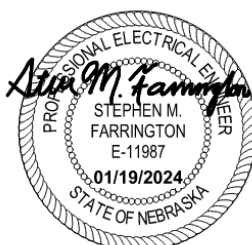


BVH Architects Woodhouse Ford Pro Omaha, Nebraska

BVHARCHITECTURE



Woodhouse
Ford PRO



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Facility Services Subgroup

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SECTION 210100 – GENERAL REQUIREMENTS 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.
- B. Division 21, 22 and 23 Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes general fire suppression requirements and shall apply to all phases of the work specified, indicated on the drawings or required to provide for complete installation of fire suppression systems.
- B. Refer to Section 230100 for “General Requirements for Mechanical Systems.”
- C. Refer to Section 230500 for “Basic Mechanical Materials and Methods.”
- D. Refer to Section 230505 for “Basic Mechanical Piping Materials and Methods.”

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 210100

SECTION 211000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following fire-suppression piping inside the building:
 - 1. Wet-pipe sprinkler systems.

1.3 SYSTEM DESCRIPTIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire-suppression system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications: Per NFPA 13.
 - 3. Minimum Density for Automatic-Sprinkler Piping Design: Per NFPA 13.
 - 4. Maximum Protection Area per Sprinkler: Per UL listing.
 - 5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13.

1.5 SUBMITTALS

- A. Qualification Data: Fire sprinkler designer with NICET-III certification or registered professional fire protection engineer.
- B. Product Data: For the following:
 - 1. Piping materials, including sprinkler specialty fittings.
 - 2. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
 - 3. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
 - 4. Hose connections, including size, type, and finish.

5. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
 6. Alarm devices, including electrical data.
- C. Fire-hydrant flow test report.
- D. Preliminary Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, submitted to Architect/Engineer for preliminary review prior to submitting to authorities having jurisdiction.
- E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- G. Operation and Maintenance Data: For sprinkler specialties include in emergency, operation, and maintenance manuals.
- H. See "Submittal Schedule" at the end of Section 230100 "General Requirements for Mechanical Systems."

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified fire sprinkler designer with NICET-III certification or registered professional fire protection engineer.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13, "Installation of Sprinkler Systems."
 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
 3. NFPA 230, "Fire Protection of Storage."

1.7 COORDINATION

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

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

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.
 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

2.2 CORROSION PROTECTION PIPING ENCASEMENT

- A. Encasement for underground ductile iron piping:
 1. Standards: ASTM A 674 or AWWA C105.
 2. Form: Sheet or tube.
 3. Material: LLDPE film of 0.008-inch minimum thickness, or high-density, cross laminated PE film of 0.004-inch minimum thickness.
 4. Color: Black

2.3 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.
 1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Couplings: ASTM A 865.
- B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795.
 1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
- C. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795.
 1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- D. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut- or roll-grooved ends.
 1. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.

2. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.
- E. Threaded-End, 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; with factory- or field-threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
 5. Steel Threaded Couplings: ASTM A 865.
- F. Plain-End, 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.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
- G. Plain-End, 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.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- H. Grooved-End, 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; with factory- or field-formed, roll-grooved ends.
1. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 2. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, **[pre-lubricated]** rubber gasket listed for use with housing, and steel bolts and nuts.
- I. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
- J. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13 specified wall thickness in NPS 6 to NPS 10.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.

- K. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.
 - 1. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - 2. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.
- L. Galvanized Piping: Where indicated, or where required by code, steel piping shall be galvanized.

2.4 COPPER TUBE AND FITTINGS

- A. Plain-End, Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) or ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only 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 tubing system.
 - 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, Mechanically Formed Tee Option: For forming T-branch on copper water tube.
 - 5. Brazing Filler Metals: AWS A5.8, BCuP-3 or BCuP-4.

2.5 DIELECTRIC FITTINGS

- A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.
- B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.
- C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.
- D. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.
- E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225 deg F.
- F. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 225 deg F.

2.6 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.

