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for tanks that do not have tank drains. Refer to Division 22 Section "Plumbing Specialties" for drain valves.

L. Install thermometers on inlet and outlet piping of storage tanks. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

M. Fill tank with water.

N. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.3 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 tanks to allow service and maintenance.

C. Connect hot- and cold-water piping with shutoff valves and unions. Connect hot-water-circulating piping with shutoff valve, check valve, and union.

D. Make connections with dielectric fittings where piping is made of dissimilar metal.

3.4 FIELD QUALITY CONTROL

A. In addition to manufacturer's written installation and startup checks, perform the following:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest until satisfactory results are achieved.
2. Verify that piping system tests are complete.
3. Check for piping connection leaks.
4. Check for clear relief valve inlets, outlets, and drain piping.
5. Check operation of circulators.
6. Test operation of safety controls, relief valves, and devices.
7. Energize electric circuits.
8. Adjust operating controls.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures for starting and stopping, troubleshooting, servicing, and maintaining equipment.

B. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."

C. Schedule training with Owner, through Architect, with at least seven days of advance notice.

END OF SECTION 22 35 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Alternates specification section for bid requirements related to alternate fixture colors.

1.2 SUMMARY

A. This Section includes plumbing fixtures and related components.

B. Related Sections include the following:

1. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers and specialty fixtures not in this Section.

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.4 SUBMITTALS

A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.

B. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 01.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

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

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Hand Sinks: NSF 2 construction.
2. Plastic Bathtubs: ANSI Z124.1.
3. Plastic Laundry Trays: ANSI Z124.6.
4. Plastic Shower Enclosures: ANSI Z124.2.
5. Slip-Resistant Bathing Surfaces: ASTM F 462.
6. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
7. 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. Faucets: ASME A112.18.1M.
3. Hose-Connection Vacuum Breakers: ASSE 1011.
4. Hose-Coupling Threads: ASME B1.20.7.
5. NSF Materials: NSF 61.
6. Pipe Threads: ASME B1.20.1.
7. Supply and Drain Fittings: ASME A112.18.1M.

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. Faucets: ASME A112.18.1M.
3. Hand-Held Showers: ASSE 1014.
4. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Pipe Threads: ASME B1.20.1.
7. Pressure-Equalizing-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 A112.18.1M.
3. Manual-Operation Flushometers: ASSE 1037.
4. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.

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

1. Floor Drains: ASME A112.21.1M.
2. Grab Bars: ASTM F 446.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Off-Floor Fixture Supports: ASME A112.6.1M.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Shower Receptors: ANSI Z124.2.
7. Plastic Toilet Seats: ANSI Z124.5.
8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. For fixture descriptions in other Part 2 articles where the subparagraph titles "Manufacturers" introduce a list of manufacturers and their products or manufacturers only, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified in other Part 2 articles.

B. Acceptable Manufacturers:

1. Lavatories:

a. Kohler
b. American Standard
c. Toto

2. Water Closets:

a. Kohler
b. American Standard
c. Toto

3. Stainless steel type 302 and 18 gauge minimum:

a. Elkay
b. Just
c. Polar

d. Kohler

4. Terrazzo:

a. Fiat
b. Florestone
c. Stern Williams
d. Arco

5. Shower Mixing Valves Pressure Balanced:

a. Kohler
b. American Standard
c. Powers
d. Symmons
e. Moen
f. Delta

6. Toilet Seats:

a. Olsonite
b. Beneke
c. Sperzel
d. Church

7. Shower/Bathub Enclosures:

a. Best Bath Systems – Contractor Direct Sales (866) 863-0202
b. Aquatic
c. Comfort Design
d. MAAX

8. Traps, Stops, Supplies, Airgaps, Drains:

a. Kohler
b. Eljer
c. American Standard
d. Bridgeport
e. Brasscraft
f. Dearborn

9. Chair Carriers:

a. Josam
b. J.R. Smith
c. Zurn
d. Wade

10. Faucets, Single Lever:

a. Kohler
b. T&S Brass
c. American Standard
d. Chicago Faucet
e. Moen

11. Faucets (Standard Two Handle):

    a. Chicago Faucet
    b. Kohler
    c. American Standard
    d. T&S Brass

C. Showers and Bathtubs:

1. 3/8” (Min.) three-ply CDX plywood shall be adhered to each wall of each manufactured shower and tub for the future addition of grab bars. The plywood shall be installed over the full width and full height of each flat surface of each wall.
2. Grab Bars: Powder coated; 1-1/2” diameter, over 18 gauge stainless steel tubular core, with matching trim rings and 16 gauge stainless steel flanges. Color selected by Architect from standard colors available.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

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

3.2 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-hanging 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-hanging 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 manufacturers' written instructions and roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Refer to Division 22 Section "General Duty Valves for Plumbing Piping" for general-duty valves.

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

K. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

L. Install toilet seats on water closets.

M. 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.

N. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

O. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install shower, flow-control fittings with specified maximum flow rates in shower arms.

Q. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

R. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 22 Section "Common Work Results for Plumbing" for escutcheons.

S. Set service basins in leveling bed of cement grout. Refer to Division 22 Section "Common Work Results for Plumbing" for grout.

T. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 07 Section "Joint Sealants" for sealant and installation requirements.

U. Install pre-manufactured insulation kits on all ADA compliant fixture supplies and traps.

3.3 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 water distribution piping to fixtures. All supplies shall be chrome plated, rigid style. Flexible water supply tubing is not approved for use.

C. Connect drain piping from fixtures to drainage piping.

D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

F. All traps shall be chrome plated brass.

G. All escutcheons shall be one-piece chrome plated brass.

3.4 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed 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.

3.5 ADJUSTING

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

B. Operate and adjust disposers. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

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

END OF SECTION 22 40 00

SECTION 23 05 00 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Concrete base construction requirements.
3. Escutcheons.
4. Dielectric fittings.
5. Mechanical sleeve seals.
6. Nonshrink grout for equipment installations.
7. Field-fabricated metal and wood equipment supports.
8. Installation requirements common to equipment specification sections.
9. Cutting and patching.
10. Touchup painting and finishing.

B. Pipe and pipe fitting materials are specified in Division 23 piping system Sections.

C. Reference Specification Section 26 05 01 “Equipment Connections and Coordination” for Division of Responsibilities.

D. Labeling and identifying mechanical systems and equipment is specified in Division 23 Section “Identification for HVAC Piping and Equipment.”

1.3 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. EPDM: Ethylene propylene diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For dielectric fittings and flexible connectors.

B. Coordination Drawings: The Mechanical Contractor (MC) shall assemble and submit coordination drawings for the buildings. Discipline specific coordination drawings shall be submitted to the MC for incorporation into the overall set by the Plumbing, Electrical, and Fire Sprinkler Contractors. Refer to Specifications Sections 210000, 220500, and 260500. The drawings shall reflect the following at a minimum:

1. All significant trades shall be reflected on the coordination drawings, including but not limited to: building structure; HVAC equipment, ducting, and piping (including refrigerant piping); lighting; electrical conduits over 2" in size; sprinkler piping; sprinkler heads; domestic water distribution; waste vent and storm piping; and all flue, venting, and combustion air piping. Indicate if sequence and coordination of installations are important to efficient flow of the Work.
2. Detail elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation, maintenance, component replacement and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. This shall include drawings for all mechanical rooms including areas directly outside of those rooms. Also included is a typical section of each typical Corridor in each wing within each building.
3. The drawings shall coordinate the location, size, spacing and elevation of all duct, piping, flue, and combustion air penetrations of concrete plank, floor slabs, roof deck, and load bearing masonry interior and exterior walls with the work of the various trades to assure that all such penetrations are in full compliance with the requirements of the structural design and meet with the approval of the Structural Engineer of Record.
4. All conflicts with other trades shall be identified and resolved through meetings with representatives of the other trades. Revisions to discipline specific coordination drawings to resolve conflicts shall be the responsibility of each discipline. Assume a minimum of two 1-hour long coordination meetings to resolve conflicts. It shall be the responsibility of the Mechanical Contractor to coordinate the meeting date and times. At a minimum, a representative of the Plumbing, Electric, and Fire Sprinkler Contractors shall be in attendance. If the conflicts cannot be resolved during these meetings the conflicts shall be identified on the drawings and provided to the Architect for review.

5. Drawings shall also be produced for all areas of the facility where physical constraints of the space require close coordination of the building components and building systems to ensure an installation that conforms to the facility design documents.
6. Show space requirements for installation, maintenance, component replacement and access.
7. Refer to Division 01 Specifications for any additional information and requirements.

1.5 QUALITY ASSURANCE

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

B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. All additional costs associated to the equipment changes shall be the responsibility of the contractor requesting the use of the equipment. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design requirements. Any equipment with larger physical dimension and/or with a larger service clearance shall be accompanied by coordination drawings detailing all service points, clearances, access areas and associated building components. Review of the request or submittal will not be reviewed without the drawings. All necessary changes to facility wall locations, construction or access points shall be incorporated into the coordination drawings prior to equipment approval.

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

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

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

E. All ductwork openings shall be protected and covered at all times until final connections are made and the system is operational.

F. All ductwork shall be stored in an area protected from moisture and shall not be exposed to rain, snow or any water. All ductwork shall be stored elevated off the floor surface. Ductwork with liner that becomes wet shall be removed from the site and replaced with new, clean ductwork and liner. Any ductwork not protected shall be cleaned, treated or replaced according to level of exposure.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

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

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

D. Review truss manufacturer shop drawings during the submittal review process and indicate locations and sizes of all required openings and locations of spread truss spaces needed to accommodate ductwork, equipment, louvers, etc.

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

F. 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.

G. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Dielectric Flanges:

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

2. Dielectric-Flange Insulating Kits:

    a. Calpico, Inc.
    b. Central Plastics Co.
    c. Epco Sales Inc.
    d. Watts Industries, Inc.; Water Products Div.

3. Dielectric Couplings:

a. Calpico, Inc.
b. Epco Sales, Inc.
c. Metraflex Co.
d. Lochinvar Corp.

4. Dielectric Nipples:

a. Epco Sales, Inc.
b. Grinnell Corp.; Grinnell Supply Sales Co.
c. Perfection Corp.
d. Victaulic Co. of America.

5. Metal, Flexible Connectors:

a. ANAMET Industrial, Inc.
b. Central Sprink, Inc.
c. Flexicraft Industries.
d. Flex-Weld, Inc.
e. Grinnell Corp.; Grinnell Supply Sales Co.
f. Hyspan Precision Products, Inc.
g. McWane, Inc.; Tyler Pipe; Gustin-Bacon Div.
h. Metraflex Co.
i. Uniflex, Inc.

6. Rubber, Flexible Connectors:

a. General Rubber Corp.
b. Mercer Rubber Co.
c. Metraflex Co.
d. Proco Products, Inc.
e. Red Valve Co., Inc.
f. Uniflex, Inc.

2.2 PIPE AND PIPE FITTINGS

A. Refer to individual Division 23 piping Sections for pipe and fitting materials and joining methods.

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

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

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

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

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

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

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

D. Solder Filler Metals: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.
4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.
5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.

E. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

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

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

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

H. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.

I. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.

1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A 47 malleable iron or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.4 DIELECTRIC FITTINGS

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

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

C. Insulating Material: Suitable for system fluid, pressure, and temperature ranges including safety factor of 1.25. Minimum temperature rating of 225 Deg. F.

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

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

2.5 PIPING SPECIALTIES

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

1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with set screws.

B. Mechanical Sleeve Seals: Modular sealing element unit, designed for field assembly to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

C. Escutcheons: Manufactured wall, ceiling, and floor plates; shallow type. Deep pattern style to conceal protruding fittings and sleeves must be approved in writing prior to use.

1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
2. OD: Completely cover opening.
3. Cast Brass: One piece, with set screw.

a. Finish: Polished chrome-plate.

2.6 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psig, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.

B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings. Provide expansion devices as required by jurisdictional codes. Provide all miscellaneous, minor offsets required to accommodate other building components and provide fully functional system.

C. Install all piping systems at indicated slope or code required slope if not indicated.

D. Install components with pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends.

G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

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

L. Install couplings according to manufacturer's written instructions.

M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls and wall board partitions.

1. Chrome-Plated: Cast brass, one piece, with set screw, and polished chrome-plated finish in exposed areas.
2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.

N. Sleeves are not required for core drilled holes.

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

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

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

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

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

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

1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.

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

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

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter and larger.
3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

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

R. Verify final equipment locations for roughing-in.

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

T. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
5. 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:
    a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
    c. Align threads at point of assembly.
    d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    e. 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.
6. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

U. Piping Connections: Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
3. Dry Piping Systems: Install dielectric unions 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.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

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

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

D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations. Provide the greater of code, manufacturer or drawing clearances in all cases.

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

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.3 PAINTING AND FINISHING

A. Refer to Architectural Divisions for paint materials, surface preparation, and application of paint.

B. Paint all louvers to match the exterior wall color. Coordinate color with Architect.

3.4 CONCRETE BASES

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

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
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 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

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

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

C. For design requirements refer to section 230548.

3.6 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair cut surfaces to match adjacent surfaces. All repairs shall be performed by individuals skilled in their particular trade.

3.7 GROUTING

A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placing of grout.

E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

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

3.8 ELECTRICAL/MECHANICAL COORDINATON

A. Furnish electrical services to Division 23 equipment as outlined below.

B. Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place, and wired By the Division 23 Contractor. Contractor should note that the intent of this wiring schedule is to have the Division 23 Contractor responsible for coordinating all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specifications. Comply with the applicable requirements of Division 23 for electrical work of this Division 26 which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Division 26 Contractor shall refer to the Division 23 specifications and plans for all power wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

Item	Furnished By	Set By	Power Wiring	Control Wiring
Equipment Motors	MC	MC	EC	---
Motor Starters / Controllers and Overload Heaters (See Note 1)	MC	EC	EC	MC
Fused & Unfused Disconnect Switches, Thermal Overload Heaters (if not integral to equipment) (See Note 5)	EC	EC	EC	---

Item	Furnished By	Set By	Power Wiring	Control Wiring
Manual Operating & Speed Switches (carrying load currents) (See Note 3 & 4)	MC	MC	MC	MC
Control Relays & Transformer (See Note 2)	MC	MC	MC	MC
Thermostats (Line Voltage)	MC	MC	EC	MC
Aquastats	MC	MC	MC	MC
Temperature Control Panels	MC	MC	MC	MC
Building Fire Alarm System Fire & Smoke Detectors, including Relays for Fan Shutdown	EC	EC	EC	EC
Motor & Solenoid Valves, Damper Motors, Control Valves, Fan Interlocking Wiring, Low Voltage Thermostats	MC	MC	MC	MC
Duct Detection (Note 6)	EC	MC	---	EC
Pilot Lights (Manually operated Switches not carrying Load Currents) (See Note 3)	MC	MC	---	MC
Fire Sprinkler System Alarms, Tamper Switches, Flow Switches and Fire Alarm Systems Tie-ins to provide a complete Fire Protection System	FPC	FPC	---	EC
Temporary Heating Connections	MC	MC	EC	MC
Smoke Dampers and Combination Fire/Smoke Dampers	MC	MC	EC	EC

MC = Mechanical Contractor Under Division 23 of the Work
EC = Electrical Contractor Under Division 26 of the Work
FPC = Fire Protection Contractor

Notes for the Electrical/Mechanical Coordination Schedule.

1. All starters, other than those noted on the Electrical Drawings shall be furnished under Division 23. All starters furnished under Division 23 shall be complete with three overload heaters and shall conform to NEC and NEMA requirements. All starters shall have 65,000 AIC rating.
2. Control relays and control transformers shall be furnished under Division 23 except where furnishing such items are specifically required under Division 26 specifications

and/or drawings.

3. Pushbuttons stations carrying full load current are to be wired under Division 26 of the work.
4. Exhaust Fans: The Electrical Contractor under Division 26 of the work shall furnish and install circuits, feeders and disconnect switches (where specified), and make all connections to motors and controls unless interlocked with other mechanical equipment or exhaust fans in locations indicated. Where exhaust fans are switched with lights, a two-pole toggle switch will be provided under Division26. Where exhaust fans are interlocked with other mechanical equipment, the interlock wiring will be furnished by the Mechanical Contractor under Division 23.
5. Some equipment will be furnished with integral disconnecting means. Refer to the Mechanical Equipment Schedule on the drawings for additional information.
6. Electrical contractor provides control wiring to fire alarm panel and from fire alarm panel to mechanical unit.

C. All temperature control conduit and wiring shall be furnished and installed under Division 23. All motorized damper equipment shall be furnished and installed under Division 23 and 120 volt power wired under Division 23.

D. Control wiring includes all low voltage and 120 volt wiring.

END OF SECTION 23 05 00

SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes basic requirements for factory-installed and field-installed motors.

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

1.4 SUBMITTALS

A. Product Data for Motors and Controllers: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.

B. Qualification Data: For testing agency.

C. Test Reports: Written reports specified in Parts 2 and 3.

D. Shop Drawings: For each enclosed controller.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

    a. Enclosure types and details.
    b. Nameplate legends.
    c. Short-circuit current rating of integrated unit.
    d. UL listing for series rating of overcurrent protective devices in combination controllers.
    e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

E. Maintenance Data: For enclosed controllers and components to include in maintenance manuals specified in Division 01. In addition to requirements specified in Division 01 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

B. Source Limitations: Obtain field-installed motors of a single type through one source from a single manufacturer.

C. 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.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner and Architect at least two days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
2. Indicate method of providing temporary utilities.
3. Do not proceed with utility interruptions without Architect's written permission.

1.7 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:

1. Compatible with the following:

a. Magnetic controllers.

2. Matched to torque and horsepower requirements of the load.
3. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

C. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

F. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subjected to weather, cover enclosed controllers to protect from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.9 EXTRA MATERIALS

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

1. Spare Fuses: Not less than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

A. Motor requirements apply to factory-installed motors except as follows:

1. Different ratings, performance, or characteristics for a motor are specified in another Section.
2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

A. Motors 3/4 HP and Larger: Three phase. (Unless otherwise noted)

B. Motors Smaller Than 3/4 HP: Single phase. (Unless otherwise noted)

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open drip-proof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Enclosure: Open dripproof.

I. Starters: Provide starters of appropriate duty and rating classification for all motors. Combination starters/disconnects shall be provided for all equipment where disconnect and starter are mounted in an interior, accessible location. Starters for equipment with exterior disconnects shall be separate from the disconnect and located inside the facility.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficiency, meeting current ASHRAE energy conservation standards.

C. Stator: Copper windings, unless otherwise indicated.

1. Multispeed motors shall have separate winding for each speed.

D. Rotor: Squirrel cage, unless otherwise indicated.

E. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating, unless otherwise indicated.

G. Insulation: Class F, unless otherwise indicated.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

1. Finish: Manufacturer’s standard painted finish.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Inverter Duty Motors: Motors used with Variable Frequency Controllers shall be Baldor Super-E type or equal and shall have a constant torque ratio of 20:1 or higher. Provide shaft grounding rings.

B. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

C. Rugged-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with nonhygroscopic material.

1. Finish: Chemical-resistant paint over corrosion-resistant primer.

D. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

E. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Designed with critical vibration frequencies outside operating range of controller output.
2. Temperature Rise: Matched to rating for Class B insulation.
3. Insulation: Class H.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Efficiency: Efficiency meeting current ASHRAE energy conservation standards.

D. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

E. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

F. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

2.6 ACCEPTABLE MANUFACTURER: (MOTORS)

A. Except where item of mechanical equipment (which otherwise complies with requirements) must be integrally equipped with motor produced by another manufacturer, provide motors for mechanical equipment manufactured by one of the following:

1. Baldor Electric Co.
2. Eaton Crop.
3. General Electric Co.
4. Lincoln Electric Co.
5. Magne Tek
6. Marathon Electric Mfg. Corp.
7. Reliance Electric Co.
8. Westinghouse Electric Corp.

2.7 ACCEPTABLE MANUFACTURERS: (STARTERS)

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

1. Manual and Magnetic Enclosed Controllers:

a. General Electrical Distribution & Control.
b. Siemens/Furnas Controls.
c. Square D Co.

2. Refer to Specification Section 237400 for Variable Frequency Controller requirements.

2.8 MAGNETIC ENCLOSED CONTROLLERS (STARTERS)

A. Description: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.

B. All starters for polyphase motors (1 HP and larger) shall be provided with phase protection, to protect against loss of phase and phase reversal.

C. Control Circuit: 120 V; obtained from equipment control system with a control power source or transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

D. Combination Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.
2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.

E. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

F. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

G. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
3. LED indicators showing motor and control status, including the following conditions:

    a. Control power available.
    b. Controller on.
    c. Overload trip.
    d. Loss of phase.
    e. Shorted silicon-controlled rectifier.

4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.
5. Motor running contactor operating automatically when full voltage is applied to motor.

2.9 ENCLOSURES

A. Description: Surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2.10 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Elapsed Time Meters: Heavy duty with digital readout in hours.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive field-installed motors for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of conduit systems to verify actual locations of conduit connections before motor installation.

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

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 MOTOR INSTALLATION

A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.

B. Comply with mounting and anchoring requirements specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.4 CONTROLLER INSTALLATION

A. See Division 26 for general installation requirements.

B. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26.

C. Install freestanding equipment on concrete bases complying with Division 03 Section "Cast-in-Place Concrete."

D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
2. Test interlocks and control features for proper operation.
3. Verify that current in each phase is within nameplate rating.
4. Test insulation resistance for each enclosed controller bus.

B. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Manufacturer's Field Service: (Controllers) Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting solid-state controllers.

1. Test Reports: Prepare a written report to record the following:

a. Test procedures used.
b. Test results that comply with requirements.
c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.7 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.8 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

3.9 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that enclosed controllers are installed and connected according to the Contract Documents.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data" and “Closeout Procedures.”
3. Schedule training with Owner, through Architect, with at least seven days of advance notice.

END OF SECTION 23 05 13

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes hangers and supports for mechanical system piping and equipment.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.
2. Division 23 Section "Vibration Controls and Seismic Restraints for HVAC Piping and Equipment" for vibration isolation and seismic restraint devices.

1.3 DEFINITIONS

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

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

C. Design seismic restraint hangers and supports for piping and equipment when required by jurisdictional authority.

D. Design and obtain approval from authorities having jurisdiction for seismic restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.

C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

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

B. Engineering Responsibility: Design and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Pipe Hangers:

a. AAA Technology and Specialties Co., Inc.
b. B-Line Systems, Inc.
c. Carpenter & Patterson, Inc.
d. Empire Tool & Manufacturing Co., Inc.
e. Globe Pipe Hanger Products, Inc.
f. Grinnell Corp.
g. GS Metals Corp.
h. Michigan Hanger Co., Inc.
i. National Pipe Hanger Corp.
j. PHD Manufacturing, Inc.
k. PHS Industries, Inc.
l. Piping Technology & Products, Inc.

2. Channel Support Systems:

a. B-Line Systems, Inc.
b. Grinnell Corp.; Power-Strut Unit.
c. GS Metals Corp.
d. Michigan Hanger Co., Inc.; O-Strut Div.
e. National Pipe Hanger Corp.
f. Thomas & Betts Corp.
g. Unistrut Corp.

h. Wesanco, Inc.

3. Thermal-Hanger Shield Inserts:

a. Carpenter & Patterson, Inc.
b. Michigan Hanger Co., Inc.
c. PHS Industries, Inc.
d. Pipe Shields, Inc.
e. Rilco Manufacturing Co., Inc.
f. Value Engineered Products, Inc.

2.2 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.

1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.

1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.

1. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
2. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
4. For Clevis or Band Hanger: Insert and shield cover over lower 180 degrees of pipe.
5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
2. Properties: Nonstaining, noncorrosive, and nongaseous.
3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

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

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

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

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8. Copper pipe rings shall be used on copper pipe. Painted steel pipe rings are not approved for use.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

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

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

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

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

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

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

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): To control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

A. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment. Support of piping and ductwork systems shall be distributed across the structural system. Alternate hanger locations when multiple pipes are supported in one area to ensure single trusses are not independently bearing the weight of multiple pipes in any one area.