- B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
- C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
- D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
- E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

2.7 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.
- B. Gate Valves with Wall Indicator Posts:
 - 1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, non-rising stem, operating nut, and flanged ends. Gate valves shall be used only where required by code.
- C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
 - 1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 3. NPS 3: Ductile-iron body with grooved ends.
- D. Butterfly Valves: UL 1091.
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
- E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
- F. Gate Valves: UL 262, OS&Y type. Gate valves shall be used only where required by code.
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
- G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
 - 1. Indicator: Electrical, 115-V ac, prewired, supervisory switch.
 - 2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
 - 3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

2.8 UNLISTED GENERAL-DUTY VALVES

- A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.
- B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

- C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends. Gate valves shall be used only where required by code.
- D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends. Globe valves shall be used only where required by code.

2.9 SPECIALTY VALVES

- A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating.
 - 1. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
- B. Pressure-Regulating Valves: UL 1468, brass or bronze, 400-psig minimum rating. Include female NPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as indicated.
- C. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.

2.10 FLEXIBLE SPRINKLER HOSE FITTINGS

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Victaulic Company.
 - b. Reliable Automatic Sprinkler Co.
- 2. Standard: UL 1474.
- 3. Type: Braided flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
- 4. Pressure Rating: 175-psig minimum.
- 5. Size: Same as connected piping, for sprinkler.
- 6. Maximum Length: 36 inches.

2.11 SPRINKLERS

- A. Sprinklers shall be UL listed and FMG approved, with 175-psig minimum pressure rating.
- B. Automatic Sprinklers: With heat-responsive element complying with the following:
 - 1. UL 199, for nonresidential applications.
- C. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- D. Sprinkler types, features, and options as follows:
 - 1. Concealed ceiling sprinklers, including flat cover plates.
 - 2. Extended-coverage sprinklers.
 - 3. Flush ceiling sprinklers, including escutcheon.
 - 4. Pendent sprinklers.

5. Pendent, dry-type sprinklers.
 6. Flexible, dry-type sprinklers. - Vicflex, no equal
 7. Quick-response sprinklers.
 8. Recessed sprinklers, including escutcheon.
 9. Sidewall sprinklers.
 10. Sidewall, dry-type sprinklers.
 11. Upright sprinklers.
- E. Sprinkler Finishes: Chrome plated, bronze, and painted.
- F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Color selected by Architect from supplier's standard colors.
 2. Sidewall Mounting: Color selected by Architect from supplier's standard colors.
- G. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.12 FIRE DEPARTMENT CONNECTIONS

- A. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."
1. Type: Exposed, projecting, with two inlets and round escutcheon plate.
 2. Finish: Selected by Architect.

2.13 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm: UL 464, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
- C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
- E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
- F. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

2.14 PRESSURE GAGES

- A. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.
 - 1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

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 Part 1 "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 EARTHWORK

- A. Refer to Architectural and Civil documents 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 thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING APPLICATIONS, GENERAL

- A. Shop weld pipe joints where welded piping is indicated.
- B. Do not use welded joints for galvanized-steel pipe.
- C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- D. Piping between Fire Department Connections and Check Valves: Galvanized standard-weight steel pipe with threaded ends; or grooved joints.
- E. Underground Service-Entrance Piping: Ductile-iron, mechanical-joint pipe and fittings and restrained joints. Provide corrosion protection encasement on all underground pipe and fittings. Match piping specified in Division 33 sections.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

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

1. Sprinkler Mains:
 - a. Steel piping as allowed by NFPA 13 and Authority Having Jurisdiction with wall thickness of schedule 10 or greater.
 - b. Copper piping as allowed by NFPA 13 and Authority Having Jurisdiction.
2. Branch Piping:
 - a. Steel piping as allowed by NFPA 13 and Authority Having Jurisdiction with wall thickness of schedule 10 or greater.
 - b. Copper piping as allowed by NFPA 13 and Authority Having Jurisdiction.

3.6 VALVE APPLICATIONS

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

1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves. Gate valves shall be used only where required by code.
2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves. Gate valves shall be used only where required by code.
 - b. Throttling Duty: Use ball valves.

3.7 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Piping Materials and Methods" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- C. Twist-Locked Joints: Insert plain-end piping into locking-lug fitting and rotate retainer lug one-quarter turn.
- D. Pressure-Sealed Joints: Use UL-listed tool and procedure. Include use of specific equipment, pressure-sealing tool, and accessories.
- E. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
 1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.

2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
3. Copper Tube: Roll-groove tubing. Use grooved-end fittings and grooved-end-tube couplings.
4. General Requirements:
 - a. All grooved joint couplings, fittings, valves, and specialties shall be the products of a same manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - b. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
 - c. Couplings shall be fully installed at visual pad-to-pad offset contact. Couplings that require gapping of bolt pads or specific torque ratings for proper installation are not permitted.
 - d. Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service. A factory trained representative (direct employee) of the coupling manufacturer shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation to ensure best practices in grooved joint installation are being followed. Contractor shall remove and replace any improperly installed products.

F. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.

1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.8 SERVICE-ENTRANCE PIPING

- A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 33 for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Refer to Division 22 for backflow preventers.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.9 PIPING INSTALLATION

- A. Refer to Division 23 Section "Basic Mechanical Piping Materials and Methods" for basic piping installation.
- B. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints.
- D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

- F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler zone control valves, test assemblies, and drain risers.
- J. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- K. Install alarm devices in piping systems.
- L. Hangers and Supports: Comply with NFPA 13 for hanger materials.
- 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. Fill wet-pipe sprinkler system piping with water.

3.10 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
- D. Specialty Valves:
 - 1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.11 SPRINKLER APPLICATIONS

- A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Concealed sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Pendent, dry sprinklers or Sidewall, dry sprinklers.
 - 5. Special Applications: Extended-coverage and quick-response sprinklers where required.
 - 6. Sprinkler Finishes:

- a. Upright, Pendent, and Sidewall Sprinklers: Color selected by Architect from standard supplier color options in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view;.
- b. Concealed Sprinklers: Rough brass, with factory-painted white flat cover plate.

3.12 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire department connections in vertical wall.
- B. Install ball drip valve at each check valve for fire department connection.

3.14 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Plumbing Specialties" for backflow preventers.
- D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- F. Electrical Connections: Power wiring is specified in Division 26.
- G. Coordinate with Electrical contractor to connect alarm devices to fire alarm.

3.15 LABELING AND IDENTIFICATION

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

3.16 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Energize circuits to electrical equipment and devices.
4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
5. Coordinate with fire alarm tests. Operate as required.
6. Verify that equipment hose threads are same as local fire department equipment.

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

3.17 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

3.18 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 211000

SECTION 220100 – GENERAL REQUIREMENTS 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. Division 21, 22 and 23 Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes general mechanical requirements and shall apply to all phases of the work specified, indicated on the drawings or required to provide for complete installation of plumbing systems.
- B. Refer to Section 230100 for “General Requirements for Mechanical Systems.”
- C. Refer to Section 230500 for “Basic Mechanical Materials and Methods.”
- D. Refer to Section 230505 for “Basic Mechanical Piping Materials and Methods.”

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220100

SECTION 220523 – VALVES FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes general duty valves common to several mechanical piping systems. Special purpose valves are specified in Division 22 piping system Sections.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.
- C. Maintenance data for valves to include in the operation and maintenance manual specified in Division 01. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.
- D. See "Submittal Schedule" at the end of Section 230100 "General Requirements for Mechanical Systems."

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- B. All valves used in potable water service shall be certified lead free per NSF-61G and NSF 372.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Division.

- b. Hammond Valve Corporation.
- c. Milwaukee Valve Company, Inc.
- d. NIBCO Inc.
- e. Stockham Valves & Fittings, Inc.
- f. Tyler Pipe.
- g. Victaulic Company of America.

2. Check Valves:

- a. Cla-Val Co.
- b. Conbraco Industries, Inc.; Apollo Division.
- c. Hammond Valve Corporation.
- d. Keystone Valve USA, Inc.
- e. Kitz Corp. of America.
- f. Metraflex Company.
- g. Milwaukee Valve Company, Inc.
- h. NIBCO Inc.
- i. Red-White Valve Corp.
- j. Stockham Valves & Fittings, Inc.
- k. Tyler Pipe.
- l. Val-Matic Valve & Mfg. Corp.
- m. Victaulic Company of America.

2.2 BASIC, COMMON FEATURES

- A. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.
- B. Sizes: Same size as upstream pipe, unless otherwise indicated.
- C. Operators: Use specified operators and handwheels, except provide the following special operator features:
 - 1. Lever Handles: For quarter-turn valves 6 inches and smaller.
- D. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- E. Threads: ASME B1.20.1.
- F. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.
- G. Solder Joint: ASME B16.18.