B. Coordinate and follow mechanical support building attachment requirements of manufacturers of truss and joist systems and structural components. Furnish shop drawings of proposed attachment methods which have been reviewed and approved by manufacturer of structural systems.

C. Regardless of the type of construction (i.e., concrete, concrete-deck-steel, concrete plank, wood or other variations) take particular care to support main lines and large and heavy pipes in an approved manner, including the furnishing and installation of supplementary steel, if required. Supplementary steel shall be mill-rolled sections. Submit shop drawings, indicating support methods, point loadings to the building structure and hanger locations for review.

D. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

E. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.

1. Field assemble and install according to manufacturer's written instructions.

2. Submit engineered drawings, calculations and details for channel support system designed by manufacturer or Professional Engineer.

F. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

G. Install all building attachments to structural components. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. All items shall be directly supported from structure. Items shall not be suspended from other building systems.

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

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

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

K. Insulated Piping: Comply with the following:

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 according to ASME B31.9.

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

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

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

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

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

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.

c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

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

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

3.6 PAINTING

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

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

B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 Section "Painting."

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

END OF SECTION 23 05 29

SECTION 23 05 33 – HEAT TRACE FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes heating cables for the following applications:

1. Heat tracing.

1.3 SUBMITTALS

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

B. Maintenance Data: For electric heating cables to include in maintenance manuals specified in Division 01.

C. Warranties: Special warranties specified in this Section.

1.4 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.

1.5 COORDINATION

A. Coordinate layout and installation of electric heating cables and system components with other construction.

1.6 WARRANTY

A. Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of electric heating cables that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Two years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Accutron Heat Tracing Systems.
2. Nelson Heat Tracing Systems.
3. Raychem Corporation.
4. Thermon Manufacturing Co.

2.2 HEATING CABLES

A. Heat-Tracing Cables: Self-regulating, electric heating cables suitable for freeze protection of metal or plastic piping.

1. Cables: Pair of parallel No. 16 AWG tinned-copper bus wires embedded in cross-linked conductive polymer core, which varies power output in response to temperature along its length.
2. Cable shall be capable of crossing over itself without overheating.
3. Heat Output: At least 90 percent of rating over a temperature range from 0 to 150 deg F pipe temperature. Eight watts per lineal foot of cable.
4. Cable Cover: Fabricated of cross-linked, modified, polyolefin dielectric jacket; tinned-copper braid; and polyolefin outer jacket with ultraviolet inhibitor.
5. Voltage: 120V/1PH/60Hz. (Unless otherwise indicted on electrical drawings.)

2.3 CONTROLS

A. Outdoor Thermostat: Remote bulb unit with adjustable temperature range from 0 to 120 deg F snap action; open-on-rise, single-pole switch with 25-A rating.

2.4 ACCESSORIES

A. Cable Installation Accessories: Tapes, cable ties, warning labels, end seals and splices, and installation clips.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive heating cables for compliance with requirements for installation, tolerances, and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
2. Ensure pipe testing is complete.
3. Ensure surfaces and substrates are level and plumb.

B. Test cables for electrical continuity before installing.

C. Test cables for insulation resistance before installing.

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

3.2 INSTALLATION

A. Cut cable to length required.

B. Install heater-to-cold lead connections in accessible locations. Do not embed in concrete or plaster.

C. Fully insulate all piping with heating cables applied.

3.3 CONNECTIONS

A. Electrical installation requirements are specified in Division 26 Sections. Drawings indicate general arrangement of wiring, conduit, and specialties.

B. Connect heating cables and other components to wiring systems.

C. Ground equipment.

1. 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.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform tests after installation but before application of coverings, such as insulation, plaster, or concrete.

1. Test cables for electrical continuity before energizing.
2. Test cables for insulation resistance before energizing. Remove cables if measured resistance is less than 10 megohms to ground.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation.

C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.6 PROTECTION

A. Protect installed heating cables, including leads, from damage before Substantial Completion.

END OF SECTION 23 05 33

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring mounts.
6. Restrained-spring isolators.
7. House-restrained-spring-isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Spring hangers with vertical-limit stops.
13. Snubbers.
14. Restraining braces and cables.
15. Mechanical anchor bolts.
16. Adhesive anchor bolts.
17. Seismic-restraint accessories.
18. Restrained vibration isolation curb rails.

1.3 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.

1.4 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 vibration isolation device and seismic-restraint component required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment, devices and system components.

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device for each system.

1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
3. 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 was examined for excessive stress and that none exists.
4. 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. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

D. Welding certificates.

E. Qualification Data: For professional engineer and testing agency.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.5 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 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 unavailable, 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

2.1 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.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

G. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

H. Housed-Restrained-Spring Isolators: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
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.

I. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- 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 and for equal resistance in all directions.

J. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- 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.

K. Elastomeric Hangers: 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.

L. Spring Hangers: 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.

M. Spring Hangers with Vertical-Limit Stop: 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.

N. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type. Oil- and water-resistant neoprene resilient isolation washers and bushings. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

O. Restraint Channel Bracings: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

P. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

Q. 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.

R. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.2 SEISMIC-RESTRAINT ACCESSORIES

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

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

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

2.3 RESTRAINED VIBRATION ISOLATION CURB

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

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

B. General Requirements for Restrained Vibration Isolation Curb: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

C. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.

1. Grade Mounted Equipment: Lower support assembly shall have a means for attaching to concrete pad and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

2. Roof Mounted Equipment: Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

D. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations.

1. Grade Mounted Equipment: Isolators shall be located so they are accessible for adjustment at any time during the life of the installation.

2. Roof Mounted Equipment: Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

3. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with wind restraint.

a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

4. 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.

a. Resilient Material: Oil- and water-resistant standard neoprene.

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

F. Water Seal:

1. Grade Mounted Equipment: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past lower support assembly.

2. Roof Mounted Equipment: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

G. Refer to contract documents for additional information.

2.4 FACTORY FINISHES

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation 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.

3.2 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 is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

D. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:

1. Comply with requirements in MSS SP-127.

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

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

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

I. 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.

J. 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.

K. 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.

3.4 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 232113 "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning isolators and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

D. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.

3.8 VIBRATION ISOLATION SCHEDULE

A. Base Types:

A = No base, isolators attached directly to equipment.
B = Structural steel rails or base
C = Concrete inertia base
D = Curb-mounted base with spring isolators
E = Integral Equipment Base Rails / Feet
F = Rail Mounted Isolator

B. Isolator Types:

1 = Pad
2 = Spring floor isolator
3 = Spring hanger
4 = Rubber in-shear hanger
5 = Thrust restraint
6 = Rubber in-shear isolator pad
7= Spring Isolated Curb
8 = Mason Type ND Rubber Mount
9 = Neoprene and Cork Pad

Equipment Type	Slab On Grade			0-70 Ft Floor Span		
	Base Type	Isol Type	Min. Defl.	Base Type	Isol Type	Min. Defl.
VTAC Units						
All Sizes	A	6	-	-	-	-
Roof Mounted Centrifugal Fan & Ventilation Sets						
All Sizes	-	-	-	D	-	1”
Split System Air Handling Units						
All sizes	A	6	-	A	3	1”
Grade Mounted VUs						
All Sizes	D	7	2”	-	-	-
Gas-Fired Furnaces						
All sizes	A	9	-	A	3	1”
Grade Mounted Condensing Units/Heat Pumps						
All sizes	A	6	-	-	-	-
Roof Mounted Condensing Units and VRF Outdoor Units						
All sizes	-	-	-	F	8	-
Suspended Fan Coils and Branch Controllers						
All sizes	-	-	-	A	3	1”

Roof Mounted VUs and MAUs						
All sizes	-	-	-	D	7	2”

END OF SECTION 23 05 48

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment markers.
3. Equipment signs.
4. Access panel and door markers.
5. Pipe markers.
6. Duct markers.
7. Valve tags.
8. Valve schedules.
9. Warning tags.

1.3 SUBMITTALS

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

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

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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 location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

a. Manufacturer, product name, model number, and serial number.
b. Capacity, operating and power characteristics, and essential data.
c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.
2. Data:

a. Name and plan code.
b. Equipment service.

3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.
2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
3. Thickness: 1/16 inch for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

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

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Preprinted, color-coded plastic with pressure-sensitive, permanent-type, self-adhesive back. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch thick brass.
2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.5 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size 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. Provide in plastic sleeves located in 3-ring binder.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Heating Recovery Units, Condensing Units and similar equipment.
2. Fans, blowers, primary balancing dampers, and mixing boxes.
3. Ventilation Units and Make-up Air Units.
4. Vertical Terminal Heat Pumps, Packaged Terminal Heat Pumps, Split System Heat Pumps and similar equipment.
5. Furnaces and similar equipment.
6. Unit Heaters.
7. Fan Coils and similar equipment.
8. Branch Controllers and similar equipment.

B. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate markers where accessible and visible. Include signs for the following general categories of equipment:

a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
b. Meters, gages, thermometers, and similar units.

c. Fuel-burning units.
d. Condensers and similar motor-driven units.
e. Fans, blowers, primary balancing dampers, and mixing boxes.
f. Packaged HVAC central-station and zone-type units.
g. Ventilation Units and Make-up Air Units.

C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:

1. Red: For exhaust ducts.
2. Yellow: For outside air ducts.
3. Blue: For return, and mixed-air ducts.
4. Green: For supply air ducts.
5. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

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

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:

   a. Refrigerant: 1-1/2 inches.
   b. Gas: 1-1/2 inches.

2. Valve-Tag Color:

   a. Gas: Orange.
   b. Refrigerant: Green.

3. Letter Color:

   a. Gas: White.
   b. Refrigerant: White.

3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule in plastic slip sheets located in the 3-ring binder.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Reporting results of the activities and procedures specified in this Section.

B. The Testing, Adjusting and Balancing (TAB) contractor shall be contracted directly with the General Contractor to provide the scope of services outlined within this specification. In addition to performing the scope of services outlined within this specification, the TAB contractor shall coordinate all work with the General Contractor and all sub-contractors to ensure complete system installation and operation within the timeframe submitted by the General Contractor and approved by the Owner. The following shall be the responsibility of the TAB contractor:

1. All scope of work shall be coordinated with the General Contractor and all sub-contractors at the start of construction. All parties shall meet to review the scope of work, responsibilities of each party, establish timelines and critical milestones and establish a process for distribution of documentation.
2. Submit all documentation including submittals and requests for information through the General Contractor for review by other trades, the Engineer and the Architect.
3. Submit a proposed schedule for submittals, system coordination, and system testing to the General Contractor for incorporation to the overall project schedule.
4. Coordinate all items required to be provided by the General Contractor and sub-contractors. Submit an agreed upon list indicating each item and associated dates for each item to be completed.
5. Attend all job conferences as outlined in item C below.

C. A Project Manager employed directly by the TAB contractor shall be on site for supervision of all system testing. This Project Manager shall attend all job conferences and all regular contractor coordination meetings during the period where any testing, adjusting and balancing is being performed. This shall include all preliminary coordination and final closeout meetings.

D. Preliminary and final TAB services shall be for each of the following systems:

1. All air-based HVAC systems.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

M. AABC: Associated Air Balance Council.

N. AMCA: Air Movement and Control Association.

O. CTI: Cooling Tower Institute.

P. NEBB: National Environmental Balancing Bureau.

Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

A. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 6 copies of the Contract Documents review report as specified in Part 3 of this Section.

B. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 6 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.

C. Certified Testing, Adjusting, and Balancing Reports: Submit 6 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

D. System Observations and Corrections List: Submit 6 copies of written report indicating conditions which will prevent the system from being properly balanced or performing properly. The report shall identify all system issues observed during the system examination as specified in Part 3 below.

1.5 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by NEBB or AABC with a minimum of 10 years of balancing experience on the specified system types.

B. Testing, Adjusting, and Balancing Conference: Meet with the General Contractor’s and Sub-Contractor’s representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, the building automation system installer, and the HVAC contractor. Provide 7 days of advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

a. Submittal distribution requirements.
b. Contract Documents examination report.
c. Testing, adjusting, and balancing plan.
d. Work schedule and Project site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

D. Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

A. Partial Owner Occupancy: The Owner may occupy the site and portions of the building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days of advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and distribution systems have been satisfactorily completed by the HVAC contractor.

1.8 WARRANTY

A. Special Guarantee: Provide a guarantee on AABC forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing

devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

3. If balancing device quantities as indicated on the Drawings are insufficient, it is the responsibility of this Contractor to provide the appropriate devices in the desired quantities to ensure a balanced system.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as fan coil units, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine equipment for installation and for properly operating safety interlocks and controls.

N. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.

3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units and mixing boxes.
4. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
5. Sensors are located to sense only the intended conditions.
6. Sequence of operation for control modes is according to the Contract Documents.
7. Controller set points are set at indicated values.
8. Interlocked systems are operating.
9. Changeover from heating to cooling mode occurs according to indicated values.

O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance, smoke, and fire dampers are open.
5. Isolating and balancing valves are open and control valves are operational.
6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
7. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

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 this Section or equivalent AABC Standards.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure total air flow.
2. Measure fan static pressures to determine actual static pressure as follows:

    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Adjust fan speed higher or lower than design. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling and full heating modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating if high-efficiency motor.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.7 PROCEDURES FOR HEAT-TRANSFER COILS

A. Electric-Heating Coils: Measure the following data for each coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

B. Refrigerant Coils: Measure the following data for each coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.8 PROCEDURES FOR AIR-COOLED HEAT RECOVERY UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.9 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings in 100% outside air systems.

C. Measure outside-air, wet- and dry-blub temperatures.

3.10 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.11 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 and equipment with fan(s).
   2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
   3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   4. Check the refrigerant charge.
   5. Check the condition of filters.
   6. Check the condition of coils.
   7. Check the operation of the drain pan and condensate-drain trap.
   8. Check bearings and other lubricated parts for proper lubrication.
   9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
   2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
   4. Balance each air outlet.

3.12 TOLERANCES

A. Set HVAC system airflow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.

3.13 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.14 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of testing, adjusting, and balancing Agent.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of testing, adjusting, and balancing Agent who certifies the report.
10. 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. Design versus final performance.
b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from design values.
15. Test conditions for fans and pump performance forms, including the following:

a. Settings for outside-, return-, and exhaust-air dampers.
b. Conditions of filters.
c. Cooling coil, wet- and dry-bulb conditions.
d. Face and bypass damper settings at coils.
e. Fan drive settings, including settings and percentage of maximum pitch diameter.
f. Inlet vane settings for variable-air-volume systems.
g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air distribution systems. Present with single-line diagrams and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.

F. Ventilation Unit and Make-Up Air Units Test Reports: For units with coils, include the following:

1. Unit Data: Include the following:

a. Unit identification.

b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data: Include the following:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches.

3. Test Data: Include design and actual values for the following:

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. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.

G. Fan Coil Units and VRF Units:
1. Unit Data: Include the following:
a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement (hi-rise, horizontal, vertical or console).
2. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Discharge static pressure in inches wg.
d. Outside airflow in cfm.
e. Return airflow in cfm.

H. VTHP, PTHP, Furnaces and Split System Heat Pump Units:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement (hi-rise, horizontal, vertical or console).

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Discharge static pressure in inches wg.
d. Outside airflow in cfm.
e. Return airflow in cfm.

I. Apparatus-Coil Test Reports: For apparatus coils, include the following:

1. Coil Data: Include the following:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch.
f. Make and model number.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.

J. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

a. System identification.
b. Make and type.
c. Model number and size.
d. Manufacturer's serial number.
e. Sheave make, size in inches, and bore.

2. Motor Data: Include the following:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches.

3. Test Data: Include design and actual values for the following:

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.

K. 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: Include the following:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Design airflow rate in cfm.
h. Design velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.

L. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:

    a. Instrument type and make.
    b. Serial number.
    c. Application.
    d. Dates of use.
    e. Dates of calibration.

3.15 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.
    b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    c. Measure sound levels at two locations.
    d. Measure space pressure of at least 10 percent of locations.
    e. Verify that balancing devices are marked with final balance position.
    f. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The 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.
4. If the 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."
5. 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.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.16 ADDITIONAL TESTS

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

C. This Contractor shall include partial system and final system balancing of common air based systems which cross phasing lines of this project. Each building or portion of building shall be balanced prior to owner occupancy. Each building shall then be rebalanced for any system which is connected to components in an adjacent building and which was not completed at the time of initial balancing. Rebalancing shall be provided for as many phases as included in the General Contractor's construction schedule.

D. Upon completion of testing and balancing services for each building, the Contractor and Engineer shall field check up to 10% of all air devices and 10% of all equipment for verification of the Test and Balance Report Information. The Engineer shall randomly pick the items to be tested and the Contractor shall be responsible for testing the equipment in the presence of the Engineer and Owner. If 15% or more of each item type tested does not match the Test and Balance Report Information, the Contractor shall test an additional 10% of the items listed for testing. If 15% or more of each item type tested does not match the Test and Balance Report, the Contractor shall rebalance all devices and equipment.

END OF SECTION 23 05 93

SECTION 23 07 00 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes semirigid and flexible duct, plenum, and breeching insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Division 07 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Division 23 Section "Pipe Insulation" for insulation for piping systems.
3. Division 23 Section "Metal Ducts" for duct liner.

1.3 SUBMITTALS

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

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

1.4 QUALITY ASSURANCE

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

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate clearance requirements with duct Installer for insulation application.

1.7 SCHEDULING

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Mineral-Fiber Insulation:

a. CertainTeed Manson.
b. Knauf FiberGlass GmbH.
c. Owens-Corning Fiberglas Corp.
d. Schuller International, Inc.
e. Johns-Manville.

2. Flexible Elastomeric Thermal Insulation:

a. Armstrong World Industries, Inc.
b. Rubatex Corp.

3. Fire Rated Duct Wrap:

a. 3M; Fire Barrier Wrap Products
b. Thermal Ceramics Firemaster

2.2 INSULATION MATERIALS

A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film. Thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging.

B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film. Thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging.

C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

D. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

2.3 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..

1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
2. Galvanized Steel: 0.005 inch thick.
3. Aluminum: 0.007 inch thick.
4. Brass: 0.010 inch thick.
5. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

D. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.

1. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.

E. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.

F. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

2.4 FIELD-APPLIED JACKETS

A. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing
b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Outdoor Applications: 2.5-mil- (0.063-mm-) thick Polysurlyn.
d. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) End caps.
4) Beveled collars.
5) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.5 OUTDOOR PRE-INSULATED DUCT SYSTEM

A. Manufacturers:

1. Thermaduct, by Thermaduct, LLC.
2. QDuct, by AQC Industries.
3. Engineer Approved Equal, pre-bid approval

B. Description:

1. The panel shall be manufactured of CFC-free Kingspan Kooltherm closed cell rigid thermoset resin thermally bonded on both sides to a factory applied .001" (25 micron) aluminum foil facing reinforced with a fiberglass scrim. An added UV stable, 1000 micron high impact resistant titanium infused vinyl is factory bonded to the outer surfaces to provide a zero permeability water tight barrier.
2. The density of the Kooltherm foam shall not be less than 3.5 pcf with a minimum compressive strength of 28 psi.
3. The standard panel (45 mm) thickness of R-12 shall be utilized unless indicated otherwise on the print.

a. Maximum Temperature: Continuous rating of 185 degrees F (70 deg C) inside ducts or ambient temperature surrounding ducts.
b. Maximum Thermal Conductivity: 0.13 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
c. Permeability: 0.00 perms maximum when tested according to ASTM E 96/E 96M, Procedure A.
d. Antimicrobial Agent: Additive for antimicrobial shall not be used but instead, raw product must pass UL bacteria growth testing.
e. Noise-Reduction Coefficient: 0.05 minimum when tested according to ASTM C 423, Mounting A.
f. Required Markings: All interior duct liner shall bear UL label and other markings required by UL 181 on each full sheet of duct panel; UL ratings for internal closure materials.
g. All insulation materials shall be closed cell with a closed cell content of >90%.

4. Duct Leakage Class, follow SMACNA Leakage Class 3 or less.
5. Closure Materials

a. V-Groove Adhesive: Silicone (interior only).
b. UV stable 1000 micron high impact resistant titanium infused vinyl (exterior).

1) Factory manufactured seamless corners for zero perms.
2) Cohesive bonded over-lap at corner seam covers for zero perms.
3) Water resistant titanium infused welded vinyl seams.

4) Mold and mildew resistant.

c. Polymeric Sealing System

1) Structural Membrane: Aluminum scrim with woven glass fiber with a laminated UV stable vinyl jacket.
2) Minimum Seam Cover Width: 2 7/8” (75 mm)
3) Sealant: Low VOC.
4) Color: Standard White (other light reflective colors available).
5) Water resistant.
6) Mold and mildew resistant.

d. Duct Connectors.

1) Factory manufactured cohesive bonded strips (low pressure only).
2) Factory manufactured all aluminum grip flange.
3) Factory manufactured galvanized 4-bolt flange.

6. Outdoor Cladding

a. Thermaduct outdoor Installations: Duct segments shall incorporate UV stable 1000 micron high impact resistant titanium infused vinyl which is introduced during the manufacturing process.

7. Flange Coverings

a. Flanges are field sealed airtight before flange covers are installed. Flange covering consists of the following:

1) Foam tape insulation with molded 1000 micron covers.
2) Air gap (heating only application) with molded 1000 micron covers.

8. Weight

a. Thermaduct shall provide low weight stresses on the building framing and support members. Assembled Thermaduct shall have a weight of 0.86 lbs. per square foot to maximum weight of 2.7 lbs. per square foot (depending on R-value). Hangers and tie-downs are to be detailed on the manufacturer’s installing contractors detail drawings prior to installation but not exceeding 13’ for duct girth <84” and 8’ for duct girth >85” between hangers and designed to carry the weight and wind load of the ductwork.

9. Duct-mounted Silencer Integration

a. Construct duct system around in-line silencers to ensure air-tight seal between insulated duct walls and outer casing of silencer. Install galvanized 4-bolt flange at end of insulated silencer section to anchor silencer section to adjacent duct section, joining with standard procedures.

2.6 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

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

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Keep insulation materials dry during application and finishing.

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

H. Apply insulation with the least number of joints practical.

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

L. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.

1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.

O. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.

1. Seal penetrations with vapor-retarder mastic.
2. Apply insulation for exterior applications tightly joined to interior insulation ends.
3. Seal insulation to roof flashing with vapor-retarder mastic.

P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

Q. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

R. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.

1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 OUTDOOR PRE-INSULATED DUCT SYSTEM APPLICATION

A. Fabrication:

1. Fabricated joints, seams, transitions, reinforcement, elbows, branch connections, access doors and panels, and damage repairs according to manufacturer’s written and detailed instructions.
2. Fabricated 90-degree mitered elbows to include turning vanes.
3. Fabricate duct segments in accordance with manufacturer’s written details.
4. Duct Fittings shall include 6 inches of connecting material, as measured, from last bend line to the end of the duct. Connections on machine manufactured duct may be 4 inches.
5. Fabricate duct segments utilizing v-groove method of fabrication. Factory welded or cohesively bonded seams will apply to fully manufactured ductwork and fittings. Internal seams will be supplied with an unbroken layer of low VOC silicone or bonding (for paint shop applications). Each duct segment will be factory supplied with either aluminum grip pro-file or pre-insulated duct connectors in accordance with manufacturer’s detailed submittal guide. Apply duct reinforcement to protect against side deformation from both

positive and negative pressure per manufacturer's design guide based on specified ductwork size and system pressure.

6. Designed and fabricated duct segments and fittings will be in accordance with "SMACNA Duct Construction Standards" latest edition.
7. Both positive and negative ductwork and fittings shall be constructed to incorporate a UL Listed as a Class 1 air duct to Standard for Safety UL 181 liner with an exterior clad for permanent protection against water intrusion.
8. Duct shall be constructed to exceed requirements for snow and wind loads.
9. Duct-mounted silencers shall be procured and delivered to the outdoor duct system manufacturer for factory-installed insulation and cladding prior to fabrication of the outdoor duct system.

B. Duct Installation

1. Duct segments shall be installed by competent HVAC installers.
2. Install ducts and fittings to comply with manufacturer's installation instructions as follows:

    a. Install ducts with fewest possible joints.
    b. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
    c. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
    d. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."
    e. Use prescribed duct support spacing as described in this specification and manufacturer's recommendations.

3. Air Leakage: Duct air leakage rates to be in compliance with "SMACNA HVAC Duct Construction Standards" latest version per applicable leakage class based on pressure.

C. Hanger and Support Installation

1. Contractor to ensure that the ductwork system is properly and adequately supported.

    a. Ensure that the chosen method is compatible with the specific ductwork system requirements per Thermaduct installation detail drawings. Pre-installation coordination should be provided prior to work commencement by installing contractor for approval.
    b. 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.

2. Supports on straight runs of ductwork shall be positioned at centers not exceeding 13 feet for duct sections when fabricated in 13 foot lengths with duct girth less than 84". Larger duct sizes and short segments with duct girth greater than 84" are to be supported at 8 foot centers or less, in accordance with the Thermaduct installation details provided prior to work commencement.
3. Ductwork shall be supported at changes of direction, at branch duct connections, tee fittings, parallel under turning vanes and all duct accessories such as dampers, both ends of sections with duct-mounted silencers, etc.
4. The load of such accessories to the ductwork shall be neutralized by the accessory support.

D. Field Quality Control

1. Inspection: Arrange for manufacturer's representative to inspect completed installation and provide written report that installation complies with manufacturer's written instructions.

    a. Remove and replace duct system where inspection indicates that it does not comply with specified requirements.

2. Perform additional testing and inspecting, at the Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.5 MINERAL-FIBER INSULATION APPLICATION

A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
    c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.

4. Impale insulation over anchors and attach speed washers.
5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Space anchor pins as follows:

    a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
    c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.

4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.6 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to ducts and plenums as follows:

1. Follow the manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the duct and plenum surface.

3.7 FIRE RATED DUCT WRAP APPLICATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Install according to manufacturer and code requirements.

3.8 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

C. Insulate plenums and duct systems according to the Application Schedules below.

D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Metal ducts with duct liner. (When located in a conditioned space)
2. Return air ducting located in heated spaces (See Specifications Section 23 31 13 for liner requirements).
3. Exhaust air ducting.
4. Factory-insulated flexible ducts.
5. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
6. Flexible connectors.
7. Vibration-control devices.
8. Testing agency labels and stamps.
9. Nameplates and data plates.
10. Access panels and doors in air-distribution systems.

3.9 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: Round, supply-air ducts and return air ducts, concealed and exposed, located in a heated space.

1. Material: Mineral-fiber blanket.
2. Thickness: 1 1/2 inches.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.

B. Service: Round, outside-air ducts, concealed and exposed, located in a heated space.

1. Material: Mineral-fiber blanket.
2. Thickness: 1 1/2 inches.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.

C. Service: Rectangular, supply-air and return-air ducts, concealed and exposed, located in a heated space. (Insulation only applied when liner is not specified.)

1. Material: Mineral-fiber blanket.
2. Thickness: 1 1/2 inches.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.

D. Service: Rectangular, outside-air ducts, concealed and exposed, located in a heated space.

1. Material: Mineral-fiber blanket.
2. Thickness: 1 1/2 inches.
3. Number of Layers: One.

4. Factory-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.

E. Service: Exhaust plenums connected to brick vents and 60” of connecting ductwork.

1. Material: AP Armaflex Self-adhering.
2. Thickness: 1/2 inch.
3. Number of Layers: One.
4. Factory-Applied Jacket: None.
5. Vapor Retarder Required: Yes.

F. Service: Exhaust and intake air plenums.

1. Material: AP Armaflex Self-adhering.
2. Thickness: 3/4 inch.
3. Number of Layers: One.
4. Factory-Applied Jacket: None.
5. Vapor Retarder Required: Yes.

G. Service: Entire Grease exhaust ductwork from point of connection to termination.
1. Material: 3M Firemaster Duct Wrap.
2. Thickness: 2”
3. Number of Layers: 1
4. Rating: 2 hours.

3.10 OUTDOOR DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: All supply-air, return-air and outside-air supply ducts and plenums located in the attic space.

1. Material: Mineral-fiber blanket.
2. Thickness: 2 inches.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.
6. Installed R-Value of Insulation: R-12

B. All exposed ductwork shall be a pre-manufactured duct system including insulation and jacket as specified in this section.

END OF SECTION 23 07 00

SECTION 23 07 10 - PIPE INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Division 07 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Division 23 Section "Duct Insulation" for insulation for ducts and plenums.
3. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for pipe insulation shields and protection saddles.

1.3 SUBMITTALS

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

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for insulation application.

1.7 SCHEDULING

A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Mineral-Fiber Insulation:

    a. CertainTeed Manson.
    b. Knauf FiberGlass GmbH.
    c. Owens-Corning Fiberglas Corp.
    d. Schuller International, Inc.
    e. Johns Manville.

2. Flexible Elastomeric Thermal Insulation:

    a. Armstrong World Industries, Inc.
    b. Rubatex Corp.

3. Calcium Silicate Insulation:
    a. Owens-Corning Fiberglas Corp.
    b. Pabco.
    c. Schuller International, Inc.

2.2 INSULATION MATERIALS

A. All insulation shall have a maximum conductivity of 0.27 Btu per inch/h-sqft-degree F.

B. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket. U.L. 25/50 fire/smoke rating compliant.
2. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:

    a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
    b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.

3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
4. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.

C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

D. Calcium Silicate Insulation: Preformed pipe sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

E. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.
2. PVC Jacket Color: Color-code piping jackets based on materials contained within the piping system.

C. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC. U.L. 25/50 smoke/fire rating compliant.

1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
2. Adhesive: As recommended by insulation material manufacturer.

D. Aluminum Jacket: Aluminum roll stock, ready for shop or field cutting and forming to indicated sizes. Comply with ASTM B 209, 3003 alloy, H-14 temper.

1. Finish and Thickness: Stucco-embossed finish, 0.016 inch thick.
2. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and kraft paper.
3. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd., tape Width of 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
2. Galvanized Steel: 0.005 inch thick.
3. Aluminum: 0.007 inch thick.
4. Brass: 0.010 inch thick.
5. Nickel-Copper Alloy: 0.005 inch thick.

2.5 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Apply multiple layers of insulation with longitudinal and end seams staggered.

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

G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

H. Keep insulation materials dry during application and finishing.

I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

J. Apply insulation with the least number of joints practical.

K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.

1. Apply insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.

4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

P. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

Q. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

R. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.

1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping".

S. Floor Penetrations: Apply insulation continuously through floor assembly.

1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
2. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
3. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

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

C. Apply insulation to fittings and elbows as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.
4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1. Apply mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.6 CALCIUM SILICATE INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of insulation to pipe with stainless-steel bands at 12-inch intervals and tighten without deforming insulation materials.
2. Apply two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch, soft-annealed, stainless-steel wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to surface of installed insulation. When dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin the finish coat to achieve smooth finish.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.
4. Finish flange insulation the same as pipe insulation.

C. Apply insulation to fittings and elbows as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded sections of insulation are not available, apply mitered sections of calcium silicate insulation. Secure insulation materials with stainless-steel wire.
3. Finish insulation of fittings the same as pipe insulation.

D. Apply insulation to valves and specialties as follows:

1. Apply mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
2. Apply insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation the same as pipe insulation.

3.7 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

C. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 09 Section "Painting."

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

3.9 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors.
2. Vibration-control devices.
3. Fire-suppression piping.
4. Drainage piping located in crawl spaces, unless otherwise indicated.
5. Chrome-plated pipes and fittings, unless potential for personnel injury.
6. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.10 FIELD QUALITY CONTROL

A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:

1. Inspect fittings and valves randomly selected by Engineer.
2. Remove fitting covers from 20 elbows or 1 percent of elbows, whichever is less, for various pipe sizes.
3. Remove fitting covers from 20 valves or 1 percent of valves, whichever is less, for various pipe sizes.

B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.11 INSULATION APPLICATION SCHEDULE, GENERAL

A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.12 INSULATION APPLICATION SCHEDULE

A. Insulate the following piping systems with material and thickness as scheduled below:

Insulation Thickness in Inches for Pipe Sizes in Inches

Interior Piping Service	Material	Less than 1”	1” up to 1.5”	1.5” up to 4”	4” to 6”	8” and larger	Notes	Vapor Barrier Yes/No	Exterior Pipe Jacket Type PVC/Alum
Condensate	Jacketed	1/2	1/2	1	1	1	1, 5	Yes	-

Drains	Fiberglass or Flexible Elastomeric								
Refrigerant Piping	Flexible Elastomeric	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	2	Yes	PVC

Notes:

1. All vertical risers and horizontal piping above grade must be insulated. Condensate piping in mechanical rooms is not required to be insulated.
2. Where piping is installed exposed to view in finished spaces, cover with PVC or aluminum jacket. Piping installed in mechanical rooms expected to be exposed to impact or abuse shall be covered with a PVC or aluminum jacket.
3. Where a rigid insulation is required because the piping is expected to be exposed to impact or abuse, use calcium silicate pipe insulation with thickness to maintain the R-value of the specified thickness schedule.
4. HVAC Insulation Omitted: Omit insulation on flexible connectors beyond control valve, located within heated space; on unions, flanges strainers, flexible connections, and expansion joints of hot systems.
5. Condensate piping exposed in unconditioned attics shall be insulated with 1-1/2” of insulation regardless of pipe size. Refer to Construction Documents for all locations.

B. Piping Exposed to Weather: Piping located outdoors and exposed to weather shall be insulated as indicated above. The insulation shall then be protected with one of the following weatherproof finishes as indicated on contract drawings.

1. UV resistant PVC jacketing may be applied in lieu of metal jacketing provided jacketing manufacturer’s limitations with regard to pipe size, surface temperature and thermal expansion and contraction are followed.
2. Fittings shall be insulated as prescribed above, jacketed with pre-formed fitting covers matching outer jacketing used on straight pipe sections, with all joints weather sealed.

END OF SECTION 23 07 10

SECTION 23 08 00- GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SPECIAL PROVISIONS

A. The commissioning services outlined within this specification will be provided by an independent, third-party commissioning agent directly employed by the Owner.

B. The Contractors are responsible for participation in the commissioning process; including providing start-up reports, attendance during functional and pre-functional testing, assistance in operating systems and in modifying non-compliant items to ensure proper system operation. This includes control operation and modification in all phases of testing and remediation. Additional Contractor's Responsibilities are outlined within this specification.

1.3 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

B. Equipment and system types included in the commissioning scope include the following:

1. Ventilation Unit
2. Make-up Air Unit
3. Exhaust Fans
4. Domestic Water Heaters
5. Domestic Hot Water Mixing Valves
6. Stand-Alone Controls
7. 15% of Furnaces
8. 15% of Fan Coils Units
9. 15% VTAC Units
10. 15% PTAC Units
11. 10% of Radiation Dampers
12. 10% of Smoke Dampers
13. Lighting Control System (Public Area System)

    a. 10% of Control Switches
    b. 10 % of Occupancy Sensors
    c. 10% of Scene Selectors
    d. Timeclock Functions

1.4 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

D. Contractor: Refers to the General Contractor or one of their designated sub-contractors who are responsible for the installation of a particular system.

1.5 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of the Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The CxA shall be hired directly by the Owner to provide the specified services.
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

1.6 OWNER'S RESPONSIBILITIES

A. Meet with the CxA and the Contractor to discuss the expectations of the project. This meeting(s) will cover items typically addressed within an OPR.

B. Assign operation and maintenance personnel and schedule them to observe commissioning team activities.

1.7 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
3. Attend commissioning team meetings held on a monthly basis.
4. Integrate and coordinate commissioning process activities with construction schedule.
5. Review and accept construction checklists provided by the CxA.
6. Complete construction checklists as Work is completed and provide to the Commissioning Authority on a regular basis.

7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
8. Complete commissioning process test procedures.
9. Complete Pre-functional Start-up Checklists.

1.8 CxA'S RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Provide commissioning plan. Provide Project-specific commissioning process test procedures and include responsibilities of all parties.

C. Attend 2 commissioning meetings prior to start of Functional Testing. Perform observation of systems and their installation during these observations and provide report to the Architect, Engineer and Contractor for review.

D. Review and provide written comments on Final Construction Documents and Specifications.

E. Review and provide written comments on equipment and controls submittals.

F. Convene commissioning team meetings throughout the Construction Phase of the project.

G. Provide and review Pre-functional Start-up Checklists.

H. Provide and complete Functional Performance Checklists.

I. Perform all Functional Performance tests with the assistance of the Contractors.

J. Verify the execution of commissioning process activities for all systems listed in 1.2-B above. Verification will include, but is not limited to, equipment submittals, construction checklists, operating and maintenance data, tests, and test reports to verify compliance with the project documents. When a functional performance test does not meet the requirement, the CxA will report the failure in the Issues Log.

K. Prepare and maintain the Issues Log.

L. Prepare and maintain completed construction checklist log.

M. Witness systems, assemblies, equipment, and component startup of all equipment specified with factory start-up provisions.

N. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 DUCT LEAK TEST VERIFICATION

A. The CxA shall witness all final duct leakage tests that are required to be performed as part of this contract. Random sampling shall be employed for three duct test sections. The results of the tests shall be recorded, and four (4) copies of the duct leakage test reports will be forwarded to the Owner's Representative.

B. Sections of the duct, which have been successfully tested, shall be visibly marked by the CxA, including date and technicians initials. All duct leakage tests will be conducted prior to the duct being concealed, either by external duct insulation of portions of the building structure, and before the systems are balanced.

C. Any deficiencies identified by the CxA shall be corrected by the installing contractor. The system shall be rechecked by CxA and deemed corrected prior to accepting the installation of the system.

3.2 COMMISSIONING PROCEDURES

A. The commissioning plan shall contain sufficient information to the detail necessary to track the commissioning process from the System Readiness Checks and Start-Up through to the Functional Performance Testing.

3.3 PRE-FUNCTIONAL READINESS CHECK AND EQUIPMENT START-UP

A. The installing contractors, Mechanical (HVAC), Electrical and Plumbing and all associated sub-contractors and factory representatives shall start all equipment, operate all systems, complete all systems readiness checks and complete all Pre-Functional Checklists included in the commissioning plan. The following items shall be completed by the installing contractors and sub-contractors as applicable.

1. All hydrostatic pressure testing of piping shall be completed with all applicable reports submitted.
2. All piping systems shall be flushed and cleaned in accordance with the specifications and all applicable reports submitted.
3. All equipment shall be lubricated in accordance with manufacturer’s recommendations.
4. Cleaning of any duct systems is completed and all filters are installed.
5. Vibration isolators have been installed and adjusted in accordance with the specifications.
6. Equipment drives have been properly aligned.
7. All electrical services have been installed, checked and energized.
8. The Mechanical Contractor has completed all control point-to-point checks and all applicable reports submitted.
9. All safety controls have been installed and operation verified with all applicable reports submitted.
10. Equipment start-up has been performed by manufacturer’s representative (when specified) and all required start-up reports have been completed and submitted.

11. All checks performed by the installing contractors should be made on the checklists provided as part of the commissioning plan as they are carried out.
12. Any deficiencies identified by the CxA shall be corrected by the installing contractor. The system shall be rechecked by CxA and deemed corrected prior to proceeding with functional testing.

3.4 FUNCTIONAL PERFORMANCE TESTING

A. The CxA shall operate all HVAC Equipment and Controls with the assistance of the Mechanical Contractor through the entire specified sequence of operation. This shall include testing in all operating modes and include all operating functions.

B. During this phase of the commissioning process, the CxA shall perform the following tests to further validate the HVAC Systems.

1. Verify the location and accessibility of all access panels.
2. Verify the location, installation and calibration of all BAS components.
3. Verify the operation of all controls systems devices on a stand-alone basis. This includes all valve actuators and damper actuators.
4. Verify the physical response of all BAS components to setpoint adjustments or other changes.
5. Verify the operation of all smoke dampers.
6. Verify the operation under every specified mode of operation and sequence of control.
7. Verify the operation in the "normal" occupied mode, unoccupied mode and under emergency conditions.

C. Any deficiencies identified by the CxA shall be corrected by the installing contractor. The system shall be rechecked by CxA and deemed corrected prior to accepting the installation of the system.

3.5 DEMONSTRATION AND OPERATION

A. The demonstration and operating instructions for the Building Operations Staff will be performed by the Contractor and shall begin once commissioning has been completed and the CxA has verified that all systems and components function in accordance with specifications.

3.6 REPORT REQUIREMENTS

A. The CxA shall submit written reports during the course of construction relating to any problems, which may develop during the course of construction to work being performed by the Contractor which might adversely affect the commissioning of the project.

B. The CxA shall submit four (4) copies of the Final Commissioning Report which shall include copies of the completed Pre-Functional Checklists and Functional Performance Tests.

END OF SECTION 23 08 00

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

B. Any special refrigerant system items which are required by a specific system manufacturer and not identified in this specification shall be incorporated to the system design and identified in refrigerant piping design shop drawings produced by the manufacturer and submitted for review by the Engineer.

C. All refrigerant piping systems shall be designed and installed according to the manufacturer’s requirements.

D. Design of the piping system is the responsibility of the Furnace and Split-System manufacturer and shall be provided to the Engineer for review.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube:

1. ASTM B280, Type ACR.
2. ASTM B 88, Type K or L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

I. Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

L. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina ore charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

M. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

N. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

O. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

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

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

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.
5. Engineer approved equal.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Hot-Gas and Liquid Lines, and Suction Lines Applications:

1. NPS 5/8 and Smaller Copper, Type ACR annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 3/4 to NPS 2”: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Provide hard line sets for all refrigerant piping lengths that exceed 50 feet from indoor unit to outdoor unit.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve where required my manufacturer.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

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

B. Install refrigerant piping according to ASHRAE 15.

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

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

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

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Refer to Section 23 81 20 “Variable Refrigerant Flow System” for Solenoid Valve Controller/Branch Controllers.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Insulate refrigerant piping per Section 23 07 03 “HVAC Pipe Insulation.”

S. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

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

U. Install sleeve seals for piping penetrations of concrete walls and slabs.

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

3.4 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

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

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

F. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

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

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Pipe hanger and support spacing schedule:

Material	Installation	Pipe Size	Max. Hanger Spacing	Min. Rod Diameter

Copper	Horizontal	1/2” to 3/4”	5 feet	1/4”
		1”	6 feet	1/4”
		1-1/4” to 2”	8 feet	3/8”
Copper	Vertical	All Sizes	10 feet or at every floor	N/A

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2 to plus 10-inch wg. Metal ducts include the following:

1. Single-wall rectangular ducts and fittings.
2. Single-wall, round, and flat-oval ducts and formed fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections include the following:

1. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 23 33 00 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
3. Section 23 05 48 “Vibration and Seismic Controls for HVAC Piping and Equipment”. For seismic and wind resistant and hangers.

1.3 DEFINITIONS

A. NUSIG: National Uniform Seismic Installation Guidelines.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 SUBMITTALS

A. Coordination Drawings: Refer to Section 23 requirements.

B. Welding certificates.

C. Field quality-control test reports.

1.6 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity, wind (for roof mounted ducting) and seismic loads and stresses. Refer to Section 250548.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports, AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 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."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. 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 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."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

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."

2.3 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: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

D. 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. 4.

E. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

F. 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.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

1. Manufacturers:

a. CertainTeed Corp.; Insulation Group.
b. Johns Manville International, Inc.
c. Knauf Fiber Glass GmbH.
d. Owens Corning.

2. Fibrous glass duct liners shall resist fungal and bacterial growth as defined and in accordance with ASTM C 1338, required for airstream surfaces per ASHRAE 62.1-2001; and additionally, ASTM G 21-96 (fungus test) required by ASTM C 1071.
3. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
b. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
c. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
d. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.5 SEALANT MATERIALS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.6 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.7 RECTANGULAR DUCT FABRICATION

A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized, sheet steel, according to SMACHNA's "HVAC Duct Construction Standards—Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

B. Static-Pressure Classifications and Construction Schedule:

Duct System	Material	Pressure Class (WC)	Seal Class	Liner
VTAC/Furnace/Fan Coil Supply Air Main from VTAC/Furnace/Fan Coil to Last Branch Duct	Galvanized Steel	+1.0"	C	1"
VTAC/Furnace/Fan Coil Return Air main and Branches	Galvanized Steel	-1.0"	C	1"
VTAC/Furnace/Fan Coil Supply Air Branch from Main Duct to Air Outlets	Galvanized Steel	+1.0"	C	1"
VU and MAU Supply Air	Galvanized Steel	+2.0"	B	NONE
Exhaust Air	Galvanized Steel	-2.0"	B	NONE
Transfer Air	Galvanized Steel	-0.5"	C	2"
Dryer Exhaust	Aluminum	-2.0"	B	NONE
Exterior Ductwork (including ductwork on roof)	Pre-manufactured System. Refer to insulation specification.			
Grease Exhaust	Carbon Steel	-3.0"	B	NONE

C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of unbraced panel area, unless ducts are lined.

D. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

2.8 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

G. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

1. Fan discharges.
2. Intervals of lined duct preceding unlined duct.
3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

I. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.9 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Flat-Oval Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible.

1. Manufacturers:

a. ACME.
b. McGill AirFlow Corporation.
c. SEMCO Incorporated.

D. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:

a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.

3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:

a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.

4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
6. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
8. Round Elbows Larger than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
11. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Through-Penetration Firestop Systems."

O. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

1. For pressure classes lower than 2-inch wg, seal transverse joints.

B. Seal ducts before external insulation is applied.

3.3 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.6 CLEANING NEW SYSTEMS

A. All building duct systems shall be protected during construction using industry defined methods for protecting openings during construction and storing materials in clean, dry environments.

B. All debris shall be removed from duct systems and equipment.

END OF SECTION 23 31 13

SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Radiation dampers.
6. Smoke dampers and Combination fire and smoke dampers.
7. Turning vanes.
8. Duct-mounting access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

B. Related Sections include the following:

1. Division 28 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Radiation dampers.
6. Smoke dampers and Combination fire and smoke dampers.
7. Flexible connectors.
8. Flexible ducts.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. CESCO Products.
4. Duro Dyne Corp.
5. Greenheck.
6. Penn Ventilation Company, Inc.
7. Ruskin Company.

B. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.063-inch- thick extruded aluminum, with welded corners and mounting flange.

D. Blades: 0.050-inch- thick aluminum sheet.

E. Blade Seals: Vinyl or Neoprene.

F. Blade Axles: Nonferrous.

G. Tie Bars and Brackets: Aluminum.

H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Flexmaster U.S.A., Inc.
4. McGill AirFlow Corporation.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Ruskin Company.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Standard Volume Dampers: Multiple- or single-blade, parallel or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
6. Blade Axles: Galvanized steel.
7. Tie Bars and Brackets: Galvanized steel.

D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.

3. Blade Axles: Galvanized steel.
4. Bearings: Oil-impregnated bronze thrust or ball.
5. Blade Seals: Neoprene.
6. Jamb Seals: Cambered aluminum.
7. Tie Bars and Brackets: Galvanized steel.

E. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 FIRE DAMPERS AND RADIATION DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. Nailor Industries, Inc.
4. Ruskin Company

B. Fire Rating: 1-1/2 and 3 hours as required for each application, UL 555 labeled.

C. Frame: SMACNA Type ‘B’ with blades outside airstream; fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.

D. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

E. Mounting Orientation: Vertical or horizontal as indicated.

F. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

G. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

H. Fusible Links: Replaceable, 165 deg F or 212 deg F rated as required by fire rating.

2.6 SMOKE AND COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.

2. Greenheck
3. Nailor Industries, Inc.
4. Ruskin Company

B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be UL labeled for 1-1/2-hour rating.

C. Fusible Links: Replaceable, 165 deg F or 212 deg F rated as required by fire rating.

D. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.

E. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

F. Damper Motors: Provide for modulating or two-position action.

1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
2. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
3. Outdoor Motors and Motors in Outside-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.
4. Electrical Connection: 115 V, single phase, 60 Hz.

2.7 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, double-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.8 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

2.9 FLEXIBLE CONNECTORS

A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

B. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

2.10 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 1.

B. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch thick, glass-fiber insulation around a continuous inner liner.

1. Reinforcement: Steel-wire helix encapsulated in inner liner.
2. Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.
3. Inner Liner: Polyethylene film.

C. Pressure Rating: 6-inch wg positive, ½-inch wg negative.

2.11 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 pilot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel; stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Downstream from volume dampers and equipment.
3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
5. On sides of ducts where adequate clearance is available.

I. Install the following minimum sizes for duct-mounting, rectangular access doors and access panels:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 12 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body Plus Ladder Access: 25 by 17 inches.

J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment."

K. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

L. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible connector to change directions.

M. Connect diffusers to low pressure ducts with maximum 96-inch lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with draw bands and adhesive.

O. Flexible ducts are not permitted for use in return or exhaust air systems.

P. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 33 00

SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on standard air conditions.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Roof framing and support members relative to duct penetrations.

2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.8 EXTRA MATERIALS

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

1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cook, Loren Company.
2. Greenheck.
3. Penn Ventilator Co.

2.2 UPBLAST EXHAUST FANS

A. Description: AMCA rated, belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades, statically and dynamically balanced.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings, minimum L_{10} life of 100,000 hours.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream. Motor shall be mounted on vibration isolators.
5. Drive shall be sized for a minimum of 150% of motor horsepower.

E. Direct-Driven Units: Permanently lubricated motor encased in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

F. Accessories: As scheduled on drawings and as follows:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Starter / Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, ½-inch mesh, aluminum or stainless steel wire.
4. Backdraft Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops. Provide motorized dampers in lieu of backdraft dampers if not on schedule.
5. Hinge kit for tilt-up access to fan parts and ducts.
6. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in raised cant and mounting flange.

2. Overall Height: 12 inches, unless noted.
3. Pitch Mounting: Manufacture curb for roof slope, where necessitated by project conditions.

2.3 UPBLAST KITCHEN HOOD EXHAUST FANS

A. Furnish and install kitchen hood exhaust fans of model, size and capacity as shown on drawings. Unit shall be UL listed for kitchen hood exhaust (UL 762).

B. Housings shall be of contour type, circular, aluminum, circumferential air discharge, upblast.
1. Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.

C. Fan shall be the backwardly inclined type with centrifugal wheel that has been statically and dynamically balanced at the factory.

D. Motor shall be installed in a totally enclosed weather-proof housing outside of the air stream. Provide outside air cooling tube and wiring conduit into motor enclosure.

E. Drives shall be direct drive or belt driven as indicated on the drawings. Belt shall be oil resistant. An adjustable sheave on the motor shall be provided to allow changes in the fan speed. Drives sized for 150% of motor horsepower. Provide pillow-bearings.

F. Ventilators shall be installed on the roof on a pre-fabricated, self-flashing aluminum curb. Provide vented extension on curb to meet NFPA 96D and to meet discharge height required by code.

G. Fan shall be provided with a factory-mounted grease drain and removable container for field cleaning of accumulated grease.

H. Provide the following accessories:
1. Disconnect switch, NEMA 3R.
2. Hinge kit for tilt-up access to fan parts and ducts.
3. Pitch Mounting: Manufacture curb for roof slope, where necessitated by project conditions.

2.4 SEQUENCE OF OPERATION

A. EF-4 shall be interlocked with MAU-1 and the hood operation. Refer to Division 23, “Ventilation Units” for sequence of operation.

A. EF-2 through EF-9 shall run continuously.

2.5 MOTORS

A. Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment" for general requirements for factory-installed motors.

B. Motor Construction: NEMA MG 1, general purpose, continuous duty, high efficiency, Design B.

C. Enclosure Type: Open dripproof or totally enclosed, fan cooled as required for fan style.

2.6 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment.

D. 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.

3.3 FIELD QUALITY CONTROL

A. Equipment Startup Checks:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.
2. Measure and record motor voltage and amperage.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

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

E. Shut unit down and reconnect automatic temperature-control operators.

F. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

G. Replace fan and motor pulleys as required to achieve design airflow.

H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

3.5 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
3. Schedule training with Owner, through Architect, with at least seven days of advance notice.

END OF SECTION 23 34 23

SECTION 23 34 33 - COMMERCIAL AIR CURTAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commercial air-curtain unit.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air curtain units.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air curtain units to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Furnish one set of filters for each unit installed.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of air curtain units that fail in materials or workmanship within specified warranty period.

1. Warranty Period (Electric Heating Units): 18 months from date of substantial completion.

PART 2 - PRODUCTS

2.1 COMMERCIAL AIR-CURTAIN UNIT

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

1. Loren Cook Company.
2. Marley Engineered Products.
3. Mars Air Doors; Mars Air Systems.

B. Source Limitations: Obtain air curtain from single source from single manufacturer.

C. Housing:

1. Galvanized Steel: Galvanized steel with electrostatically applied, epoxy-enamel, powder-coat finish.
2. Discharge Nozzle: Integral to housing, containing adjustable air-directional vanes with 40-degree sweep front to back.

D. Mounting Brackets: Galvanized steel, for wall mounting.

E. Air-Intake Grilles:

1. Grilles: Integral to, and same material as, housing.

F. Fans:

1. Centrifugal, forward curved, double width, double inlet.
2. Galvanized steel.
3. Statically and dynamically balanced.
4. Direct drive.

G. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Variable speed.
3. Resiliently mounted.
4. Continuous duty.
5. Totally enclosed, air over.
6. Integral thermal-overload protection.
7. Bearings: Permanently sealed, lifetime, prelubricated, ball bearings.

8. Disconnect: Lockable disconnect.

H. Electric-Resistance Coils:

1. Coil Assembly: Comply with UL 1995.
2. Frame: Galvanized-steel frame.
3. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
4. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit.

    a. Secondary Protection: Manually reset thermal cutouts.

5. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:

    a. Magnetic contactor.
    b. Solid-state stepless pulse controller.
    c. Time-delay relay.
    d. Airflow-proving switch.

I. Filters:

1. Washable Panel Filters: Removable, aluminum, baffle-type filters with spring-loaded fastening; with minimum 0.0781-inch- thick, stainless steel filter frame.

J. Controls:

1. Automatic Door Switch: Combination roller-plunger type installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.
2. Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 0.5 seconds to 10 minutes
3. Operation: Automatic on when door is opened, off after time delay period after door is closed.
4. Motor-Control Panel: Complete with motor starter, 115-V ac transformer with primary and secondary fuses, terminal strip, and NEMA 250, Type 1 enclosure with built-in, variable fan-speed control.

K. Accessories:

1. Mounting Brackets: Adjustable mounting brackets for wall mounting.

2.2 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Aerodynamic Performance Rating: Test, rate, and label, air curtain units in accordance with AMCA 211.

B. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label, air curtain units in accordance with AMCA 311.

C. Comply with AHRI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine work areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION, GENERAL

A. Install air curtains with clearance for equipment service and maintenance.

B. Equipment Installation: Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 ADJUSTING

A. Adjust motor speed to achieve specified airflow.

B. Adjust discharge louver and dampers to regulate airflow.

C. Adjust air-directional vanes.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:

1. After installing air curtains completely, perform visual and mechanical check of individual components.
2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Air-curtain unit will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial air curtains.

END OF SECTION 23 34 33

SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections include the following:

1. Division 10 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
3. Division 23 Section "Testing, Adjusting, and Balancing" for balancing diffusers, registers, and grilles.

1.3 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

1.4 SUBMITTALS

A. Product Data: For each model indicated, include the following:

1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated. Other manufacturers' products with equal performance characteristics materials, size and aesthetics may be considered. Refer to Division 01 Section "Substitutions." NC levels must be equal to or less than those produced by the scheduled air device at the same design conditions.

B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

C. Source Quality Limitations: Obtain all diffusers, registers and grilles from single manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Diffusers, registers, and grilles are scheduled on Drawings.

B. Manufacturers:

1. Tuttle & Bailey.
2. Nailor Industries Inc.
3. Price.
4. Titus.

2.2 SOURCE QUALITY CONTROL

A. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

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 practicable. For units installed in lay-in ceiling panels,

locate units in the center of the panel. 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 connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 23 37 13

SECTION 23 74 00 – VENTILATION UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Packaged Ventilation Units and Make-up Air Unit.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air Ventilation Units and Make-up Air Unit equipment to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1. Filters: One set of each type of filter specified.
2. Fan Belts: One set of belts for each belt-driven fan in Ventilation Units and Make-up Air Unit.

1.6 QUALITY ASSURANCE

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

B. ARI Compliance:

1. Capacity ratings for air-to-air Ventilation Unit equipment shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Ventilation Unit Ventilation Equipment."
2. Capacity ratings for air coils shall comply with ARI 410, "Forced-Circulation Air- Cooling and Air-Heating Coils."

C. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air Ventilation Unit equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance:

1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815.

1.7 COORDINATION

A. Coordinate layout and installation of Ventilation Units and Make-up Air Unit equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air Ventilation Units and Make-up Air Unit equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Packaged Ventilation Units and Make-up Air Units: Two years.
2. Provide five year extended warranty for compressors.
3. Provide five year heat exchanger limited warranty.

PART 2 - PRODUCTS

2.1 PACKAGED VENTILATION UNIT

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

1. Trane.
2. Aaon.
3. Carrier.
4. Daikin.

B. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Housing: Wall and roof panels shall be acoustical type and consist of 2 inch thick (min.) dual wall 20 gauge galvanized solid exterior skins and 20 gauge galvanized steel solid interior skins enclosing 2 inch thick foam insulation with a minimum U-value of, 0.24 per inch (minimum equivalent R-value equal to R-12). Center wall and fan wall construction shall be the same as the exterior panel construction with a minimum thickness of 2". A painted structural steel base shall support the housing. The base includes a solid welded, water tight, epoxy painted 12-gauge floor with 2" thick foam insulation (minimum equivalent R-value equal to R-12). Lifting lugs shall be welded to the structural base.

1. Outdoor air intake openings shall have galvanized steel sheet metal hoods with openings covered with bird screen.
2. Unit shall be provided with a weather-resistant baked enamel finish. The unit's surface shall be in compliance with ASTM B45 salt spray testing at a minimum of 672 hour duration.
3. Provide a custom color for the exterior of the unit. The color will be selected by the architect.
4. Roof Curb 18" high spring isolated base per vibration control specification. Refer to contract documents for additional information.

D. Access: Access shall be provided through large hinged, tightly sealed doors or removable access panels. Access doors shall be constructed of the same materials as the unit casing. Access doors shall be a minimum of 18" wide with a minimum height of 66". When the unit plenum height is less than 66", the door shall be no shorter than the plenum height less 12" with the shortest door acceptable being 30" in height. Doors shall be provided with a minimum of two hinges and two door latches operable from both sides of the door to achieve maximum sealing. All doors shall open against the air pressure. Removable panels may be provided for heating and cooling coils.

E. Supply Fans: Direct drive plenum fans with spring isolators and flexible duct connections.

1. Performance - Fans shall be tested in accordance with AMCA 211 and AMCA 311 test codes for air moving devices and shall be guaranteed by the manufacturer to deliver rated published performance levels. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air.
2. Construction - Fans shall be designed without a scroll type housing and shall incorporate a non-overloading type backward inclined airfoil blade wheel, heavy-gauge reinforced steel inlet plate, structural steel frame, and shaft and bearings in the AMCA Arrangement 3 configuration to form a heavy duty integral unit.
3. Frame and Inlet Plate - Inlet plates shall be of heavy-gauge reinforced steel construction. The inlet plate incorporates a removable spun inlet cone designed for smooth airflow into the accompanying inlet retaining ring of the fan wheel.
4. Fan Wheel - Wheels shall have a spun non-tapered style blade-retaining ring on the inlet side to allow higher efficiencies over the performance range of the fan. The wheels shall be non-overloading type. The blades shall be securely welded, die-formed backward curved or airfoil type. All wheels shall be statically and dynamically balanced on precision electronic balancers to a level of G6.3 (per ANSI 2-19) or better.
5. Shaft - Shafts shall be AISI 1040 or 1045 hot rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed. All shafts must be dial indicated for straightness after the keyways are cut and straightened as required.
6. Bearings - Bearings shall be heavy duty, grease lubricated, antifriction ball or roller, self-aligning, pillow block type and selected for a minimum average bearing life (AFBMA L-50) in excess of 200,000 hours at the maximum fan RPM. All bearings shall be equipped with greasable zerk fittings and, where necessary, extended lube lines for easy access for re-lubrication.

7. Finish and Coating - The entire fan assembly, excluding the shaft, shall be thoroughly degreased and deburred before application of a rust-preventative primer. After the fan is completely assembled, a finish coat of paint shall be applied to the entire assembly. The fan shaft shall be coated with a petroleum-based rust protectant. Aluminum components shall be unpainted.
8. Factory Run Test - All fans prior to shipment shall be completely assembled and test run as a unit at the specified operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96 “Balance Quality and Vibration levels for Fans” to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings. Records shall be maintained and a written copy shall be available upon request.
9. Motors and Guards - Fan motors shall be standard NEMA frame, inverter duty, high efficiency, with 1.15 service factor and open drip-proof TEFC enclosures. Protective guards shall enclose rotating fan and drive parts.
10. Fan Vibration Isolation - Fans assemblies shall have adjustable motor bases, motors and V-belt drives mounted with the assembly mounted on RIS isolators with flexible connections between fan and fan wall.
11. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
12. Inverter duty motors and a factory installed VFD shall be provided for supply fans.

F. Pre- Filters:

1. Comply with NFPA 90A.
2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
3. Factory-fabricated, viscous-coated, flat-panel type.
4. Thickness: 2 inches
5. Minimum Merv: 5 according to ASHRAE 52.2.
6. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
7. Frame: Stainless steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

G. Final Filters:

1. Comply with NFPA 90A.
2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
3. Factory-fabricated, viscous-coated, flat-panel type.
4. Thickness: 4 inches
5. Minimum Merv: 13 according to ASHRAE 52.2.
6. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
7. Frame: Stainless steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.
8. Filter gauge with control panel readout and alarm.

H. Cooling-Coil Condensate Drain Pans:

1. Fabricated from stainless-steel sheet and sloped in multiple planes to collect and drain condensate from cooling coils, coil piping connections, coil headers, and return bends.

2. Complying with requirements in ASHRAE 62.1.
3. Drain Connections: At low point of pan with threaded nipple.
4. Units with stacked coils shall have an intermediate drain pan to collect and drain condensate from top coil.
5. Insulation: 1” thick foam.

I. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.

1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
2. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
3. Include disconnect switches.

J. Accessories:

1. Low-Leakage, Isolation Dampers: Double-skin, aluminum airfoil-blade, Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.
2. Damper shall have modulating electric actuators with an integral limit switch.
3. Dampers shall be TAMCO 900SC series with aluminum construction, insulated blades, frame with thermal break and silicone blade gaskets or equivalent.

2.2 REFRIGERANT COILS

A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label. Coils shall be factory leak test in accordance with ANSI/ASHRAE 15-1992 at a minimum pressure of 500 psig.

B. Coil Casing Material: Galvanized or stainless steel.

C. Tube Material: Copper.

D. Tube Header Material: Copper.

E. Fin Material: Aluminum.

F. Fin and Tube Joints: Mechanical bond.

G. Leak Test: Coils shall be leak tested with air underwater.

H. Refrigerant Coil Capacity Reduction: Circuit coils for face control.

I. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.

J. Coating: Phenolic epoxy corrosion-protection coating after assembly.

K. Outdoor-Air Refrigerant Coil:

1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

3. Baked phenolic coating.

L. Hot-Gas Reheat Refrigerant Coil:

1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan. To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and hot gas reheat coil face shall be separated by a minimum of six inches.
3. Baked phenolic coating.

2.3 REFRIGERATION SYSTEM

A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."

B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.

A. Compressors: One Variable Speed compressor (or digital scroll) with integral, rubber vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater. Remaining compressors shall be scroll type provided with the same components. Provide each circuit with automatic reset high and low pressure and high temperature switches for safety control.

B. Refrigerant: R-134a or R-410A.

1. Classified as Safety Group A1 according to ASHRAE 34.
2. Provide unit with operating charge of refrigerant.

C. Refrigeration System Specialties:

1. Expansion valve with replaceable thermostatic element.
2. Refrigerant dryer.
3. High-pressure switch.
4. Low-pressure switch.
5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
6. Brass service valves installed in discharge and liquid lines.
7. Hot gas reheat.

D. Capacity Control:

1. Hot-gas bypass control with zero to 100 percent modulating capacity control using hot-gas bypass. Evaporator coil shall be continuously active for dehumidification.
2. Variable speed lead compressor (or digital scroll as noted above.)

E. Condenser Fan Assembly:

1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
2. Fan Safety Guards: Steel with corrosion-resistant coating.

F. Safety Controls:

1. Compressor motor and condenser coil fan motor low ambient lockout.

2. Overcurrent protection for compressor motor.

2.4 INDIRECT-FIRED GAS FURNACE

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and NFPA 54, "National Fuel Gas Code."

1. AGA Approval: Designed and certified by and bearing label of AGA.
2. Burners: Aluminized steel with stainless-steel inserts.

a. Gas Control Valve: Modulating 10:1.
b. Fuel: Natural gas.
c. Minimum Combustion Efficiency: 80 percent.
d. Ignition: Electronically controlled electric spark with flame sensor.

B. Venting: Gravity vented.

C. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

D. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly. Inlet hood shall include a bird screen.

E. Outside Unit External Housing: Weatherproof steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.

1. External Casing and Cabinet Finish: Baked enamel over corrosion-resistant-treated surface in color to match fan section.

F. Internal Casing: Aluminized steel, arranged to contain airflow, with duct flanges at inlet and outlet.

G. Heat Exchanger: Stainless Steel.

H. Heat-Exchanger Drain Pan: Stainless steel.

I. Safety Controls:

1. Vent Flow Verification: Flame rollout switch.
2. Control Transformer: 24-V ac.
3. High Limit: Thermal switch or fuse to stop burner.
4. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
5. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
6. Gas Manifold: Safety switches and controls to comply with ANSI standards and IRI.
7. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
8. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
9. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.5 VARIABLE FREQUENCY CONTROLLER

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

1. ABB.
2. Baldor Electric Company.
3. Danfoss Inc.; Danfoss Drives Div.
4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
5. Square D; a brand of Schneider Electric.

B. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

1. Provide unit suitable for operation of standard-efficiency motor as defined by NEMA MG 1.
2. Provide a filter on the incoming power to each variable frequency controller matched to the controller style and operating characteristics to prevent passage of any harmonics through any building electrical systems.

C. Design and Rating: Match load type to fans and type of connection used between motor and load such as direct or through a power-transmission connection.

D. Output Rating: 3-phase; 0 to 150 Hz.

E. Unit Operating Requirements:

1. Input ac voltage tolerance of 208 V, plus or minus 10 percent and 380 to 480 V, plus or minus 10 percent.
2. Input frequency tolerance of 47 Hz to 63 Hz.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 98 percent.
5. Overload Capability: 1.0 times the base load current for 60 seconds; 1.5 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

F. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

G. Internal Adjustability Capabilities:

1. Minimum Speed: 3 percent of maximum rpm.
2. Maximum Speed: 150 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

H. Self-Protection and Reliability Features:

1. EMI / RF Filters, Line Impedance with DC Choke to prevent harmonics within the system and in adjacent systems.
2. Input transient protection by means of surge suppressors.

3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
4. Motor Overload Relay: Adjustable and capable of NEMA 250 performance.
5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
6. Instantaneous line-to-line and line-to-ground overcurrent trips.
7. Loss-of-phase protection.
8. Reverse-phase protection.
9. Short-circuit protection.
10. Motor overtemperature fault.

I. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

J. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

K. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

L. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

M. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer.

O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

P. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

    a. 0 to 10-V dc.
    b. 0-20 or 4-20 mA.
    c. Potentiometer using up/down digital inputs.
    d. Fixed frequencies using digital inputs.
    e. RS485.
    f. Keypad display for local hand operation.

3. Output Signal Interface:

    a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

        1) Output frequency (Hz).
        2) Output current (load).
        3) DC-link voltage (VDC).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

    a. Motor running.
    b. Set-point speed reached.
    c. Fault and warning indication (overtemperature or overcurrent).
    d. PID high- or low-speed limits reached.

Q. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BAS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

R. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

S. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

T. Isolating Switch: Non-load-break switch arranged to isolate VFC and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

U. NEMA 250, Type 1 enclosure.

V. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.

3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

W. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

X. Provide factory start-up and perform all tests stated in NETA ATS.

Y. All variable frequency controllers shall be located within the building and not at or within equipment which is outside the building thermal envelope.

2.6 SEQUENCE OF OPERATION

A. The unit (VU-1 and VU-2) shall include factory sensors pre-wired to the factory mounted control panel for operation of all internal components. A remote mounted LCD touchscreen interface shall be provided and installed in the First Floor NRC Mechanical Room A110 (for VU-1) and First Floor NRC Housekeeping A156 (for VU-2).

1. The Ventilation Unit shall operate to deliver “space neutral” air to the facility using the most energy efficient energy management sequence possible. The system shall modulate the gas heater and DX cooling with hot gas reheat to dehumidify and temper the 100% outside air stream to the facility. The unit shall perform all operating functions using the factory provided controller. The unit mounted fan VFDs shall operate with constant volume operation and be utilized for system balancing. The VU factory mounted control panel shall provide (at a minimum) the following command, status and alarm control points: System Enable (on/off); Setpoint Adjustment (Discharge Air and Discharge Humidity); Fan Status; Fan Speed (Hz); Discharge Air Temperature; Discharge Air Humidity; Outside Air Temperature; Stages of Cooling Operating; Reheat Operating Point; Dirty Filter; and General Unit Alarm.
2. The Ventilation Unit shall operate continuously with on-off-auto DDC controls and automatic start. The unit will be energized after opening the outdoor air damper 100%. The damper end switch will allow the unit fan to run.
3. At outside air temperatures below minus 10 degrees the unit shall shut down, close all dampers and alarm to the panel. The unit shall automatically initiate operation on a rise above minus 5 degrees.
4. The outside air temperature (OAT) shall be used to index the system between four operating modes: Heating, Cooling, Economizer and Dehumidification. During operation the unit shall operate on discharge air temperature and space dehumidification controls.
5. Heating Mode

    a. On an OAT of 69deg. F or lower (adj.), heating mode shall be enabled.
    b. On an OAT of 71deg. F or higher (adj.), heating mode shall be disabled.
    c. During the Dehumidification and Cooling Modes the heating coil shall be disabled.
    d. The gas heat shall modulate to maintain the discharge air temperature (DAT) setpoint of 72 deg. F (adj.).
    e. The discharge air temperature setpoint shall be compared to the discharge air temperature to reset the gas heater control valve.

6. Cooling Mode

    a. On an OAT of 80deg. F or higher (adj.), cooling mode shall be enabled.
    b. On an OAT of 78 deg. F or lower (adj.), cooling mode shall be disabled.

c. During the Heating Mode the cooling functions shall be disabled.
d. The DX cooling shall modulate to maintain the discharge air temperature (DAT) setpoint of 72 deg. F (adj.).
e. The discharge air temperature setpoint shall be compared to the discharge air temperature to reset the compressor modulation.

7. Economizer Mode

a. On an OAT from 70 deg. F to 79 deg. F (adj.), economizer mode shall be enabled.
b. On an outside relative humidity of 55% or higher (adj.), economizer mode shall be disabled.
c. During Economizer Mode both the Heating Mode and Cooling Mode functions shall be disabled.

8. Dehumidification Mode

a. Dehumidification mode shall override Heating Mode, Cooling Mode and Economizer Mode.
b. The DX cooling and hot gas reheat shall be modulated to maintain a space setpoint of 50% RH (adj.).
c. At a space humidity of 52% RH or higher (adj.), the DX cooling shall modulate to begin dehumidification. If the space humidity falls to 50% RH or lower (adj.), dehumidification shall be disabled.
d. During dehumidification operation the reheat coil shall be modulated to maintain a DAT of 75 deg. F (adj.). The discharge air temperature setpoint shall be compared to the discharge air temperature to modulate the refrigerant valve position.