2.3 BRONZE BALL VALVES

- A. Ball Valves, 4 Inches and Smaller: MSS SP-110, Class 150, 600-psi CWP, ASTM B 584 or ASTM B283 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for 1/2-inch valves and smaller and conventional port for 3/4-inch valves and larger; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections, lever handle operator. Valves shall be certified lead free.

2.4 CHECK VALVES

- A. Swing Check Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections. Valves shall be certified lead free.
- B. Wafer Check Valves: Class 125, 200-psi CWP, ASTM A 126 cast-iron body, bronze disc/plates, stainless-steel pins and springs, Buna N seals, installed between flanges. Valves shall be certified lead free.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

- A. Install valves as indicated, according to manufacturer's written instructions.
- B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the center of the pipe.
- F. Install valves in a position to allow full stem movement.
- G. Installation of Check Valves: Install for proper direction of flow as follows:
 - 1. Swing Check Valves: Horizontal position with hinge pin level.
 - 2. Wafer Check Valves: Horizontal or vertical position, between flanges.

3.3 VALVE END SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2-1/2 Inches and Smaller: Solder ends.

3.4 APPLICATION SCHEDULE

A. General Application:

1. Use ball valves for shutoff duty.
2. Use ball valves for throttling duty.
3. Refer to piping system Specification Sections for specific valve applications and arrangements.

B. Domestic Water Systems: Use the following valve types:

1. Ball Valves: Class 150, 600-psi CWP, with stem extension.
2. Bronze Swing Check: Class 125, with rubber seat.
3. Check Valves: Class 125, swing or wafer type as indicated.

3.5 ADJUSTING

A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION 220523

SECTION 220720 - PIPE INSULATION FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 SUBMITTALS

- A. Product Data: Include product data description, list of materials, thickness, density and k-values for each product type, locations, manufacturer's installation instructions, flames spread and smoke developed ratings.
- B. See "Submittal Schedule" at the end of Section 230100 "General Requirements for Mechanical Systems."

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.

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.

2.2 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.
 - a. Nominal density is 2.5 lb/cu. Ft. or more.
 - b. Thermal conductivity (k-value) at 100 deg F is 0.28 Btu x in./h x sq. ft. x deg F or less
 - 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.
 - 5. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
- B. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
- C. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.
 - 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.

2.3 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, pre-sized a minimum of 8 oz./sq. yd, 4 inch tape width.
- B. Bands: 3/4 inch wide, materials compatible with jacket:
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

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 AND PREPARATION

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

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

3.2 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. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- D. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- E. Apply insulation with the least number of joints practical.
- F. 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.
- G. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
- H. 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.
- I. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- J. 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.
 - 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.
- K. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.
- L. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- M. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.
- N. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

3.3 MINERAL-FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes by securing each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
- B. Apply preformed pipe insulation to outer diameter of pipe flange.
- 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.
- 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.
 3. 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.
 4. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.4 INSULATION APPLICATION SCHEDULE

- A. 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. Chrome-plated pipes and fittings, unless potential for personnel injury.
 4. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

B. See drawings for “PIPING INSULATION SCHEDULE”.

END OF SECTION 220720

SECTION 221116 - WATER DISTRIBUTION 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 water distribution piping from locations indicated to fixtures and equipment inside building.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the 125 psig minimum working-pressure ratings, unless otherwise indicated:

1.4 QUALITY ASSURANCE

- A. Provide listing/approval stamp, label, or other marking on piping made to specified standards.
- B. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
- C. NSF Compliance:
 - 1. Comply with NSF 61 Annex G for materials for water-service piping and specialties for domestic water.
- D. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.5 SUBMITTALS

- A. Product Data: Tube and fittings.
- B. System purging and disinfecting activities report.
- C. Field quality-control reports.
- D. See "Submittal Schedule" at the end of Section 230100 "General Requirements for Mechanical Systems."

1.6 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPES AND TUBES

- A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.
- B. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.

2.3 PIPE AND TUBE FITTINGS

- A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.
- B. Copper, Solder-Joint Pressure Fittings: ASME B16.18 cast-copper alloy or ASME B16.22 wrought copper.
- C. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- E. Copper Unions: ASME B16.18, cast-copper-alloy, hexagonal-stock body with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends. Include threads conforming to ASME B1.20.1 on threaded ends.
- F. Pressure-Seal-Joint Fittings, Copper or Bronze - Domestic Water:
 - 1. Source Limitations: Obtain pressure-seal-joint fittings, copper or bronze, from single manufacturer.
 - 2. Housing: Copper.
 - 3. O-Rings and Pipe Stops: EPDM.
 - 4. Tools: Manufacturer's special tools.
 - 5. Minimum 200 psig working-pressure rating at 250 deg F.