9. Outside Air Damper Control

a. When the unit is commanded to run, the controller will command the outside air damper to open. The supply fan will not be permitted to operate until the outside air damper end switch indicates the damper open.
b. If a damper proof indicates the damper command and the damper end switch status have not matched for at least 150 seconds (adj.), the controller will generate an alarm and disable the unit. The unit will remain disabled until a manual reset has been initiated by the end-user.
c. If a damper open command is on and the damper status has indicated that the damper is open for 5 seconds (adj.), the controller will indicate that the damper is open.
d. The controller will generate a hand operation alarm if the damper is commanded closed and the damper status indicates the damper is open.
e. The controller will require that both the damper open command and the damper status indicate that the damper is operating normally for 10 seconds (adj.), before cleaning the alarm.

10. Supply Fan Control

a. When the unit is commanded to run and the outside air damper end switch indicates the damper is open, the controller will command the supply fan to start.
b. If a fan proof indicates the signal to the fan and the fan status feedback from the fan has not matched for at least 30 seconds (adj.), the controller will generate an alarm and disable the unit. The unit will remain disable the unit. The unit will remain disabled until a manual reset has been initiated by the end-user.
c. If a run signal is on and the fan status has indicated that the unit has air flow for 5 seconds (adj.), the controller will indicate that the fan has flow.

d. The controller will generate a hand operation alarm if the run signal commands the fan off and the fan status indicates the fan is running.
e. The controller will require that both the fan enable signal and the fan status indicate that the fan is operating normally for 10 seconds (adj.) before clearing an alarm.

11. Safeties:

a. Fail Safe Positions:
Outside Air Damper: Closed
Gas Heater: Off
b. If a low temperature thermostat, located on the discharge side of the coil is in alarm (temperature falls below 36 deg F) the controller will generate an alarm and, via hard wire interlock, shut down the supply fan and position all damper actuators to their fail safe positions. This safety sequence will also be commanded in the unit's controller software. An alarm will be sent to the remote panel.
c. If the supply air duct smoke detector is in alarm, the controller will generate the respective alarm and, via hardwire interlock, shut down the supply air fan. The controller will also position all damper actuators to their fail safe positions.
d. If the condensate pan level switch is in alarm, the controller will generate an alarm and, via hard wire interlock, disable all stages of DX cooling. This safety sequence will also be commanded in the unit's controller software.
e. A current sensing relay will provide proof that the unit is running when energized and will send an alarm to the control panel upon failure.
f. The equipment-mounted smoke detectors will deactivate the system upon detection of smoke.

12. Temperature and humidity sensors shall be located in appropriate locations throughout the unit for proper unit control. A freezestat shall be included. Pressure transducers shall be included to display filter loading. Pressure transducers are included to display fan airflow. Current transformers are included for fan status.
13. All controls for the unit shall be rated for operation to minus 10 degrees F or shall be remotely located within the building thermal envelope.

B. The unit (MAU-1) shall include factory sensors pre-wired to the factory mounted control panel for operation of all internal components. A remote mounted LCD touchscreen interface shall be provided and installed in the First Floor NRC Mechanical Room A110.

1. MAU-1 shall be interlocked with EF-4 and the hood operation.
a. The grease exhaust fan shall be started automatically via a heat detection device mounted in the grease exhaust hood or manually with a single switch at the kitchen hood to initiate operation. The automatic operation via the heat detector will over-ride the manual switch at the hood.
b. An interlock shall be provided to activate the make-up air unit operation automatically upon operation of the grease exhaust fan. When the kitchen grease exhaust fan is automatically or manually started at the hood, the associated supply-air fan motorized intake damper will open. When the intake damper is proven open by an electric end-switch the supply fan will start.
c. The normally closed safety shutoff gas valve will be interlocked with the kitchen grease exhaust fan and will be installed on the gas line in an accessible location. The safety shutoff gas valve shall open only when the kitchen grease exhaust fan is activated.
d. The normally closed safety shutoff gas valve will also be interlocked with the grease exhaust hood fire protection system and fail closed upon activation of the hood fire suppression system.

e. A direct digital, terminal equipment controller with temperature sensor located on the MAU discharge will provide input to modulate the gas firing rate and digital scroll compressor to maintain a constant discharge temperature of 65 deg. F (adj.) during heating mode and 70 deg. F (adj.) during cooling mode. A space mounted discharge temperature reset controller shall be provided for local adjustment of the discharge air temperature setpoint.

f. The MAU shall utilize the digital scroll compressor and hot gas reheat to provide a discharge air condition of 70 degrees and 50% RH (adj.) during dehumidification mode.

g. The MAU shall implement an enthalpy based economizer mode to minimize cooling operation when OSA can provide leaving air conditions between 65 and 70 deg F (adj). dehumidification shall override economizer operation.

h. A signal from the building fire alarm system shall de-energize the supply fan upon an alarm condition. A low temperature detector on the heating coil discharge will de-energize the supply fan should a temperature below 36 deg. F (adj.) be sensed. During either a fire alarm condition or freeze-stat condition the outside air damper shall close and the unit shall terminate operation. The exhaust fan shall continue to operate in both conditions.

i. When the kitchen exhaust fan is manually stopped at the hood the exhaust fan shall stop and the associated supply fan intake damper will close and the supply fan will stop.

j. MAU-1 and EF-4 system shall be interfaced with the exhaust hood control system for variable speed operation. Minimum speed thresholds shall be programmed to prevent each system and their respective equipment from operating below 50% (adj.) of the airflow design capacity.

k. Safeties:
   1) Fail Safe Positions:
      Outside Air Damper: Closed
      Gas Heater: Off
   2) If a low temperature thermostat, located on the discharge side of the coil is in alarm (temperature falls below 36 deg F) the controller will generate an alarm and, via hard wire interlock, shut down the supply fan and position all damper and valve actuators to their fail safe positions. This safety sequence will also be commanded in the unit's controller software. An alarm will be sent to the panel.
   3) If the supply air duct smoke detector is in alarm, the controller will generate the respective alarm and, via hardwire interlock, shut down the supply air fan. The controller will also position all damper actuators to their fail safe positions.
   4) If the condensate pan level switch is in alarm, the controller will generate an alarm and, via hard wire interlock, disable cooling. This safety sequence will also be commanded in the unit's controller software.
   5) A current sensing relay will provide proof that the unit is running when energized and will send an alarm to the control panel upon failure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air Ventilation Unit equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Equipment Mounting: Install air-to-air Ventilation Unit and Make-up Air Unit equipment on spring isolated base. Refer to specification section 230548.

B. Roof Curb: Install air-to-air Ventilation Unit and Make-up Air Unit equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure air-to-air Ventilation Unit and Make-up Air Unit equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

C. Unit Support: Install unit level. Coordinate penetrations and flashing with wall and roof construction. Secure air-to-air Ventilation Unit and Make-Up Air Unit equipment to structural support with anchor bolts.

D. Install units with clearances for service and maintenance.

E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

F. Pipe drains from drain pans to adjacent grade, use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection.

3.3 CONNECTIONS

A. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

B. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

C. Install electrical devices furnished with units but not factory mounted.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to start-up, inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Air-to-air Ventilation Unit and Make-up Air Unit equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air Ventilation Units and Make-up Air Units.

END OF SECTION 23 74 00

SECTION 23 8113 - PACKAGED TERMINAL HEAT PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes packaged terminal heat pumps and their accessories and controls, in the following configurations:

1. Vertical heat pump units with electric heat.
2. Packaged through wall heat pump units with electric heat.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: For packaged terminal heat pumps. Include plans, elevations, sections, details for wall penetrations, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: See Special Warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged terminal heat pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

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

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

D. IECC Compliance: All efficiencies of equipment must meet the 2015 IECC requirements.

1.6 COORDINATION

A. Coordinate layout and installation of packaged terminal heat pumps and wall construction with other construction that penetrates walls or is supported by them.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged terminal air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Substantial Completion, including components and labor.
2. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than five years from date of Substantial Completion, including only components and excluding labor.
3. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Friedrich (Applies to VTHPs and PTHPs)
2. Amana (Applies to VTHPs Only)
3. First Company (Applies to VTHPs Only)

2.2 VERTICAL TERMINAL HEAT PUMPS

A. Description: Factory-assembled and -tested, self-contained, packaged, terminal heat pump with room cabinet, electric refrigeration system, electric heat, and temperature controls; fully charged with refrigerant and filled with oil; with hard-wired chassis.

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

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASHRAE Thermal Comfort: Applicable requirements in ASHRAE 55.

F. UL listed and ETL performance certified.

G. Units must comply with energy efficiency criteria of the 2015 International Energy Conservation Code.

H. Note: Units shall be provided without outside air intake or shall have outside air intake opening permanently fixed in the closed position.

2.3 CHASSIS

A. Cabinet: 0.052-inch- thick steel with removable front panel with concealed latches.

1. Mounting: Floor with subbase.
2. Vertical arrangement with duct connections for supply air. Return air shall be non-ducted.
3. Louver: Extruded-aluminum architectural wall louver. Color shall be selected by Architect.
4. Finish: Baked enamel.
5. Access Door: Front of unit with removable panels.
6. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1. Entire unit shall be rated for return air plenum installation.
7. Wall Sleeves: Galvanized steel with baked enamel finish. Plenum shall be black in color for minimal visibility of unit from exterior of building.

B. Refrigeration System: Direct-expansion indoor coil and hermetically sealed scroll compressor with vibration isolation and overload protection.

1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins with capillary tube distributor on indoor coil.
2. Accumulator.
3. Constant-pressure expansion valve.
4. Reversing valve.
5. Charge: R-410A.

C. Indoor Fan: Forward curved, centrifugal; with two speed motor.

D. Filters: Disposable MERV 8.

E. Condensate Drain: Sloped galvanized drain pain with bottom outlet.

1. Comply with ASHRAE 62.1 for drain pan construction and connections.

F. Corrosion Protection: The unit shall feature corrosion resistant materials and finish to help prevent deterioration.

G. Outdoor Fan: Propeller type with separate motor.

1. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

a. Fan Motors: Permanently lubricated split capacitor.
b. 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.
c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

H. Electric-Resistance Heating Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

I. Accessories

1. Factory mounted disconnect.
2. Condensate drain kit.
3. Wall Sleeve.
4. Condensate overflow switch.
5. Architectural Louver.
6. Support stand. (Factory or Shop Fabricated)

2.4 PACKAGED TERMINAL HEAT PUMPS

A. Description: Factory-assembled and -tested, self-contained, packaged terminal heat pump unit with cabinet, electric refrigeration system, electric heat, and temperature controls; fully charged with refrigerant and filled with oil; with cord-connected chassis.

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

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASHRAE Thermal Comfort: Applicable requirements in ASHRAE 55.

F. UL listed and ETL performance certified.

G. Units must comply with energy efficiency criteria of the 2015 International Energy Conservation Code.

2.5 CHASSIS

A. Cabinet: 0.052-inch- thick steel with removable front panel with concealed latches.

1. Mounting: Wall angle with wall sleeve.
2. Grille: Punched-louver discharge grille, tamperproof, and carrying a flame test rating in accordance with UL standard 494.
3. Finish: Baked enamel.
4. Access Door: Front of unit removable panels.
5. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Electrical Subbase: Enameled steel with four adjustable leveling feet and adjustable end plates, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit.
7. Wall Sleeves: Galvanized steel with baked enamel finish.

B. Refrigeration System: Direct-expansion indoor coil and hermetically sealed scroll compressor with vibration isolation and overload protection.

1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins with capillary tube distributor on indoor coil.
2. Accumulator.
3. Constant-pressure expansion valve.
4. Reversing valve.
5. Charge: R-410A.

C. Indoor Fan: Forward curved, centrifugal; with ECM motor.

D. Filters: Disposable MERV 8.

E. Condensate Drain: Sloped galvanized drain pain with bottom outlet.

1. Comply with ASHRAE 62.1 for drain pan construction and connections.

F. Outdoor Fan: Propeller type with separate motor.

1. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

a. Fan Motors: Permanently lubricated split capacitor.
b. 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.
c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

G. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

H. Accessories

1. Factory mounted disconnect.
2. Condensate drain kit.
3. Wall Sleeve.
4. Condensate overflow switch.
5. Decorative Subbase with power kit.
6. Support legs or stand. (Factory or Shop Fabricated)

2.6 CONTROLS

A. Control Module: Unit-mounted terminal strip with remote wall mounted Honeywell Touchscreen RTH7600D Programmable Thermostat in Public Areas and Honeywell T6 Pro Programmable Thermostat in the Resident Rooms. Include the following features:
1. Low Ambient Lockout Control: Prevents cooling-cycle operation below 40 deg F outdoor air temperature.
2. Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above 40 deg F and to supplemental heating below plus 25 deg F.
3. Temperature-Limit Control: Prevents occupant from exceeding preset setback temperature.
4. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup

5. Automatic-reset timer to prevent rapid cycling of compressor.
6. Thermostat to have cooling/heating/auto mode and on/off/auto fan controls. Color to be selected by Architect. Install thermostats and connect to VTHP and PTHP terminal strip or controller for control of heating and cooling operation and unit fan.

B. Outdoor Air: None for Vertical Terminal Heat Pumps. Intake opening shall not be included. A fixed plate with R-12 insulation closing the opening shall be installed in the factory.

C. Outdoor Air: Motorized intake damper for Packaged Terminal Heat Pumps as scheduled. If no, intake opening is scheduled a fixed plate with R-12 insulation closing the opening shall be installed in the factory.

2.7 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Factory test to comply with ARI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."

B. Unit Performance Ratings: Factory test to comply with ARI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.

B. For Vertical Terminal Heat Pumps install exterior louver in finished wall assembly; seal and waterproof.

C. For Vertical Terminal Heat Pumps install and anchor exterior louver to withstand, without damage to equipment and structure, seismic forces required by building code.

D. For Packaged Terminal Heat Pumps install wall sleeves in finished wall assembly; seal and weatherproof.

E. For Packaged Terminal Heat Pumps install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform the following test and inspections with the assistance of a factory-authorized service representative:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing packaged terminal heat pumps and after electrical circuitry has been energized, test for compliance with requirements.
3. Unit is level on base and is flashed in exterior wall.
4. Unit casing has no visible damage.
5. Compressor, air-cooled condenser coil, and fans have no visible damage.
6. Labels are clearly visible.
7. Controls are connected and operable.
8. Filters are installed and clean.
9. Drain pan and drain line are installed correctly.
10. Electrical wiring installation complies with manufacturer's submittal and installation requirements in electrical divisions.
11. Installation: Perform startup checks according to manufacturer's written instructions including the following:
    a. Lubricate bearings on fan.
    b. Check fan-wheel rotation for correct direction without vibration and binding.
12. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
13. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. After performance test, change filters.

D. Packaged terminal heat pumps will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged terminal air conditioners.

END OF SECTION 23 81 13

SECTION 23 81 20 – VARIABLE REFRIGERANT FLOW SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes split-type variable refrigerant flow systems and controls. The system shall utilize indoor terminal units with a refrigerant management system and outdoor air-cooled condenser to provide simultaneous heating and cooling to all terminal units within the system.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings for Refrigerant Piping System: Include plans, elevations, sections, details, and attachments to other work.

1. Detail all piping and accessories including equipment assemblies and indicate dimensions, components, and location and size of each field connections.

C. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

D. Warranty: Sample of special warranty.

E. Provide sequence of operation for review and comment.

1.4 QUALITY ASSURANCE

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

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007.

1.5 INSTALLATION REQUIREMENTS

A. The system must be installed by factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements.

B. The system installation shall be inspected a minimum of three times during the course of system construction by a trained and certified manufacturer's installation technician.

1.6 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of variable refrigerant air handling units and outdoor heat recovery units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Six years from date of Substantial Completion.
b. For Parts: One year from date of Substantial Completion.
c. For Labor: One year from date of Substantial Completion.

1.8 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. Filters: One set for each air-handling unit.
2. Fan Belts: One set for each air-handling unit fan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Daikin.
2. LG.
3. Mitsubishi.

2.2 SYSTEM DESCRIPTION

A. The variable capacity, multi-zone heat recovery air conditioning system shall consist of multiple evaporators, branch controller boxes, system compatible refrigerant joints and headers, a two or three pipe refrigeration distribution system and a direct expansion (DX), air-cooled heat recovery condensing units with variable speed inverter driven compressors using R-410A refrigerant.

B. Operation of the system shall permit individual cooling or heating of each indoor unit simultaneously.

C. Manufacturer is responsible for the entire refrigerant piping system design in accordance with the specified materials and installation requirements listed in Section 232300.

D. The VRF system scope shall consist of the provision of all labor, materials, piping, equipment, controls and appurtenances, even though these may not be specifically mentioned in this specification or on the drawings, which are required for a complete and fully functional variable refrigerant flow air conditioning and heating system.

E. Provide refrigerant access port tamper protection. Access port tamper protection shall be provided with locking caps to prevent unqualified personnel from removing or adding refrigerant from any portion of the VRF refrigerant system.

2.3 OUTDOOR HEAT RECOVERY UNITS

A. General: The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, strainers, check valves, shut off valves, oil separators, service ports and refrigerant regulator.

1. The following safety devices shall be included on the condensing unit: high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter, anti-recycling timers, oil management system, and automatic defrost cycles.
2. Manufacturer shall provide low ambient operation kit if required to meet scheduled performance of any individual or multiple terminal units. Note that each system will have individual terminal unit(s) under cooling operation in heating season during outdoor air temperatures below 0 Degrees.
3. Outdoor units shall not be loaded beyond 102% of their heating or cooling capacity when calculating the total connected load of the indoor terminal units. All outdoor units shall be capable of providing 100% of the rated heating capacity simultaneously for each terminal unit connected to an individual system while maintaining the minimum leaving air temperature as scheduled for each indoor terminal unit.
4. Units shall be provided with factory installed microprocessor based controls to efficiently operate the VRF system. The unit shall have the following sensors as standard:

    a. Suction temperature sensor.
    b. Discharge temperature sensor.
    c. High pressure sensor.
    d. Low pressure sensor.
    e. Outdoor temperature sensor.
    f. Outdoor unit heat exchanger temperature sensor.

B. Unit Cabinet:
1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from galvanized steel panels coated with a baked enamel finish. The unit panels shall be removable for access.

C. Fan:

1. The condensing unit shall consist of one or more vertical discharge propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The fan motor shall have inherent thermal overload protection and permanently lubricated bearings.
3. The fan motor shall be provided with a fan guard.

D. Condenser Coil:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins.

E. Compressor:

1. Hermetically sealed scroll type compressors. Compressors shall be inverter type, variable speed control and operation.
2. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, over and under current protection, phase failure and phase reversal protection, and internal thermal overload protector.
3. Oil separators shall be standard with the equipment together with an intelligent oil management system.
4. Compressors shall be spring mounted to avoid the transmission of vibration.

F. Electrical:

1. The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded, stranded 2 conductor cable.
2. The control wiring shall be a two-wire multiplex transmission system.

2.4 BRANCH CONTROLLERS

A. General:

1. The controller boxes shall be factory assembled, wired, and piped.

B. Unit Cabinet

1. These units shall have a galvanized steel plate casing.
2. Each cabinet shall house multiple refrigeration control valves and a liquid gas separator.
3. The unit shall have sound absorption thermal insulation material.

C. Refrigerant Valves:

1. The unit shall be furnished with electronic expansion valves to control the direction of refrigerant.

D. Accessories:

1. Integral Condensate Pump: Factory installed and wired condensate pump capable of minimum 21 inches of lift.
2. Condensate overflow switch.

2.5 INDOOR UNIT – HORIZONTAL DUCTED UNIT

A. General: Indoor unit shall be a built-in concealed fan coil unit, operable with refrigerant R410A, equipped with an electronic expansion valve, for installation either vertically or horizontally.

B. Indoor Unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an adjustable external static pressure switch.
2. The indoor units shall be equipped with a return air thermistor.

C. Unit Cabinet:

1. The cabinet shall be constructed of galvanized steel with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall be ECM type with thermal overload protection.

E. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be a minimum 3 row copper evaporator coil, completely factory tested.
3. The refrigerant connections shall be flare connections and the condensate will be 1 inch outside diameter PVC.
4. A condensate pan shall be located under the coil.
5. A thermistor will be located on the liquid and gas line.

F. Controls:

1. The unit shall contain a controller to perform all necessary functions required by the connected thermostat.

G. Accessories as scheduled and as follows:

1. Integral Condensate Pump: Factory installed and wired condensate pump capable of minimum 21 inches of lift.

2. Condensate overflow switch.

2.6 INDOOR UNIT – CEILING CASSETTE

A. General: The indoor unit shall be a ceiling cassette fan coil unit, operable with R410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grille. It shall be a 4-way air distribution type, ivory white, impact resistant, and washable concentric grille on the bottom of the unit. The supply air is distributed via motorized louvers which can be vertically adjusted from 0 degrees to 40 degrees.

B. Indoor Unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an adjustable external static pressure switch.
2. The indoor units shall be equipped with a return air thermistor.
3. The ceiling cassette assembly is provided with an off-white ABS polymeric resin architectural grille equipped with a tapered trim edge and a hinged, spring clip return air filter-grille door.

C. Unit Cabinet:

1. The cabinet shall be constructed of galvanized steel with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall be ECM type with thermal overload protection.

E. Filter:

1. Provide high efficiency filters.
2. Return air grille shall be removable, washable filter with anti-fungal treatment.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be a minimum 3 row copper evaporator coil, completely factory tested.
3. The refrigerant connections shall be flare connections and the condensate will be 3/4 inch outside diameter PVC.
4. A condensate pan shall be located under the coil.
5. A thermistor will be located on the liquid and gas line.

G. Controls:

1. The unit shall contain a controller to perform all necessary functions required by the connected thermostat.

H. Accessories as scheduled and as follows:

1. Integral Condensate Pump: Factory installed and wired condensate pump capable of minimum 21 inches of lift.
2. Condensate overflow switch.

2.7 CONTROLS

A. Individual Unit Control:

1. All indoor terminal units shall be provided with a surface mount, backlight LCD display, auto-changeover, 7-day programmable thermostat model number PAR-33MAA-J. Thermostats shall have independent cooling and heating set-point with adjustable deadband. Color shall be white. Thermostat shall be capable of connecting to a central building remote controller. The heat pump shall automatically switch between heating and cooling modes to meet the setpoint. The fan shall operate continuously to supply outside air to the space. The Thermostat display shall indicate the following functions:

a. On/off
b. Operation mode
c. Fan speed
d. Set point
e. Current room temperature
f. All other thermostat functions shall be hidden unless specifically requested by the Owner.

B. Central System Controller:

1. Central System Controller shall be Mitsubishi AE-200A Master Controller. This controller shall be wall mounted and hard wired to each of the terminal fan coil units and outdoor VRF units. It will be manufactured with color LCD touch panel display and will be the manufacturer’s standard color. The controller shall be capable of connecting all of the individual indoor units and all of the outdoor units with the following functions:

a. ON/OFF selection for each indoor unit or group.
b. Temperature set point adjustment for each indoor unit or group.
c. Fan speed adjustment for each indoor unit or group
d. Mode selection
e. Forced shutdown of indoor units
f. Priority setting for restriction of local access to start/stop, heat/cool mode and set point adjustment functions.
g. Temperature limitations in both heating and cooling mode.
h. Schedule adjustments
i. Reset of error codes and filter replacement warning

2. Each Intelligent controller unit shall be accessed remotely via standard web browser. Real time status, operation, and history shall be accessible. Malfunction reports shall be able to be sent via email when connected to the building local area network.
3. The controller shall include optional hardware for the addition of up to 8 digital inputs for the monitoring of other equipment located in the building.
4. Connectivity:

a. One (1) RJ-45 Ethernet port to support interconnection with a network PC
b. One (1) RS 232C port

c. One (1) PCMCIA Card Slot
d. Terminal block for 24V power supply
e. Terminal block for communication with the indoor heat pump units and outdoor condensing units.
f. Controller shall be provided with data drop connection to provide web browser access with passwords and standard security features.