2.4 JOINING MATERIALS

- A. General: Applications of the following piping joining materials are indicated in Part 3 "Piping Applications" Article.
- B. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for commonly used joining materials.
- C. Solder: ASTM B 32, Alloy Sn95, Sn94, or E; lead free.
- D. Brazing Filler Metal: AWS A5.8, BCuP, copper phosphorus or BAg, silver classification.
- E. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.
- F. Mechanical Couplings for Grooved-End Copper Tubing: Copper-tube dimensions and design similar to AWWA C606, ferrous housing sections, EPDM-rubber gaskets suitable for domestic hot and cold water (gasket to serve as dielectric fitting), bolts and nuts. Minimum pressure rating = 300 psig.

2.5 VALVES

- A. Refer to Division 22 Section "Valves for Plumbing" for general-duty valves.
- B. Refer to Division 22 Section "Plumbing Specialties" for special-duty valves.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.
- B. Fitting Option: Mechanically formed tee-branch outlets and brazed joints may be used on aboveground copper tubing.
- C. Water Distribution Piping:
 - 1. Aboveground (2-1/2 Inch NPS and Smaller): Hard copper tube, Type L; copper, solder-joint fittings; and soldered joints or copper pressure-seal-joint fittings; and pressure-sealed joints.

3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball, or butterfly valves.
 - 2. Throttling Duty: Use ball or butterfly valves.

3.3 PIPING INSTALLATION, GENERAL

- A. Refer to Division 23 Section "Basic Mechanical Piping Materials and Methods" for basic piping installation.
- B. Install piping level without pitch or with 0.25 percent slope downward toward drain when drains are indicated.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Mechanically Formed Outlets: Form tee in copper tube according to equipment manufacturer's written instructions. Use tool designed for copper tube, drill pilot hole, form collar for outlet, dimple tube forming seating stop, and braze branch tube into collar.
- C. Grooved Joints: Assemble joints with coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- D. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

3.5 VALVE INSTALLATION

- A. Sectional Valves: Install sectional valves close to main on each branch and riser serving plumbing fixtures or equipment, and where indicated. Use ball valves for piping 2-inch NPS and smaller.
- B. Shutoff Valves: Install shutoff valve on each water supply to equipment, on each supply to plumbing fixtures without supply stops, and where indicated. Use ball valves for piping 2-inch NPS and smaller.
- C. Drain Valves: Install hose-end drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

3.6 FIELD QUALITY CONTROL

- A. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- B. Test water distribution 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 interior piping uncovered and unconcealed new, altered, extended, or replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 3. Cap and subject piping to static water pressure as required by the local Plumbing Code. If the local Plumbing Code does not stipulate testing requirements, cap and subject piping to static water pressure of 100 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 15 minutes. Leaks and loss in test pressure constitute defects that must be repaired.

4. If testing is to be performed at temperatures below freezing, an air test may be performed in lieu of water testing if allowed by local plumbing code and approved by engineer.
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.

3.7 CLEANING

- A. Clean and disinfect service entrance piping and water distribution piping as follows:
 1. Purge new piping and parts of existing water piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, procedure 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 3 hours.
 - c. Flush system with clean, potable water until chlorine is no longer in water coming from system after the standing time.
- B. Prepare and submit reports for purging and disinfecting activities.
- C. Clean interior of piping system. Remove dirt and debris as work progresses.

3.8 START-UP

- A. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- B. Perform the following steps before putting into 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.
- C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

END OF SECTION 221116

SECTION 221316 - DRAINAGE 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 sanitary drainage and vent piping inside building and to locations indicated.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Soil, Waste and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Test Results and Reports: Specified in "Field Quality Control" Article.
- B. See "Submittal Schedule" located at the end of Section 230100 "General Requirements for Mechanical Systems."

1.5 QUALITY ASSURANCE

- A. Provide listing/approval stamp, label, or other marking on piping made to specified standards.
- B. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.6 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PIPES AND TUBES

- A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.
- B. Hub-and-Spigot, Cast-Iron Soil Pipe: ASTM A 74, Service and Extra Heavy classes. Include ASTM C 564 rubber gasket, with dimensions required for pipe class, for each hub.
- C. Hubless, Cast-Iron Soil Pipe: ASTM A 888 or CISPI 301.
- D. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
- E. Hard Copper Tube: ASTM B 306, drainage tube, drawn temper.

2.2 PIPE AND TUBE FITTINGS

- A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.
- B. Threaded-Fitting, End Connections: ASME B1.20.1.
- C. Hub-and-Spigot, Cast-Iron, Soil-Pipe Fittings: ASTM A 74, Service and Extra Heavy classes, hub and spigot. Include ASTM C 564 rubber gasket, with dimensions required for pipe class, for each hub.
- D. Hubless, Cast-Iron, Soil-Pipe Fittings: CISPI 301.
- E. Copper, Solder-Joint Drainage Fittings: ASME B16.23 cast copper or ASME B16.29 wrought copper.

2.3 JOINING MATERIALS

- A. Refer to Division 23 Section "Basic Mechanical Piping Materials and Methods" for commonly used joining materials.
- B. Solder: ASTM B 32, Alloy Sn95, Sn94, or E; lead free.
- C. Hubless, Cast-Iron, Soil-Piping Couplings: CISPI 310/NSF assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve or gasket with integral, center pipe stop. Neoprene Couplings with stainless steel clamps.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.
- B. Aboveground, Sanitary Waste and Vent Piping: Use the following:
 - 1. 1-1/2 to 4-Inch NPS: Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and hubless, cast-iron, soil-piping couplings.

2. 1-1/4 to 4-Inch NPS: Hard copper drainage tube; copper, solder-joint drainage fittings; and soldered joints.
- C. Underground, Sanitary Waste and Vent Piping: Use the following:
1. 2- to 4-Inch NPS: Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.
 2. 2- to 4-Inch NPS: Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and hubless, cast-iron, soil-piping couplings.

3.2 PIPING INSTALLATION

- A. Refer to Division 23 Section "Basic Mechanical Piping Materials and Methods" for basic piping installation.
- B. Install wall penetration system at each service entrance pipe penetration through foundation wall. Make installation watertight. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for wall penetration systems.
- C. 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."
- D. Make changes in direction for 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 make change in direction of flow greater than 90 degrees. Use proper size of standard increasers and reducers if different sizes of piping are connected. Reducing size of drainage piping in direction of flow is prohibited.
- E. Lay buried building drain 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.
- F. Install drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 1. Sanitary Drain: Unless otherwise indicated, 1/4" per foot downward in direction of flow for piping 3-inch NPS and smaller; 1/8" per foot downward in direction of flow for piping 4-inch NPS and larger.
 2. Vent Piping: 1/8" per foot downward toward vertical fixture vent or toward vent stack.
- G. 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. Compression Joints: Make with rubber gasket matching class of pipe and fittings.
 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- H. Install indirect waste piping per local code requirements. Maintain code required air gaps.

3.3 FIELD QUALITY CONTROL

- A. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- B. Test drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedure, 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 has been covered or concealed before it has been tested and approved.
 - 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 feet of head. Water level must not drop from 15 minutes before inspection starts through completion of inspection. 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 using new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.4 CLEANING AND PROTECTING

- A. Clean interior of piping system. 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 221316

SECTION 221319 - 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 plumbing specialties for the following:
 - 1. Water distribution systems.
 - 2. Soil, waste, and vent systems.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Water Distribution Piping: 125 psig.
 - 2. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Product Data: For each plumbing specialty indicated. Include rated capacities of selected equipment 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 plumbing specialty products:
 - 1. Backflow preventers.
 - 2. Hose bibbs and hydrants.
 - 3. Outlet boxes.
 - 4. Cleanouts.
 - 5. Floor drains.
 - 6. Vent caps, vent terminals, and roof flashing assemblies.
- B. Maintenance Data: For specialties to include in the maintenance manuals. Include the following:
 - 1. Backflow preventers.
- C. See "Submittal Schedule" located at the end of Section 230100 "General Requirements for Mechanical Systems."