C. Control Sequence

1. System shall operate on manufacturer provided unit mounted controls and system controller.
2. The factory mounted unit controller shall provide (at a minimum) the following command, status and alarm control points: System Enable (on/off), Setpoint Adjustment (Discharge Air Temperature); Fan Status; Discharge Air Temperature; Discharge Air Humidity; VRF Operating Mode and General Unit Alarm.

2.8 MOTORS

A. 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.

2.9 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate compressor and condenser units according to ARI 210/240.

B. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1-2004, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."

C. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install unit level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in in Division 3.

C. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

D. Vibration Isolation: Mount compressor and condenser units on restrained spring isolators with a minimum deflection meeting manufacturer's requirements. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.2 CONNECTIONS

A. Comply with requirements for piping in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

C. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

D. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping."

E. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts" Drawings indicate the general arrangement of ducts. Connect supply[and return] ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Inspect for physical damage to unit casing.
b. Verify that access doors move freely and are weathertight.
c. Clean units and inspect for construction debris.
d. Verify that all bolts and screws are tight.
e. Adjust vibration isolation and flexible connections.
f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

F. Measure and record airflow and air temperature rise over coils.

G. Verify proper operation of condenser capacity control device.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION 23 81 20

SECTION 23 81 26 - SPLIT-SYSTEM HEAT PUMP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes split-system heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system heat-pump units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Filters: One set(s) for each air-handling unit.

1.7 QUALITY ASSURANCE

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

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Daikin Industries.
2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
3. SANYO North America Corporation; SANYO Fisher Company.

2.2 INDOOR UNIT, WALL MOUNTED UNIT

A. General: The indoor unit shall be a wall mounted fan coil unit, operable with R410A refrigerant, equipped with an electronic expansion valve, for installation on a wall equipped with an air panel grille. It shall be a 1-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be vertically adjusted from 0 degrees to 90 degrees.

B. Indoor Unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan

motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21 inches of lift.
3. The indoor units shall be equipped with a return air thermistor.

C. Unit Cabinet:

1. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall contain thermal overload protection.

E. Filter:

1. Provide high efficiency filters.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design.
3. The coil shall be a 2 row cross fin copper evaporator coil with 17 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/4 inch outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 21 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.
8. Include a condensate overflow switch in unit.

G. Accessories:

1. A high efficiency air filter, 65% efficiency.

H. Controls:

1. The unit shall contain a controller to perform all the necessary functions required by the connected thermostat.

2. Provide manufacturer programmable wired wall thermostat. Thermostat shall be provided with a surface mount, backlight LCD display, auto-changeover, 7-day programmable thermostat model number PAR-40MAAU. Thermostats shall have independent cooling and heating setpoint with adjustable deadband. Color shall be white. The heat pump shall automatically switch between heating and cooling modes to meet the setpoint. The thermostat display shall indicate the following functions:

   a. On/Off
   b. Operation mode
   c. Fan speed

d. Set point
e. Current room temperature
f. All other thermostat functions shall be hidden unless specifically requested by the Owner.

2.3 INDOOR UNIT – CEILING CASSETTE

A. General: The indoor unit shall be a ceiling cassette fan coil unit, operable with R410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grille. It shall be a 4-way air distribution type, ivory white, impact resistant, and washable concentric grille on the bottom of the unit. The supply air is distributed via motorized louvers which can be vertically adjusted from 0 degrees to 40 degrees.

B. Indoor Unit:
1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an adjustable external static pressure switch.
2. The indoor units shall be equipped with a return air thermistor.
3. The ceiling cassette assembly is provided with an off-white ABS polymeric resin architectural grille equipped with a tapered trim edge and a hinged, spring clip return air filter-grille door.

C. Unit Cabinet:
1. The cabinet shall be constructed of galvanized steel with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:
1. The fan shall be direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall be ECM type with thermal overload protection.

E. Filter:
1. Provide high efficiency filters.
2. Return air grille shall be removable, washable filter with anti-fungal treatment.

F. Coil:
1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be a minimum 3 row copper evaporator coil, completely factory tested.
3. The refrigerant connections shall be flare connections and the condensate will be 3/4 inch outside diameter PVC.
4. A condensate pan shall be located under the coil.
5. A thermistor will be located on the liquid and gas line.

G. Controls:
1. The unit shall contain a controller to perform all necessary functions required by the connected thermostat.

H. Accessories as scheduled and as follows:
1. Integral Condensate Pump: Factory installed and wired condensate pump capable of minimum 21 inches of lift.

2. Condensate overflow switch.

2.4 OUTDOOR UNITS, AIR-COOLED, HEAT PUMP

A. Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Inverter duty.
    b. Two-speed compressor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant Charge: R-410A.
    d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 0 deg F.
7. Provide crankcase heater.
8. Mounting Base: Equipment Support Rails

B. Manufacturer is responsible for the entire refrigerant piping system design in accordance with the specified materials and installation requirements list in Section 23 23 00.

C. The split system scope shall consist of the provision of all labor, materials, piping, equipment, controls and appurtenances, even though these may not be specifically mentioned in this specification or on the drawings, which are required for a complete and fully functional split system air conditioning and heating system.

D. Provide refrigerant access port tamper protection. Access port tamper protection shall be provided with locking caps to prevent unqualified personnel from removing or adding refrigerant from any portion of the split system refrigerant system.

2.5 ACCESSORIES

A. Thermostat: Low voltage wall mounted to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Condensate Pump

E. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

D. Install roof-mounted, compressor-condenser components on Equipment Supports. Anchor units to supports with removable, cadmium plate fasteners.

3.2 CONNECTIONS

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

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 23 82 39 - ELECTRIC HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Forced Air Heaters.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, furnished specialties, and accessories.

B. Samples for Initial Selection: For units with factory-applied color finishes.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For electric radiators to include in maintenance manuals.

E. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 WARRANTY

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

1. Warranty Period: One year from date of Substantial Completion.

PART 2 PRODUCTS

2.1 FORCED AIR HEATERS

A. Manufacturers:

1. Qmark Electric Heating.
2. Marley Electric Heating; a United Dominion Company.
3. Trane.

4. Indeeco

B. Heating Elements: Enclosed in metallic sheath mechanically expanded into aluminum fins, with high-temperature cutout. Element supports eliminate thermal expansion noise.

C. Enclosures: Steel with exposed corners rounded; removable front panels with tamperproof fasteners braced and reinforced for stiffness.

1. Front and Top: 0.0598-inch- thick steel.
2. Back and Ends: 0.0478-inch- thick steel.
3. Insulation: 1/2-inch- thick, fibrous glass on inside at front, sides, and back of enclosure.
4. Finish: Factory-applied baked enamel in color selected by Architect from manufacturer's custom colors.
5. Enclosure Style: As specified.

D. Unit Controls: Integral line-voltage thermostat with range of 40 to 100 deg F or Integral low-voltage relay and control transformer for remote thermostat as specified.

1. Upon a drop below setpoint, 70°F (adj.), the heater, and fan when applicable, shall engage to meet the space setpoint.

E. Accessories:

1. Integral disconnect switch.
2. Fan of style specified.
3. Mounting frame (ceiling heaters).

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in to verify actual locations of electrical connections before equipment installation.

B. Examine walls for suitable conditions where electric heaters will be installed.

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

3.2 INSTALLATION

A. Install wall unit heaters to comply with HFPA 90A.

B. Install wall unit heaters level and plumb and according to the following, unless otherwise indicated:

1. Center units where shown on documents.
2. Terminate enclosures with manufacturer's end caps.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Specification Section 26 0526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Specification Section 26 0519 "Low-Voltage Electrical Power Conductors And Cables."

F. 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.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing and prepare test reports:

1. Operate electric heating elements through each stage to verify proper operation and electrical connections.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 82 39

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Common electrical installation requirements.

1.3 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 26 05 00

SECTION 26 05 01 - EQUIPMENT CONNECTIONS AND COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide final connections to equipment and coordinate same in accordance with the Contract documents.

B. Equipment to receive final connections shall include but not be limited to the following:

1. Motors and equipment.
2. Appliances.
3. Owner furnished equipment.

C. Drawings and general provisions of the Contract, including general and supplementary conditions and Division 01 specification sections, apply to this section.

D. Related work specified in Division 26.

1. Low-Voltage Electrical Power Conductors and Cables – Section 26 05 19.
2. Raceways and Boxes for Electrical Systems – Section 26 05 33.
3. Grounding and Bonding for Electrical Systems – Section 26 05 26.
4. Enclosed Switches and Circuit Breakers – Section 26 28 16.

E. Related work specified in other division of these specifications:

1. Motors.
2. FF&E Package.
3. Control Wiring.
4. Appliances.
5. Kitchen and Laundry Equipment.

1.2 QUALITY ASSURANCE

A. Prior to the submitting of bids, the Contractor shall familiarize himself with all conditions affecting the proposed installation of equipment requiring electrical connections and shall make provisions as to the cost thereof. Failure to comply with the intent of this paragraph shall in no way relieve the Contractor of performing all necessary work required for final electrical connections and equipment and the coordination thereof.

B. Connections and overcurrent protection devices shall be in accordance with the manufacturer’s recommendations and approved shop drawings.

PART 2 - PRODUCTS

2.1 Only those products listed in Division 26 shall be employed.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Connections for and coordination of motors and equipment requiring electrical connections shall include but not be limited to the following:

1. Provide and install a disconnect switch for each motor and each piece of equipment, except where combination starter/disconnects or disconnects integral to equipment are provided by mechanical or plumbing contractor. Provide disconnects where required by code.
2. Verify that the motor rotation is correct and reconnect if necessary.
3. Provide separate ground wires in flexible, metal conduit and non-metallic conduit so as to provide an electrically continuous ground path. Ground all equipment.
4. Provide motor branch circuit conductors and connections to each individual motor controller and from each controller to the motor through an approved disconnect switch. Make final connection per Division 26 Section “Raceways and Boxes for Electrical Systems”.
5. Where equipment is fed from branch circuit routed in or under the slab, terminate branch circuit at junction box on 2 foot rigid conduit stub-up and make final connection to equipment per Division 26 Section “Raceways and Boxes for Electrical Systems”. Provide suitable knee brace on conduit stub-up.
6. Where equipment is fed from overhead support conduit feeder descending from ceiling on flanged floor fitting with conduit type fitting connecting to motor. Make connection per Division 26 Section “Raceways and Boxes for Electrical Systems”.
7. Where nameplate on equipment indicates fuse protection the disconnecting means shall be equipped with dual element fuses.

3.2 APPLIANCES

A. Connections for and coordination of appliances shall include but not be limited to the following:

1. The basic requirements for motors and equipment specified above shall apply where applicable.
2. Where cord and plugs are provided with the appliances the Contractor shall coordinate the receptacle installation to match.
3. Direct connected equipment shall be serviced by disconnecting means.

B. Where cord and plug connections are required but not provided with the appliance this contractor shall coordinate the cord and plug and receptacle installation with the appliance supplier.

3.3 KITCHENS

A. The Contractor shall make final electrical connections to all kitchen equipment.

3.4 ELECTRICAL/MECHANICAL COORDINATION

A. Refer to Division 23 specification section 23 05 00 for electrical service requirements for equipment connections.

B. Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place and wired by the Division 23 contractor. Contractor should note that the intent of this wiring schedule is to have the Division 23 contractor responsible for coordinating all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specification. Comply with the applicable requirements of Division 23 for electrical work of this Division 26 which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Division 26 Contractor shall refer to the Division 23 specifications and plans for all power wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

C. All starters, other than those noted on the Drawings, shall be furnished under Division 23. All starters furnished under Division 23 shall be complete with three overload heaters and shall conform to NEC and NEMA requirements. All starters shall have 65,000 AIC rating.

D. Control relays and control transformers shall be furnished under Division 23 except where furnishing such items are specifically required under Division 26 Specifications and/or Drawings.

E. Switches carrying full load current are to be wired under Division 26 of the work.

F. Exhaust Fans: The electrical contractor under Division 26 of the work shall furnish and install circuits, feeders and disconnect switches, and make all connections to motors and controls unless interlocked with other mechanical equipment or lights in locations indicated. Where exhaust fans are switched with lights, a two-pole toggle switch will be provided under Division 26. Where exhaust fans are interlocked with other mechanical equipment, the interlock wiring will be furnished by the mechanical contractor under Division 23.

G. Electrical contractor shall provide disconnects for all starters and variable frequency drives. Electrical contractor shall provide disconnects at the equipment if it is not in line of sight of starter disconnect.

H. Contractor provides control wiring to fire alarm panel and from fire alarm panel to mechanical unit.

I. All temperature control conduit and wiring shall be furnished and installed under Division 23. All motorized damper equipment shall be furnished and installed under Division 23. 120 volt power wiring shall be by Division 26.

END OF SECTION 26 05 01

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Building wires and cables rated 2000 V and less.
2. Connectors, splices, and terminations rated 2000 V and less.

B. Related Requirements:

1. Section 27 15 00 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

A. VFC: Variable-frequency controller.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. Alpha Wire.
2. Belden Inc.
3. Encore Wire Corporation.
4. General Cable Technologies Corporation.
5. Southwire Incorporated.

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

C. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable used in VFC circuits.

E. Conductors: Aluminum and Copper, complying with NEMA WC 70/ICEA S-95-658.

1. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2, Type XHHW-2, and Type SO.

F. Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC, mineral-insulated, metal-sheathed cable.

G. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for hospital-grade armored cable, Type AC with ground wire.

2.2 CONNECTORS AND SPLICES

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

1. 3M Electrical Products.
2. AFC Cable Systems; a part of Atkore International.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. O-Z/Gedney; a brand of Emerson Industrial Automation.
6. TE Connectivity Ltd.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders smaller than No. 1 AWG; copper or aluminum for feeders No. 1 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Provide copper conductors for feeders No. 1 AWG and larger if required by the equipment manufacturer to maintain UL ratings

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Minimum wire size shall be #12 AWG.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in metallic raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces subject to physical damage: Type THHN/THWN-2, single conductors in metallic raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in metallic raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in metallic raceway or Type MC, metal clad cable.

Note: Hospital grade MC cable shall be used for all branch circuit wiring in the Beauty Shop, the Multi-Purpose Room, and the Patient Room.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. Feeders have been sized to limit voltage drop to 2%. The Contractor shall increase branch circuit conductors, as required, to limit voltage drop in each branch circuit to 3%.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."

C. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

3.4 CONNECTIONS

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

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

D. All wiring connections made at or below grade shall be waterproof with UL listed waterproof connectors.

3.5 IDENTIFICATION

A. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.

2. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
b. Inspect compression applied connectors for correct cable match and indentation.
c. Inspect for correct identification.
d. Inspect cable jacket and condition.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:
   1. Foundation steel electrodes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

   1. Burndy; Part of Hubbell Electrical Systems.
   2. ERICO International Corporation.
   3. Galvan Industries, Inc.; Electrical Products Division, LLC.
   4. Harger Lightning & Grounding.
   5. ILSCO.
   6. O-Z/Gedney; a brand of Emerson Industrial Automation.
   7. Siemens Power Transmission & Distribution, Inc.

2.2 SYSTEM DESCRIPTION

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled 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 for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

I. Straps: Solid copper, copper lugs. Rated for 600 A.

J. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

K. Water Pipe Clamps:

1. Mechanical type, two pieces with zinc-plated bolts.

   a. Material: Tin-plated aluminum.
   b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches below grade.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Health Care Facilities, Patient Care Areas: Provide additional grounding per NEC Article 517.13 for all patient care areas of NRC including the Beauty Shop, Multi-Purpose Room and Patient Room.

C. Health Care Facilities, Panelboards: Where normal and critical branch circuits serve the same individual patient vicinity, bond panels as required by NEC 517-14.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

C. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

D. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 05 26

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems; a part of Atkore International.
2. Allied Tube & Conduit; a part of Atkore International.
3. Anamet Electrical, Inc.
4. Calconduit.
5. FSR Inc.
6. Korkap.
7. Opti-Com Manufacturing Network, Inc (OMNI).
8. O-Z/Gedney; a brand of Emerson Industrial Automation.
9. Perma-Cote.
10. Picoma Industries, Inc.
11. Republic Conduit.
12. Southwire Company.
13. Thomas & Betts Corporation; A Member of the ABB Group.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. FMC: Comply with UL 1; zinc-coated steel or aluminum.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

a. Material: Steel.
b. Type: Set-screw for conduits less than 2” and compression type for conduits 2” or larger.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

I. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems; a part of Atkore International.
2. Anamet Electrical, Inc.
3. Arnco Corporation.
4. CANTEX INC.
5. Condux International, Inc.
6. Electri-Flex Company.
7. Kraloy.
8. Lamson & Sessions.
9. Niedax Inc.
10. RACO; Hubbell.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. LFNC: Comply with UL 1660.

E. RTRC: Comply with UL 1684A and NEMA TC 14.

F. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

G. Fittings for LFNC: Comply with UL 514B.

H. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. B-line, an Eaton business.
2. Hoffman; a brand of Pentair Equipment Protection.
3. MonoSystems, Inc.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, NEMA Type 1 for interior and NEMA Type 3R for exterior unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

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

1. Crouse-Hinds, an Eaton business.
2. FSR Inc.
3. Hoffman; a brand of Pentair Equipment Protection.
4. Hubbell Incorporated.
5. O-Z/Gedney; a brand of Emerson Industrial Automation.
6. RACO; Hubbell.
7. Spring City Electrical Manufacturing Company.
8. Thomas & Betts Corporation; A Member of the ABB Group.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Metal Floor Boxes:

1. Material: Steel.

2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. FSR FL-500P or approved equal.

F. 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.

G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

L. Gangable boxes are prohibited.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, NEMA Type 1 for interior and NEMA Type 3R for exterior with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:

1. NEMA 250, NEMA Type 1 for interior and NEMA Type 3R for exterior galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

O. Exterior Building-Mounted Boxes: Arlington Industries InBox series with clear cover, or approved equal flush-mounted box. Provide box type and depth appropriate for exterior cladding application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.
2. Concealed Conduit, Aboveground: GRC or IMC.
3. Underground Conduit: RNC, Type EPC-40-PVC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:

    a. Loading dock.
    b. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use set screw for conduits less than 2” and compression type for conduits 2” or larger, steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Arrange stub-ups so curved portions of bends are not visible above finished slab.

D. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

E. Support conduit within 12 inches of enclosures to which attached.

F. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed thread less fittings in concrete.

G. Stub-ups to Above Recessed Ceilings:

1. Use EMT for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

I. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

J. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

K. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

L. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

N. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

O. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

P. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Q. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

R. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

S. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements.

T. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

U. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

V. Locate boxes so that cover or plate will not span different building finishes.

W. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

X. Set metal floor boxes level and flush with finished floor surface.

Y. Where installed in fire-rated partitions, apply firestop putty pads or similar fire rated products on or around outlet boxes as required to maintain the fire rating of the partition.

Z. Support outlet boxes and switch boxes from two (2) adjacent studs. Outlet boxes designed to attach to one metal stud and be “sandwiched” between the front and back layers of gypsum wallboard are not allowed.

AA. Back-to-back outlets in common walls are not permitted. Outlet boxes shall be separated by at least one stud wherever possible. In cases of outlet boxes of adjacent rooms in the same stud cavity at the same height, provide a layer of expandable spray foam insulation around each box in that cavity. There must be a minimum of a 1” horizontal separation space between boxes of adjacent rooms. If this condition occurs in a fire rated wall, provide a 1 hour fire rated putty pad to cover the back of outlets of one side of the partition. Other junction box installations on fire rated walls shall comply with UL requirements.

BB. Where shown adjacent to receptacles, telephone, data and cable TV outlets shall be located no further than 6” on center from the center of the receptacle. Cable television outlets shall be combined in a single faceplate in resident units.

CC. Contractor shall not install conductors or cables in a building that is not completely waterproofed, unless the conductors or cable is rated for wet location installations.

3.3 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.4 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. MCCB: Molded-case circuit breaker.

E. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing. Coordinate room names and/or numbers to be used in panel schedules with final naming and numbering conventions.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.9 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Height: 84 inches maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
5. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.

F. Incoming Mains:

1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum.

    a. Plating shall run entire length of bus.
    b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

I. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

J. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

K. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A RMS symmetrical.

2.2 POWER PANELBOARDS

A. Manufacturers: Match existing switchboard manufacturer.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker or lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Match existing switchboard manufacturer.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Match switchboard manufacturer.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

    a. Inverse time-current element for low-level overloads.
    b. Instantaneous magnetic trip element for short circuits.
    c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
3. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
4. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
5. Subfeed Circuit Breakers: Vertically mounted.
6. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Breaker handle indicates tripped status.
    c. UL listed for reverse connection without restrictive line or load ratings.
    d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
    f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position for fire-alarm control panel circuits or emergency lighting circuits.

2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim 90 inches above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

J. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

L. Install filler plates in unused spaces.

M. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs.

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate.

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate.

E. Install warning signs.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Straight-blade convenience, hospital-grade, and tamper-resistant receptacles.
2. GFCI receptacles.
3. Twist-locking receptacles.
4. Cord and plug sets.
5. Toggle switches.
6. Wall-box dimmers.
7. Wall plates.
8. Floor service outlets.

1.3 DEFINITIONS

A. Abbreviations of Manufacturers' Names:

1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
3. Leviton: Leviton Mfg. Company, Inc.
4. GE: General Electric

B. EMI: Electromagnetic interference.

C. GFCI: Ground-fault circuit interrupter.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

C. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

D. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

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

a. Cooper; 5362 (duplex).
b. Hubbell; CR20 (duplex).
c. Leviton; BR20 (duplex).

B. Tamper-Resistant Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

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

a. Cooper; TR5362 (duplex).
b. Hubbell; CR20TR (duplex).
c. Leviton; TBR20 (duplex).

C. Hospital-Grade, Tamper-Resistant, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

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

a. Cooper; TR8300 (duplex).
b. Hubbell; 8300TR (duplex).
c. Leviton; 8300-SG (duplex).

2.4 GFCI RECEPTACLES

A. General Description:

1. Indoors: 125 V, 20 A, straight blade, tamper-resistant, non-feed-through type.
2. Outdoors: 125 V, 20 A, straight blade, tamper-resistant, weather-resistant, non-feed-through type.
3. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.

B. Duplex GFCI Convenience Receptacles:

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

a. Cooper: VGF20 (indoor), WRVGF20 (outdoor).
b. Hubbell: GFST20 (indoor), GFWRST20 (outdoor).
c. Leviton: GF2 (indoor), GFW2 (outdoor).

C. Tamper-Resistant, Duplex GFCI Convenience Receptacles:

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

a. Cooper: TRVGF20 (indoor), TWRVGF20 (outdoor).
b. Hubbell: GFTRST20 (indoor), GFTWRST20 (outdoor).
c. Leviton: GFTR2 (indoor), GFWT2 (outdoor).

D. Hospital-Grade, Tamper-Resistant, Duplex GFCI Convenience Receptacles: Comply with UL 498 Supplement SD.

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

a. Cooper: TRVGH20.
b. Hubbell: GFR5362SG.
c. Leviton: WT899-HG.

2.5 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

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

a. Cooper: AHL520R.
b. Hubbell: HBL7210B.
c. Leviton: 2310.

2.6 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.

2.7 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

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

a. Cooper: CSB120 (single pole), CSB220 (two pole), CSB320 (three way), CSB420 (four way).
b. Hubbell: CSB120 (single pole), CSB220 (double pole), CSB320 (three way), CSB420 (four way).
c. Leviton: CSB1-20 (single pole), CSB2-20 (double pole), CSB3-20 (three way), CSB4-20 (four way).

C. Pilot-Light Switches: 120/277 V, 20 A.

1. Description: Single pole, with LED-lighted handle, illuminated when switch is off.

D. Toggle Switches: Square Face, 120/277 V, 20 A; comply with NEMA WD 1, UL 20, and FS W-S-896.

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

a. Cooper: 7621 (single pole), 7622 (two pole), 7623 (three way), 7624 (four way).
b. Hubbell: DS120 (single pole), DS220 (double pole), DS320 (three way), DS420 (four way).
c. Leviton: 5621-2 (single pole), 5622-2 (double pole), 5623-2 (three way), 5624-2 (four way).