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, dimensional requirements, and characteristics of plumbing specialties and are based on the specific types and models indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- B. Provide listing/approval stamp, label, or other marking on plumbing specialties made to specified standards.
- C. Listing and Labeling: Provide electrically operated plumbing specialties specified in this Section that are listed and labeled as defined in National Electrical Code, Article 100.
- D. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Backflow Preventers:
 - a. Ames Co., Inc.
 - b. B & K Industries, Inc.
 - c. Cla-Val Co.
 - d. CMB Industries; Febco Div.
 - e. Conbraco Industries, Inc.
 - f. FLOMATIC Corp.
 - g. Grinnell Corp.; Mueller Co. Marketing Group for Hersey Products Div.
 - h. IMI Cash Valve.
 - i. Sparco, Inc.
 - j. Watts Industries, Inc.; Water Products Div.
 - k. Zurn Industries, Inc.; Wilkins Div.
 - 2. Thermostatic Water Mixing Valves:
 - a. Acorn
 - b. Lawler Manufacturing Co., Inc.
 - c. Leonard Valve Co.
 - d. Mark Controls Corp.; Powers Process Controls.
 - e. Symmons Industries, Inc.
 - f. T & S Brass and Bronze Works, Inc.
 - 3. Outlet Boxes:
 - a. Acorn Engineering Co.
 - b. Guy Gray Manufacturing Co., Inc.
 - c. IPS Corp.
 - d. LSP-Specialty Products Co.
 - e. Oatey Co.
 - f. Plastic Oddities, Inc.
 - g. Symmons Industries, Inc.
 - 4. Hydrants:

- a. Enpoco, Inc.
- b. Josam Co.
- c. Murdock, Inc.
- d. Smith: Jay R. Smith Mfg. Co.
- e. Tyler Pipe; Wade Div.
- f. Watts Industries, Inc.; Ancon Drain Div.
- g. Watts Industries, Inc.; Water Products Div.
- h. Woodford Manufacturing Co.
- i. Zurn Industries, Inc.; Hydromechanics Div.

5. Floor Drains, Drain Specialties

- a. Josam Co.
- b. Sioux Chief Manufacturing Co., Inc.
- c. Smith: Jay R. Smith Mfg. Co.
- d. Tyler Pipe, Wade Div.
- e. Watts Industries, Inc., Ancon Drain Div.
- f. Zurn Industries, Inc., Hydromechanics Div.
- g. MIFAB, Inc.

6. Trench Drains:

- a. ACO USA
- b. Josam Co.
- c. Smith: Jay R. Smith Mfg. Co.
- d. Tyler Pipe, Wade Div.
- e. Watts Industries, Inc.
- f. Zurn Industries, Inc.
- g. MIFAB, Inc.

2.2 BACKFLOW PREVENTERS

- A. General: ASSE standard, backflow preventers, of size indicated for maximum flow rate and maximum pressure loss indicated.
 - 1. 2-Inch NPS and Smaller: Bronze body with threaded ends.
 - 2. Interior Components: Corrosion-resistant materials.
 - 3. Exterior Finish: Polished chrome-plate if used in chrome-plated piping system.
 - 4. Strainer on inlet.
- B. Pipe-Applied, Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.
- C. 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.
- D. Double-Check Backflow Prevention Assemblies: ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; and test cocks with 2 positive-seating check valves.
- E. Hose-Connection Backflow Preventers: ASSE 1052, suitable for at least 3-gpm flow and applications with up to 10-foot head back pressure. Include 2 check valves; intermediate atmospheric vent; and nonremovable, ASME B1.20.7 garden-hose thread on outlet.

2.3 THERMOSTATIC WATER MIXING VALVES

- A. General: ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body. Include check stop and union on hot- and cold-water-supply inlets, adjustable temperature setting, and capacity at pressure loss as indicated.
 - 1. Bimetal Thermostat, Operation and Pressure Rating: 125 psig minimum.
 - 2. Liquid-Filled Motor, Operation and Pressure Rating: 100 psig minimum.
- B. Thermostatic Water Mixing Valves: Unit, with the following:
 - 1. Piping, of sizes and in arrangement indicated. Include valves and unions.
 - 2. Piping Component Finish: Polished chrome-plate.
 - 3. Piping Component Finish: Satin spray.
 - 4. Piping Component Finish: Rough brass.
 - 5. Cabinet: Steel box with steel hinged door and white enameled finish.
 - 6. Cabinet: Stainless-steel box with stainless-steel hinged door.
 - 7. Cabinet Mounting: Recessed.
 - 8. Cabinet Mounting: Surface.
 - 9. Thermometer: Manufacturer's standard.
- C. Single Fixture under counter thermostatic mixing valves. Rough chrome, thermostatic mixing valve with adjustable outlet temperature, integral check valves on both inlets, elastomer seal to prevent cross connection from hot to cold.