Note: All receptacles shall be standard (not Decora). All switches shall be Decora style.

2.8 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover and listed and labeled for use in wet and damp locations.

Note: Refer to drawings for locations in finished spaces where metal wall plates shall be utilized in lieu of thermoplastic wall plates.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.10 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 27 15 00 "Communications Horizontal Cabling."

2.11 FINISHES

A. Device Color:

1. Coordinate both device and wall plate color with Interior Designer prior to submitting product data for review.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

B. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

C. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

D. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
4. Provide dimmers rated for the appropriate load type and wattage. Follow manufacturer’s instructions for grouping devices in multi-gang boxes. Derate dimmers as necessary.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

I. Requirements for hospital grade receptacles:

a. Hospital grade receptacles shall be provided in Patient Room.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number on the front of the wall plate. Match process used in Fishwick.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections:

1. Prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Test straight-blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

F. Wiring device will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Provide tamper resistant receptacles in all areas accessible by residents.

END OF SECTION 26 27 26

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

A. Fusible switches.
B. Nonfusible switches.
C. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

A. Enclosure types and details for types other than NEMA 250, Type 1.
B. Current and voltage ratings.
C. Short-circuit current ratings (interrupting and withstand, as appropriate).
D. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers.

A. Include plans, elevations, sections, details, and attachments to other work.
B. Include wiring diagrams for power, signal, and control wiring.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

A. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
B. Fuse Pullers: Two for each size and type.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

A. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
B. Altitude: Not exceeding 6600 feet.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

A. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

A. Manufacturers: Match existing switchboard manufacturer.

B. Type HD, Heavy Duty:

A. Single throw.
B. Three pole.
C. 240-V ac.
D. 1200 A and smaller.
E. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
F. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

A. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
B. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
C. Hookstick Handle: Allows use of a hookstick to operate the handle.
D. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

A. Manufacturers: Match existing switchboard manufacturer.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

A. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
B. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
C. Hookstick Handle: Allows use of a hookstick to operate the handle.
D. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance of the Work.

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

A. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches: Provide enclosures at installed locations with the following environmental ratings.

A. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
B. Outdoor Locations: NEMA 250, Type 4X
C. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

3.3 INSTALLATION

A. Coordinate layout and installation of switches, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

B. Label each enclosure with laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections for Switches:

A. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Verify correct phase barrier installation.
h. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, and accessories.

1.3 DEFINITIONS

A. CCT: Correlated Color Temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See “Luminaire.”

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:

1. Physical description and dimensions of luminaires.
2. Include battery and charger data for emergency lighting units.
3. Ballast, including BF.
4. Include life, output (lumens, CCT and CRI), and energy efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM45, IES LM-79, and IES LM-80.

a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.

1. Include Samples of color and finish selection.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Sample warranty for all LED Luminaires.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Lamps: Five for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
4. LED Drivers: One for every 50 of each LED fixture type installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory is accredited under the NVLAP for Energy Efficient Lighting Products.

1.9 DELIVERY, STORAGE AND HANDLING

A. Protect finished of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years minimum for all LED Luminaires and Two year(s) minimum for all other luminaires from date of Substantial Completion

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

1.11 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

1.12 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

2.2 LUMINAIRE REQUIREMENTS

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

B. NRTL Compliance:

1. Fabricated and label emergency lighting units, exit signs and batteries to comply with UL 924.

C. Lamp base complying with ANSI C81.61 or IEC 60061-1.

D. Nominal Operating Voltage: As indicated on the Light Fixture Schedule.

E. Recessed Luminaires: Comply with NEMA LE 4.

F. Comply with NFPA 70 and NFPA 101 for emergency lighting.

G. Bulb Shape: Complying with ANSI C79.1 for incandescent, LED, and emergency lighting.

2.3 LED

A. CRI of minimum 90. CCT of as indicated on Light Fixture Schedule.

B. Rated lamp life of minimum 35,000 hours.

C. Lamps dimmable from 100 percent to 0 percent of maximum light output.

D. Internal driver (unless indicated otherwise on the Light Fixture Schedule).

E. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

F. Housings:

1. Extruded-aluminum housing and heat sink.

G. Minimum allowable luminaire efficacy of 80. Lumens per watt.

H. Each LED luminaire shall be binned within a three-step macadam ellipse minimum to ensure color consistency among luminaires.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Operating at nominal voltage of as indicated on Light Fixture Schedule.
2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Glass: Annealed crystal glass unless otherwise indicated.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.6 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish shall match luminaire.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod

E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation.

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

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Remote Mounting of Ballasts: Distance between the ballast and luminaire shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Install lamps in each luminaire.

E. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them.

F. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

G. Ceiling-Grid-Mounted Luminaire Supports: Use grid as a support element.

1. Install ceiling support system rods or wires independent of the ceiling suspension devices, for each luminaire. Locate not more than 6 inches from luminaire corners.
2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on luminaire. Wire or rod shall have breaking strength of the luminaire weight at a safety factor of 3.

H. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

I. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls or Attached to a minimum 20 gauge backing plate attached to wall structural members.
2. Do not attach luminaires directly to gypsum board.

J. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 CONNECTIONS

A. Ground equipment.

1. 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.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals.

3.6 FIELD QUALITY CONTROL

A. The Contractor shall inspect each installed fixture for damage. Replace damaged fixtures and components.

B. The Contractor shall provide instruments to make and record test results.

C. Tests: As follows:

1. Verify normal operation of each fixture after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.

D. Malfunctioning Fixtures and Components: The Contractor shall replace or repair, then retest. Repeat procedure until units operate properly.

E. Corrosive Fixtures: Replace during warranty period.

3.7 START-UP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner.

B. Perform startup service:

1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.

3.8 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer. All luminaires shall be thoroughly cleaned and clear from dust, paint, construction debris and fingerprints after all other trades are complete, but prior to the date of substantial completion.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 51 00

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding labeling.

1.3 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

A. Comply with TIA-607-B.

2.2 CONDUCTORS

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

1. Burndy; Part of Hubbell Electrical Systems.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG copper conductor, and 1/4 inch (6.3 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

1. Burndy; Part of Hubbell Electrical Systems.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

C. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

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

1. Burndy; Part of Hubbell Electrical Systems.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-B.

3.3 APPLICATION

A. Conductors: Install solid copper conductor for No. 8 AWG and smaller and stranded copper conductors for No. 6 AWG and larger unless otherwise indicated.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

C. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

D. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.

4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

    a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 CONNECTIONS

A. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pre-twist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

B. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond equipment to the ground bar of the panelboard.

C. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding screened, balanced, twisted-pair cables.

END OF SECTION 27 05 26

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Surface pathways.
7. Boxes, enclosures, and cabinets.
8. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 05 33 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

2. All of Division 27.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Alpha Wire Company.
4. Electri-Flex Company.
5. Robroy Industries.
6. Western Tube and Conduit Corporation.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6Retain "ARC" Paragraph below for corrosion resistance and other special conditions.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel.
b. Type: Setscrew.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

H. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corporation.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Kraloy.
9. Lamson & Sessions; Carlon Electrical Products.
10. Niedax-Kleinhuis USA, Inc.
11. RACO; Hubbell.
12. Thomas & Betts Corporation.

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651B.

F. RTRC: Comply with UL 1684A and NEMA TC 14.

G. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

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

1. Alpha Wire Company.
2. Arnco Corporation.
3. Endot Industries Inc.

4. IPEX.
5. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

2.4 BOXES, ENCLOSURES, AND CABINETS

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

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. Hoffman.
6. Lamson & Sessions; Carlon Electrical Products.
7. O-Z/Gedney.
8. Quazite:Hubbell Power Systems, Inc.
9. RACO; Hubbell.
10. Spring City Electrical Manufacturing Company.
11. Stahlin Non-Metallic Enclosures.
12. Thomas & Betts Corporation.
13. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy , Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.

I. Gangable boxes are allowed.

J. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 for indoor use Type 3R for outdoor use with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1 for indoor, Type 3R for outdoor, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-B.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. NewBasis.
   d. Oldcastle Precast, Inc; Christy Concrete Products.
   e. Quazite: Hubbell Power System, Inc; Hubbell Power Systems.
   f. Synertech Moulded Products.

2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "COMMUNICATIONS.".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified on drawings:

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

    a. Loading dock.
    b. Mechanical rooms.

4. Damp or Wet Locations: GRC.
5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway and EMT where indicated on drawings.
6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Plenum-type, optical-fiber-cable pathway and EMT where indicated on drawings.
7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Plenum-type, optical-fiber-cable pathway or EMT where indicated on drawings.
8. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 1-inch trade size. Minimum size for optical-fiber cables is 1 1/4 inch.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

H. Comply with all local Code requirements.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum

pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Stub-ups shall be between 1”-3” AFF.

E. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

F. Arrange stub-ups so curved portions of bends are not visible above finished slab.

G. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

I. Support conduit within 12 inches of enclosures to which attached.

J. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC- before rising above floor.

K. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

M. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

S. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows where required:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

U. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

V. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

W. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

X. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a rain-tight connection between box and cover plate or supported equipment and box.

AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

DD. Set metal floor boxes level and flush with finished floor surface.

EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand-tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches

of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, a minimum of 24” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

SECTION 27 11 00 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Sections Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Telecommunication service entrance pathways.
5. Grounding.

B. Related Documents:

1. Section 27 13 00 “Communications Backbone Cabling” for voice and data cabling associated with system panels and devices.
2. Section 27 15 00 “Communications Horizontal Cabling” for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

C. LAN: Local area network.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finished for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and locations and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For Installer, layout technician, installation supervisor, and field inspector.

1.5 QUALITY ASSURANCE

A. BICSI is an industry trade association. See Editing Instruction No. 2 in the Evaluations for summaries of qualifications for registration.

1. Layout Responsibility: Prepare of Show Drawings shall be under the direct supervision of RCDD.
2. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
3. Installation Supervisor: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
4. Field Inspector. Currently registered by BICSI as RCDD to perform the on-site inspection.

B. Electrical Components, devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and applications.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-B.

D. Grounding: Comply with TIA-607-B,-NEC, and AHJ requirements.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather-tight wet work in spaces is complete and dry, and work above ceilings is complete.

1.7 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment supplier, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangements and space requirements of telephone switch and LAN equipment.

4. Adjust arrangements and locations of equipment with distribution frames, cross-connections. And patch panels of cabling systems of other communications, electronic safety and security and relates systems that share space in equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA-569-B.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening reusable straps to brackets.
3. Lacing bars, spools, J-hooks, and D-rings.
4. Straps and other devices.

C. Cable Trays:

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

a. Hubbell.

2. Cable Tray Materials: Metal, suitable for indoor and protected against corrosion by hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than .002165 thick.

a. Ladder Cable Trays: Nominally 12 inches wide and a rung spacing of 9 inches.

D. Conduit and Boxes – Comply with requirements in Division 26 Section “Raceway and Boxes for Electrical Systems.”

2.2 BACKBOARDS.

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 06 "Rough Carpentry.”

2.3 EQUIPMENT FRAMES

A. Manufacturers: Provide equipment shown on drawings or an approved equal by one of the following:

1. Hubbell

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1362.

1. Rack mounting.
2. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Circuit breaker and thermal fusing: Unit continues to supply power if protection is lost.
6. Cord connected with 15 foot line cord.
7. Rocker –type on-off switch, illuminated when in one position.
8. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
9. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330V.

2.5 GROUNDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Telecommunications Main Grounding Bus-bar.

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connections to ground bus bar.
2. Ground Bus Bar. Copper minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Telecommunications Grounding Bus-bar.

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long barrel, two-bold connection to ground bus bar.
2. Ground Bus Bar. Copper, minimum 1/4 inch thick by 2 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

D. Comply with TIA, NEC, and AHJ requirements.

2.6 LABELING

A. Comply with TIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 27 05 28 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

F. Ladder Rack installation requirements.

1. Provide all components of the ladder rack system (ladder rack, turns, splices, supports, and accessories) from a single manufacturer.
2. Ladder rack shall be secured to the structural ceiling, building truss system, wall, floor or the tops of equipment racks and/or cabinets using the manufacturer’s recommended supports and appropriate hardware as defined by local code or the authority having jurisdiction (AHJ).
3. Ladder rack shall be supported every 5’ or less in accordance with TIA-569-B. Ladder rack shall be supported within 2’ on both/all sides of every splice or intersection. Support ladder rack on both sides of every change in elevation.
4. Secure ladder rack to each support with included hardware so that at minimum ladder rack is connected to each support by two fasteners.
5. Ladder rack splices will be made in mid-span, not over a support, with the manufacturer’s recommended splice hardware.

6. Heavy-duty splices are recommended for ladder rack in excess of 18” width. Heavy-duty splices are required for any splice formed in the vertical orientation including changes in elevation formed using vertical-to-horizontal 90° turns or horizontal-to-vertical 90° turns. Use heavy-duty splices to secure all overhead turns to the overhead horizontal pathway(s).
7. When the pathway is overhead, ladder rack shall be installed with a minimum clearance of 12” above the ladder rack. Leave a minimum of 12” in between ladder rack and ceiling/building truss structure. Leave a minimum of 3” in between ladder rack and the tops of equipment racks and/or cabinets. Multiple tiers of ladder rack shall be installed with a minimum clearance of 12” in between the ladder rack. When located above an acoustical drop ceiling, ladder rack shall be installed a minimum of 3” above the drop ceiling tiles.
8. Within each telecommunications room, ladder rack should be bonded together, electrically continuous, and bonded to the TGB, unless otherwise noted in the specifications and contract documents. Ladder rack and turns shall be bonded across each splice with a UL Classified Splice Kit or other accepted method as recommended by the AHJ. Ladder rack shall be bonded to the Telecommunications Grounding Busbar (TGB) using an approved ground lug on the ladder rack and a minimum #6 grounding wire or as recommended by the AHJ. Verify the bonds at splices and intersections between individual ladder rack sections and turns and the bond to the TGB.
9. The quantity of cables within the ladder rack will not exceed a whole number value equal to 50% of the interior area of the ladder rack divided by the cross-sectional area of the cable. The interior area of ladder rack will be considered to be the width of the ladder rack multiplied by a height of 2”, unless cable retaining posts are added to the ladder rack. The interior area of ladder rack equipped with cable retaining posts will be considered to be the width of the ladder rack multiplied by a height of 6”. Actual cable fill for ladder rack that is not equipped with cable retaining posts will not exceed 2” in height. Actual cable fill for ladder rack equipped with cable retaining posts will not exceed 6” in height.
10. The combined weight of cables within the ladder rack will not exceed the stated load capacity of the ladder rack as stated in the manufacturer’s product specifications or design tables.
11. Cables (cable bundles) will be secured to the cross members of ladder rack with ¾” wide reusable straps. Straps are not required when ladder rack is equipped with cable retaining posts.
12. Separate different cable media types within the ladder rack pathway. Treat each type of cable media separately when determining cable fill limits.
13. Where cable exits or enters the side of overhead ladder rack to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field, a radius drop will be used to guide the cable.
14. Maintain a minimum separation of 2’ between ladder rack used for communications cables and pathways for other utilities or building services.

3.3 FIRE-STOPPING

A. Comply with requirements in Section 07 "Penetration Fire-stopping."

B. Comply with TIA-569-B, Annex A, "Fire-stopping."

C. Comply with BICSI TDMM, "Fire-stopping Systems" Article.

3.4 GROUNDING

A. Comply with NEC and AHJ requirements.

B. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG copper grounding electrode conductor from grounding bus bar to suitable electrical building ground.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG copper equipment grounding conductor.

D. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Section 27 15 00 "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA standard as it applies to this Section

D. Labels shall be preprinted or computer-printed type.

END OF SECTION 27 11 00

SECTION 27 13 00 – COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable.
3. 50/125-micrometer, OM3, Multimode, all dielectric, armored, optical fiber cabling.
4. Coaxial cable.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Cabling identification products.

B. Related Sections:

1. Section 27 15 00 “Communications Horizontal Cabling” for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-

connection. All backbone and horizontal cabling including associated hardware shall be by the same Manufacturer.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

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

1. For coaxial cable, include the following installation data for each type used:

    a. Nominal OD.
    b. Minimum bending radius.
    c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:

    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer’s rating for tray and its support elements.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise o-site testing.

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: 50 or less.

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. Telecommunications Pathways and Spaces: Comply with TIA-569-B.

E. Grounding: Comply with NEC and the AHJ requirements.

1.8 DELIVERY, STORAGE AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.9 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.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA-569-B.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent

degradation of cable performance and pinch points that could damage cable.

1. Support brackets with Velcro slots for securing cable with Velcro.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

2.2 UTP CABLE

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

1. Hubbell NextSpeed.
2. Systemax GigaSpeed Products.
3. The Siemon Company.

B. Description: 100-ohm, Multi-pair UTP, formed into 25-pair binder groups covered with a thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA-568-C.1 for performance specifications.
3. Comply with TIA-568-C.2, Category 3.
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, Plenum Rated: Type CMP, complying with NFPA 262.
    b. Communications, Riser Rated: Type CMR, comply with UL 1666.

2.3 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements and operate as a warrantied system with cabling, provide products by one of the following O.A.E:

1. Hubbell NextSpeed.
2. Systemax GigaSpeed Products.
   The Siemon Company.

B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.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. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: Four for each conductor in assigned cables.

E. 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.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, 4-pair cables in lengths suitable for proper patching with 12” of slack in each cord; terminated with 8-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.4 OPTICAL FIBER CABLE

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

1. Hubbell NextSpeed.
2. Systemax GigaSpeed Products.
3. The Siemon Company.

B. Description: Multimode, 50/125 micrometer, OM3, Loose-tube, Interlocking-Armored, Indoor/Outdoor, Optical-fiber cable.

1. Comply with TIA-492AAAC-B, IEC-60793-2-10 type A1A.2, ITU-T G.651.1 for detailed specifications.
2. Comply with TIA568-C.3 for optical fiber component standards.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. National Electrical Code® (NEC®) OFCP, CSA FT-6
    b. Outdoor aerial and duct; indoor vertical riser and general purpose horizontal according to NEC Article 770.
    c. ANSI/ICEA S-104-696; NFPA 262 (for plenum, riser and general building applications).

4. Maximum attenuation: 2.8 dB/km / 1.0 dB/km.

C. Jacket:

1. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
2. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.5 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements and operate as a warrantied system with cabling, provide products by one of the following, O.A.E.:
1. Hubbell NextSpeed.
2. Systemax GigaSpeed Products.

3. The Siemon Company.

B. Cross-Connect sand Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each pair of fiber cables assigned to field, plus spares and blank positions adequate to suit a minimum of 25% expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in custom lengths to provide a maximum of 24” of slack post termination.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2, TIA-604-3-A, and TIA-604-12. Comply with TIA-568-C.3.
2. Quick-connect, duplex, Type LC connectors. Insertion loss not more than 0.75 dB
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.
4. Fusion-spliced pigtails only. No crimp connectors.

2.6 COAXIAL CABLE

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

1. Belden CDT Inc.; Electronics Division.
2. CommScope, Inc.
3. Superior Essex

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-11/U: NFPA 70, Type CATV.

1. No. 14 AWG, solid, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
4. Jacketed with sunlight-resistant, black PVC or PE.
5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg. C.

D. RG-6/U: NFPA 70, Type CATV or CM.

1. Quad Shield
2. Jacketed with black PVC or PE.
3. Suitable for indoor installations.

E. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR, complying with UL 1666.
4. CATV Limited Rating: Type CATVX.

2.7 COAXIAL CABLE HARDWARE

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

1. Belden
2. Leviton Voice & Data Division.
3. Siemon Co. (The).

B. Coaxial-Cable Connectors: Type F, 75 ohms.

2.8 GROUNDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.9 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.10 SOURCE QUALITY CONTROL

A. Testing: All cable testing shall be performed by a BICSI certified technician and reviewed and stamped by an RCDD.

B. Factory test cables on reels according to TIA -568-C.1.

C. Factory test UTP cables according to TIA -568-C.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA-568-C.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Use a minimum of ¾” wide Velcro, no plastic “zip-ties”.

3.3 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 27 11 00 "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

B. Comply with TIA/EIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.1.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical fiber Cable Installation:

1. Comply with TIA-568-C.3.
2. Cable may be terminated on connecting hardware that is rack mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wire-way or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

G. Group connecting hardware for cables into separate logical fields.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Section 07 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B, NEC, and the AHJ requirements.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Administration Class: 2.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration including optional identification requirements of this standard.

D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

F. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA-606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Contractor shall perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber 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 TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA-568-C.1.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports that have been reviewed and stamped by an RCDD.

END OF SECTION 27 13 00

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. Coaxial cable.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Telecommunications outlet/connectors.
5. Cabling system identification products.
6. Cable management system.

B. Related Requirements:

1. Division 27 All Sections.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a

"permanent link," a term that is used in the testing protocols.

1. TIA-568-C.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
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. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment and in the horizontal cross-connect.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1 when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product.

1. For coaxial cable, include the following installation data for each type used:

   a. Nominal OD.
   b. Minimum bending radius.
   c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.
5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Field quality-control reports.

E. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver of 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.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with the Owner’s telecommunications and LAN equipment and service suppliers. Arrange for a pre-installation meeting with the Owner prior to beginning any rough-in, or installing any cables.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA-569-B.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with slots for reusable straps. Use reusable straps, not cable ties.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

2.2 UTP CABLE

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

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

C. Grounding: Comply with NEC and the AHJ requirements.

D. Manufacturers: All cable, hardware, and patch cords shall be by the same Manufacturer. Subject to compliance with requirements, provide products by one of the following O.A.E.:

   1. Hubbell NextSpeed.
   2. Systemax GigaSpeed Products.
   3. The Siemon Company.

E. Description: 100-ohm, four-pair UTP covered with a thermoplastic jacket. Coordinate cable colors with Owner. Basis of Design; Hubbell PN# C6RPB

   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA-568-C.1 for performance specifications.
   3. Comply with TIA-568-C.2, Category 6.
   4. Sweep Tested to 500Mhz
   5. 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, Plenum Rated: Type CMP, complying with NFPA 262.
      b. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

2.3 UTP CABLE HARDWARE

A. Manufacturers: All cable, hardware, and patch cords shall be by the same Manufacturer. Subject to compliance with requirements, provide products by one of the following O.A.E.:

   1. Hubbell NextSpeed.
   2. Systemax GigaSpeed Products.
   3. The Siemon Company.

B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.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. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. 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.

   1. Number of Jacks per Field: One for each four-pair UTP cable indicated plus spares and blank positions adequate to suit specified expansion criteria.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, 4-pair cables in lengths, by the same manufacturer as the horizontal cable, suitable for proper patching with 12" of slack in each cord plus or minus 3 inches**;** terminated with 8-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.4 COAXIAL CABLE

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

1. Hubbell NextSpeed.Systemax GigaSpeed Products.
3. The Siemon Company.

B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-6/U: NFPA 70, Type CATV or CM.

1. Quadshield
2. Jacketed with black PVC or PE.
3. Suitable for indoor installations.

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.

2.5 COAXIAL CABLE HARDWARE

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

1. Hubbell Premise Wiring.
2. Systemax GigaSpeed Products.
3. Panduit Corp.

B. Coaxial-Cable Connectors: Type F, 75 ohms.

2.6 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA-568-C.1.

B. Outlets: Refer to floor plans for number of ports per faceplate. Coordinate with Architect for faceplate colors.

1. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

2. Legend: Snap-in, clear-label covers and machine-printed paper inserts. Coordinate with service provider for CATV labels.

2.7 GROUNDING

A. Comply with requirements in Division 26 Section “Grounding and Bonding for Electrical Systems” for grounding conductors and connectors.

B. Comply with TIA-607-B, the NEC, and the AHJ requirements.

2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Confirm cabling color scheme with Owner prior to purchasing cable.

C. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Contractor shall evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA-568-C.1.

C. Factory test UTP cables according to TIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA-568-C.3.

E. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section “Raceway and Boxes for Electrical Systems.”

B. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27Section “Communications Equipment Room Fittings.” Drawings indicate general arrangement of pathways and fittings.

B. Comply with TIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Division 26 Section “Raceway and Boxes for Electrical Systems” for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for UTP at least 49 feet from communications equipment room.

4. Terminate conductors; Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

A. Comply with requirements in Section 07 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, “Grounding, Bonding, and Electrical Protection” Chapter.

B. Comply with TIA-607-B, the NEC, and the AHJ requirements.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Administration Class: 2.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-A for Class 2 level of administration, including optional identification requirements of this standard.

C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Contractor shall submit test results to Owner at project completion in paper and electronic format.

B. Perform the following tests and 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 TIA-568-C.1.
2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

    a. Test for each outlet and MUTOA. Perform the following tests according to TIA-568-C.1 and TIA-568-C.2:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).
        7) Power sum equal-level far-end crosstalk (PSELFEXT).
        8) Return loss.
        9) Propagation delay.
        10) Delay skew.

6. Coaxial Cable Tests: Conduct tests according to Section 27 41 33 "Master Antenna Television System."
7. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

    a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
    b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

3.9 Cabling System certification and mission critical warranty

A. Must Provide Manufacturer's 25-year warranty

B. Mission Critical Warranty coverage includes application assurance and compliance to applicable performance specifications.

C. Installed Category 6 cabling systems may be granted a full channel warranty by Manufacturer under the conditions stated below.

1. A certified installer registered with the Manufacturer's training program performs the construction.
2. Contractors performing the certified installation are properly registered in the Manufacturer's warranty program.
3. The channel components are supplied entirely by Manufacturer (including patch cords for channel warranty).
4. Cable used in the installation is supplied by Manufacturer.
5. Installed channel systems are properly documented and tested with a "PASS" result.
6. Field test equipment used for augmented category 6 cabling is minimum level IIIe classification and complies with TIA/EIA-568-C.2 requirements.
7. Required test results, stored on a CD, and project documentation including as-built drawings, are submitted to Manufacturer by the registered contractor.

END OF SECTION 27 15 00

SECTION 27 51 24 - INTEGRATED AUDIO VISUAL SYSTEMS AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. The audiovisual systems shall be provided for each space listed. The audiovisual contractor shall provide turnkey delivery of the specified audiovisual systems to include: hardware/product, installation, configuration, software programming, testing, performance verification, final documentation and user training.

B. All AV controls shall be programmed per the Owner's needs. Meetings shall be held to discuss the exact layout, functioning and naming conventions for all of the touchscreen controls asked for below.

C. All work outline in this specification section shall be an Add Alternate to the project. Please price accordingly.

1.2 TERMS AND ABBREVIATIONS

A. AV = Audiovisual

B. AVC = Audiovisual Contractor

C. AVD = Audiovisual Designer

D. CATV = Cable Television

E. VTC = Video Teleconferencing

F. ATC = Audio Teleconferencing

G. DSP = Digital Signal Processor

H. PC = Personal Computer

1.3 REFERENCES

A. Building Codes

1. NFPA 70, The National Electrical Code
2. ADA Standards for Accessible Design

B. Industry Standards

1. ANSI/INFOCOMM 2M-2010 Standard Guide for Audiovisual Systems Design and Coordination Processes.

2. ANSI/INFOCOMM 10:2013 Audiovisual Systems Performance Verification

C. Manufacturer Standards

1. Crestron DigitalMedia Design Guide (Doc. 4546E)
2. Middle Atlantic Products Integrating Electronic Equipment and Power into Rack Enclosures (Rev. 4b)

1.4 VENDOR QUALIFICATIONS

A. The selected AV contractor shall have significant experience with similar projects and must currently employ staff with the following minimum certifications (provide certificates upon request):

1. InfoComm CTS-D
2. Crestron Certified Master Programmer
3. Crestron DMC-D-4K Certified
4. HDBaseT Alliance - HDBaseT Expert Installer

1.5 PRELIMINARY SUBMITTALS

A. Product Data

1. The AVC shall submit equipment cut sheets and product information for review, coordination and/or finish selection.
2. Equipment shall be indexed by room/system then by primary system function (video, audio, control, misc.) and finally alphabetically by Manufacturer and Model. Accessories shall directly follow the associated primary component.
3. Where equipment cut sheets include multiple part numbers or finish options, the AVC shall denote the intended part number and finish along with any applicable accessories or options.
4. Provide finish samples as required for review/approval prior to equipment/furniture order.

B. Shop Drawings

1. The AVC shall submit system shop drawings allowing the Owner and Owner’s Representative(s) to review details of the systems prior to equipment ordering and implementation.
2. Shop drawings shall include adequate detail to fully understand the intended installation, connectivity and operation of the systems.

1.6 CLOSEOUT SUBMITTALS

A. Drawings of Record

1. Following systems acceptance, the AVC shall provide electronic (PDF is acceptable) and full-size hard copies of the final system wiring and configuration. At a minimum, the documentation shall include cable numbers, wiring details and make and model for all components. All documentation shall be accurate based on final configurations at the time of systems acceptance. Include test reports/results as appropriate.

2. As-built drawings shall include all wiring and configuration information needed to restore the systems to their original state.
3. System settings shall be recorded and inserted into the drawings of record and/or submitted as a separate file. The following minimum settings shall be recorded:

    a. Firmware version of all applicable, major components
    b. Level/value settings for any hard adjustments such as volume knobs, dip switches, rotary dials, format selection switches and similar.
    c. Patch panel/port numbers for connection to any networked equipment
    d. EDID information used at all input connections within the systems
    e. Internal video scaler/processing settings as applicable
    f. Video output parameters: resolution, frame rate, color space, etc.
    g. Primary camera settings as applicable: white balance, focus, gain, color, etc.
    h. Primary image adjustment settings for display devices: brightness, contrast, color temperature, sharpness, color, etc…
    i. All system and/or device passwords
    j. Device address: proprietary device ID, IP address/subnet info, etc.

4. The AVC shall provide an AV Device Network Table for any devices furnished by the AV contractor which are connected to an IP network (either standalone or facility network). The network table shall list relevant network information for each device such as: Location, Model, Description of Device, IP Address, Default Gateway and Subnet Mask.

B. Custom Software Files

1. The AVC shall provide the Owner with the complete and unlocked source code for any custom software and DSP or device configurations. The owner shall have all rights of ownership. All programming related files shall be provided to the customer on a flash drive in an organized fashion.
2. All files shall be accurate as of the final systems' configurations. Any changes from subsequent work shall be captured, and updated files shall be created and distributed.

C. Custom Control Systems User Guides

1. The AVC shall provide user guides for all custom developed user interfaces. User guides shall be provided in electronic and paper formats. In all cases, user guides shall be specific and custom to each system provided; generic guides will not be accepted.
2. Hard copy versions shall be bound and printed in full color.
3. Equipment Owner's Manuals
4. Provide indexed PDF and/or binder with all equipment owner's manuals.

1.7 DELIVERY, STORAGE AND HANDLING

A. All equipment shall be stored and delivered by the AVC. Equipment shall be stored within the AVC's facility or in an appropriate storage facility with conditions suitable for the stored material.

B. The AVC is responsible for all costs associated with the delivery, storage and handling of the provided equipment.

C. The AVC is responsible for the storage and protection of all provided materials delivered to the project site until owner acceptance.

PART 2 - PRODUCTS

2.1 MULTIPURPOSE ROOM ROOM A112

A. System Description

1. Provide the following system in the space listed above.
2. Display system

a. Provide a flat panel 98” diag., NEC C981Q 4KUltraHD TV. Provide all programming and interface with the TV as required by the AV controls system.

3. Presentation Sources and Connectivity

a. Provide the following connection points for user-provided sources:

1) DVD Player–Provided by AVC: Located in AV Equipment Rack (quantity 1) Basis of Design: Samsung UBD-M8500.
2) Wall Input Plates as shown on plans: HDMI, VGA and Stereo Analog Audio (see plans for location, quantity 2).
Basis of Design: Crestron DM-TX-200-C-2G
3) Digital Cable box (quantity 1, coordinate with network vendor). Cable box provided by Owner, installed and programmed by AVC.
4) Apple TV4K.

4. Audio System

a. Provide an audio system consisting of distributed ceiling speakers (see plans)
Basis of Design: QSC AD-Ci52T

b. Provide programmed DSP for ceiling speakers supporting configuration and preset recall.

Basis of Design: Crestron DMPS3-4K-300-C

c. Provide (2) wireless microphone systems: (1) lavalier and (1) handheld.

Basis of Design: Shure SLX Series

d. Provide assistive listening induction hearing loop system. Williams PLA DL210NET, (5) body packs, ADA wall sign (t-coil), and all associated accessories and required components. Provide loop layout and design during the submittal process.

5. Switching and Control

a. Provide (1) wall-mounted controller with 5” touch screen display to control the system. The touch panel shall provide the user with system on/off and volume controls. Coordinate with Owner for specific programming requirements.
Basis of Design Touch Panel Controller: Crestron TSW-760-X

6. Integrations

   a. The AVC shall provide integration to the lighting control system being provided by the GC/EC. The AVC shall meet with the Owner/GC/EC to discuss lighting levels and lighting scenes for the different room set up options. Further lighting control shall be by manual on-screen “sliders” to raise and lower the lighting levels per zone.

7. Miscellaneous

   a. Equipment Rack

      1) Provide a standalone equipment rack to house central AV components. The equipment rack shall include appropriate ventilation, cable management hardware, wheels for ease of access and integrated power distribution. See floor plans for location. Provide Middle Atlantic ERK Series rack.

   b. Cabling

      1) Provide all cabling as required to provide a complete and operational system. Provide manufacturer recommended cables. Provide plenum rated cables.
      2) Provide a 12”x12”x4” junction box and (2) 2” conduit to accessible ceiling at rack for all cabling for the system to be concealed within the wall.

   c. Broadcast Camera

      1) Provide a wall mounted PTZ camera to be controllable from the Owner’s LAN. This camera shall be injected into the Owner’s CATV distribution system through existing equipment (coordinate with Owner). AVC shall provide all required cabling.
         Basis of Design: Marshall CV620-NDI ceiling-mount, White

         a) Provide audio-video feed to in-house cable channel broadcast equipment (coordinate with Owner). AVC shall provide all required cabling, video extenders, etc. for a complete and operational system.
         b) Provide output stream to Owner-provided PC for recording or live streaming to LAN.
         c) Provide (4) preset camera views for choosing from the control system. Coordinate with Owner.

   d. Electrical

      1) The electrical contractor will provide 120-volt power and pathway requirements as coordinated with the AVC.
      2) AVC to provide surge suppression/power conditioning hardware for all components connected to building power.
      3) Provide appropriately sized junction box and conduit to accessible ceiling at rack for all cabling for the system to be concealed within the wall.

PART 3 - EXECUTION

3.1 PREPARATION

A. The AV contractor shall maintain regular attendance to project meetings and perform site surveys as beneficial to the project.

B. Field measure and verify all dimensions and conditions as needed throughout the project and identify any discrepancies before performing the work.

C. The AV contractor shall coordinate all aspects of the installation of any provided equipment. This typically includes, but is not limited to: delivery, staging, custom cutouts, infrastructure and network or other systems connectivity.

D. Installed cabling and rough-in work shall be completed when appropriate based on the construction schedule

E. Systems shall be staged and tested to the extent possible prior to delivery to the project site to identify any defective/damaged components and minimize on-site time.

3.2 INSTALLATION

A. Install equipment as specified and in accordance with the following requirements as applicable (listed in order of precedence):

1. Local regulatory/safety requirements as specified by the Authority Having Jurisdiction
2. Project Documentation
3. National/International Standards
4. Manufacturer Documentation
5. Standard Guides
6. Best Practices

B. All components shall be installed in a professional and responsible manner. Devices shall be plumb, level and appropriately secured. The AV contractor shall clean all components before final delivery of the systems to remove any dirt or residue from on-site activities.

C. All cables shall be labeled at both ends using a printed label. Labels shall be consistent with the system drawings.

D. Equipment, plates/panels and any other components with system connections shall have a unique device identifier which correlates to the systems drawings; the physical device shall be labeled with this identifier in a discrete location.

3.3 EQUIPMENT MOUNTING

A. All mounted/suspended equipment shall be installed using appropriate mounting methods, hardware and safety measures. Enlist services of a licensed professional to certify mounting methods as required.

3.4 CABLING AND WIRING

A. All cabling shall be installed in a professional manner. Provide all cable support and management hardware for audiovisual cabling and related cabling which connects to audiovisual equipment such as telecom cabling. Provide all connectors and terminate

tools/hardware required.

B. Label all cables with unique identifiers. Labels shall correspond to the AVC's installation/shop drawings for easy reference.

C. Certify all installed, field-terminated cables used for video extension and/or Ethernet communications and provide test results. Verify cable performance against manufacturer specifications.

D. Proper signal separation and bundling techniques shall be used. Separate signals based on application and signal level/type to minimize cable interference. Isolate signal cabling from AC power to the practical extent possible. If required, cross AC power cabling at 90 degrees when possible.

3.5 EQUIPMENT RACKS

A. Ensure that equipment racks are properly vented and that component placement and wiring promote unrestricted airflow. Utilize vents, vent blockers, variable thermostatic controllers and similar air flow control measures to optimize efficiency and improve ventilation effectiveness.

B. Cables shall be properly supported with appropriate strain relief and cable ties/wraps.

C. Components shall be secure and accessible. Ensure appropriate ventilation and access around each component. Position components to minimize the amount of internal rack cabling when possible.

3.6 DEVICE CONFIGURATIONS

A. Products which support features to optimize and improve the operation of the systems shall be configured appropriately to implement these features. The AV contractor shall consult the operational manual for all components and perform and verify that optimal settings have been configured. This typically includes, but is not limited to, the following:

1. Perform basic brightness and contrast adjustment using a suitable test pattern under typical lighting for all displays (save settings as a preset)
2. Rename inputs and outputs used for system connections with a relevant system/device name
3. Capture and store EDID information at all applicable locations in the system: Transmitters, switchers, processors/scalers, signal converters/extractors, etc.

B. Scaler and signal converter settings shall be set appropriately to the optimal resolution, color-space, timing and format to provide the best performance and reliability.

C. Sound systems shall be equalized and balanced for optimal frequency response and coverage within each location. Audio processing shall be utilized to enhance performance as well as to ensure safe and reliable operation of the system.

3.7 TRAINING

A. General User Training

1. Provide training on the general use and operations of the systems to include:

a. Overview of system features
b. Startup and shutdown procedures
c. Operation of each system capability and function
d. Best practices and recommendations

2. Complete and provide system user guides prior to training so they may be referenced/utilized during training.

B. Technical/Support Staff Training

1. Provide training on all general operation items above in addition to the following:

a. Closeout documentation review
b. Component and subsystem overview
c. Basic troubleshooting steps
d. Admin/Advanced user functions
e. System maintenance

2. Training shall be video recorded for Owner's future use.

3.8 ACCEPTANCE TESTING

A. Perform systems acceptance testing to ensure proper operation and performance.

B. The AV contractor shall provide all test/measurement equipment required to effectively verify that the system meets the stated requirements.

C. Record component settings as stated in the closeout submittals section indicating the as-built state of the systems at the time of acceptance

3.9 SYSTEMS WARRANTY

A. Provide a one year warranty on all provided equipment and workmanship.

B. The warranty shall cover, at no additional cost, any defects, failures or incidents which are not a result of misuse or neglect.

END OF SECTION 27 51 24

SECTION 31 20 13 – EARTHWORK WITHIN PERIMETER OF BUILDING FOOTPRINT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subsurface drainage backfill for walls and trenches.
5. Excavating and backfilling trenches within building lines.

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls."

1.3 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

C. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

D. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.

E. Excavation: Removal of material encountered above subgrade elevations.

1. Additional Excavation: Excavation below subgrade elevations as directed by Architect. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavations more than 10 feet in width and pits more than 30 feet in either length or width.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material exceeding 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, short-tip-radius rock bucket; rated at not less than 120-hp flywheel power with bucket-curling force of not less than 25,000 lbf and stick-crowd force of not less than 18,700 lbf; measured according to SAE J-1179.
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp flywheel power and developing a minimum of 45,000-lbf breakout force; measured according to SAE J-732.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

J. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.
3. Laboratory compaction curve according to ASTM D 1557 for each on-site or borrow soil material proposed for fill and backfill.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, GC, SW, SP, SC, ML, CL, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: ASTM D 2487 soil classification groups MH, CH, OL, OH, and PT, or a combination of these group symbols.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Slab-0n-Grade Subgrade: VDOT No. 21-A dense graded aggregate.

G. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Blasting is not permitted on the project.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: 12 inches on each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 APPROVAL OF SUBGRADE

A. Notify Geotechnical Engineer when excavations have reached required subgrade.

B. If Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

C. Proof roll subgrade with suitable equipment approved by the Geotechnical Engineer to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Geotechnical Engineer.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Architect.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Inspecting and testing underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.11 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Backfill trenches excavated under footings and within 18 inches of bottom of footings; fill with concrete to elevation of bottom of footings.

C. Coordinate backfilling with utilities testing.

D. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.

E. Place and compact final backfill of satisfactory soil material to final subgrade.

F. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under slabs.

3.12 FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

C. Place and compact fill material in layers to required elevations as follows:

1. Under building slabs, use satisfactory fill.
2. Under footings and foundations, use engineered fill.

3.13 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 3 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 3 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, and steps, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill material at 95 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 02305

SECTION 32 13 16 DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

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

B. Section Includes:

1. Integrally colored concrete driveway under porte cochere.
2. Stamping/Imprinting.
3. Curing of integrally colored and imprinted concrete.

C. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for general applications of concrete and coordination of sample submittal [and color selection].
2. Division 07 Section "Joint Sealants" for colored sealants for joints.

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 301 "Specification for Structural Concrete for Buildings."
2. ACI 302 IR "Recommended Practice for Concrete Floor and Slab Construction."
3. ACI 303.1 "Standard Specification for Cast-In-Place Architectural Concrete."
4. ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing of Concrete."
5. ACI 305R "Recommended Practice for Hot Weather Concreting."
6. ACI 306R "Recommended Practice for Cold Weather Concreting."

B. American Society for Testing and Materials (ASTM):

1. ASTM C309 "Liquid Membrane-Forming Compounds for Curing Concrete."
2. ASTM C494 "Standard Specification for Chemical Admixtures for Concrete."
3. ASTM C979 "Standard Specification for Pigments for Integrally Colored Concrete."

C. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M194 "Chemical Admixtures."

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's complete technical data sheets for the following:

1. Colored admixture.
2. Powder antiquing release agent.
3. Imprinting/Texturing tools.
4. Curing compound.

B. Design Mixes: For each type of integrally colored concrete.

C. Qualification Data: For firms indicated in "Quality Assurance" Article, including list of completed projects.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer with 10-years experience in production of specified products.

B. Installer Qualifications: An installer with 5-years experience with work of similar scope and quality.

C. Comply with the requirements of ACI 301.

D. Obtain each specified material from same source and maintain high degree of consistency in workmanship throughout Project.

E. Notification of manufacturer's authorized representative shall be given at least 1-week before start of Work.

F. Integrally Colored Concrete Field Samples:

1. At location on Project selected by Architect, place and finish two (2) 8 by 8 feet areas, one area shall have the powder antiquing release agent applied and the other sample shall not have the antiquing agent applied.
2. For accurate color, the quantity of concrete mixed to produce the sample should not be less than 3 cubic yards (or not less than 1/3 the capacity of the mixing drum on the ready-mix truck) and should always be in full cubic yard increments. Excess material shall be discarded according to local regulations.
3. Construct sample panel using processes and techniques intended for use on permanent work, including curing procedures. Include samples of control, construction, and expansion joints in sample panels. Field sample shall be produced by the individual workers who will perform the work for the Project.
4. Retain samples of cements, sands, aggregates and color additives used in mockup for comparison with materials used in remaining work.
5. Accepted field sample provides visual standard for work of Section.
6. Field sample shall remain through completion of the work for use as a quality standard for finished work.
7. Remove field sample when directed.

1.5 DELIVERY, STORAGE AND HANDLING

A. Colored Admixture: Comply with manufacturer's instructions. Deliver colored admixtures in original, unopened packaging. Store in dry conditions.

1.6 PROJECT CONDITIONS

A. Integrally Colored Concrete Environmental Requirements:

1. Schedule placement to minimize exposure to wind and hot sun before curing materials are applied.
2. Avoid placing concrete if rain, snow, or frost is forecast within 24-hours. Protect fresh concrete from moisture and freezing.
3. Comply with professional practices described in ACI 305R and ACI 306R.

B. Schedule delivery of concrete to provide consistent mix times from batching until discharge. Mix times shall meet manufacturer’s written recommendations.

1.7 PRE-JOB CONFERENCE

A. One week prior to placement of integrally colored concrete, a meeting shall be held to discuss the Project and application methods.

B. General Contractor, Subcontractor, Ready-Mix Concrete Representative, and a Manufacturer's Representative be present.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Sika Corporation (Scofield brand).

2.2 MATERIALS

A. Colored Admixture for Integrally Colored Concrete: CHROMIX® P Admixtures, CHROMIX® G Admixtures, and CHROMIX® L Admixtures, Sika Corporation.

1. Admixture shall be a colored, water-reducing, admixture containing no calcium chloride with coloring agents that are lime proof and UV resistant.
2. Colored admixture shall conform to the requirements of ACI 303.1, ASTM C979, ASTM C494, and AASHTO M194.

B. Stamping/Imprinting Tools and Materials: LITHOTEX® Pavecrafters® imprinting tools, Sika Corporation.

C. Powder Antiquing Release Agent: LITHOCHROME® Antiquing Release Pro, Sika Corporation.

1. Powder antiquing release agent shall be recommended by pattern tool manufacturer and compatible with integral color additives.

D. Curing and Sealing Compound: Scofield® Cureseal-W™ Semi Gloss, Sika Corporation. Curing and sealing compound shall comply with ASTM C309 and be of same manufacturer as colored admixture, for use with integrally colored concrete.

2.3 **COLORS** AND PATTERNS

A. Concrete Colors:

1. Cement: Color shall be gray.
2. Sand: Color shall be locally available natural sand.
3. Aggregate: Concrete producer's standard aggregate complying with specifications.
4. Colored Admixture: C-12, Mesa Beige.
5. Stamp/Imprinting Pattern: Rugged Texture, Heavy Stone.
6. Powder Antiquing Release Agent: As selected by Architect from manufacturer's standard colors..

B. Curing Compound: Color to match colored concrete.

2.4 CONCRETE MIX DESIGN

A. Refer to Division 3 Section "Cast-In-Place Concrete.".

B. Slump of concrete shall be consistent throughout Project at 4-inches or less. At no time shall slump exceed 5-inches.

C. Do not add calcium chloride to mix as it causes mottling and surface discoloration.

D. Supplemental admixtures shall not be used unless approved by manufacturer.

E. Do not add water to the mix in the field.

F. Add colored admixture to the mix according to manufacturer's written instructions in premeasured bags, not by weight of cement content.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install concrete according to requirements of Division 3 Section "Cast-In-Place Concrete."

B. Do not add water to the mix in the field.

C. Surfaces shall be finished uniformly with the following finish:

1. Stamped/Imprinted: Apply pattern according to tool manufacturer's instructions. Touch-up pattern and finish edges with hand tools as necessary.

3.2 CURING

A. Integrally Colored Concrete: Apply curing and sealing compound for integrally colored concrete according to manufacturer's instructions using manufacturer's recommended application techniques. Apply curing and sealing compound at consistent time for each pour to maintain close color consistency.

B. Curing compound shall be same color as the colored concrete and supplied by same manufacturer of the colored admixture.

C. Precautions shall be taken in hot weather to prevent plastic cracking resulting from excessively rapid drying at surface as described in CIP 5 *Plastic Shrinkage Cracking* published by the National Ready Mixed Concrete Association.

D. Do not cover concrete with plastic sheeting.

3.3 TOLERANCES

A. Minor variations in appearance of colored concrete, which are similar to natural variations in color and appearance of uncolored concrete, are acceptable.

3.4 APPLICATORS

A. For a list of qualified contractors, contact your local Scofield representative.

END OF SECTION 32 13 16