2.4 OUTLET BOXES

- A. General: Recessed-mounting outlet boxes with fittings complying with ASME A112.18.1M. Include box with faceplate, services indicated for equipment connections, and wood-blocking reinforcement.
- B. Ice Maker Outlet Boxes: With recessed box and faceplate, hose connection and shut-off valve.

2.5 INTERCEPTORS

- A. Oil Interceptor: Construct oil interceptor per local code requirements.
- B. Solids Interceptor: Construct solids interceptor per local code requirements.

2.6 HYDRANTS

- A. See drawings for "PLUMBING SPECIALTIES SCHEDULE"

2.7 CLEANOUTS

- A. Cleanout Plugs: Cast iron or brass, threads complying with ANSI B2.1, countersunk head. Engrave heads to identify system.
- B. Floor Cleanouts: Cast iron body and frame with cleanout plug and adjustable round nickel bronze top. Provide to match floor system:
 - 1. Exposed finish type, standard mill finish.

2. Exposed flush type, standard non-slip scored or abrasive finish.
 3. Exposed flush type, standard mill finish and carpet marker.
 4. Heavy duty for traffic applications.
- C. Wall Cleanouts: Cast iron body adaptable to pipe with cast bronze, brass cleanout plug; stainless steel cover, vandal proof screws.
- 2.8 FLOOR DRAINS
- A. See drawings for "PLUMBING SPECIALTIES SCHEDULE"
- 2.9 TRENCH DRAINS
- A. See drawings for "PLUMBING SPECIALTIES SCHEDULE"
- 2.10 FLASHING
- A. Floor Drains: Non-plasticized , chlorinated, polyethylene, concealed, water-proof membrane, 0.40" thick, solvent weldable. 48" square minimum.
- B. Vents thru Roof (VTR): 24" square minimum
1. Non-plasticized , chlorinated, polyethylene, concealed, water-proof membrane, 0.40" thick, solvent weldable.
 2. Lead sheet, 2-1/2" lb/sf, concealed
- 2.11 MISCELLANEOUS PIPING SPECIALTIES
- A. Domestic water expansion tanks: Precharged hydropneumatic expansion tank approved for potable water, with steel shell, polypropylene liner, stainless steel system connection and FDA diaphragm. Working temperature and pressure shall be 200°F and 150 psig. Tanks over 5 cubic feet capacity of 250 psi shall be ASME constructed.
- B. Roof Flashing Assemblies: Manufactured assembly made of 4-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting.
- C. Floor-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.
- D. Air-Gap Fittings: ASME A112.1.2, cast iron or cast bronze, with fixed air gap, inlet for drain pipe or tube, and threaded or spigot outlet.
- E. 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.
- F. Vent Terminals: Commercially manufactured, shop-fabricated or field-fabricated, frost-proof assembly constructed of galvanized steel, copper, or lead-coated copper. Size to provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing, as indicated.

PART 3 - EXECUTION

3.1 PLUMBING SPECIALTY INSTALLATION

- A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.
- B. Install backflow preventers of type, size, and capacity indicated, at each water-supply connection to mechanical equipment and systems, and to other equipment and water systems as indicated. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment. Install air-gap fitting on units with atmospheric-vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer.
- C. Install cleanouts in aboveground piping and building drain piping as indicated, and where not indicated, according to the following:
 - 1. Size same as drainage piping up to 4-inch NPS. Use 4-inch NPS 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 4-inch NPS and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
 - 5. Install wall cleanout at the beginning of an above ground horizontal waste line which serves multiple water closets.
- D. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
- E. Install cleanout wall access covers with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- F. Install individual stop valve in each water supply to plumbing specialties. Use ball[, gate, or globe] valve if specific valve is not indicated. Install water-supply stop valves in accessible locations.
- G. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- H. Locate drainage piping as close as possible to bottom of floor slab supporting fixtures and drains.
- I. 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.
- J. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- K. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- L. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- M. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor or as indicated. Size outlets as indicated.
- N. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

- O. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
- P. Position floor drains for easy access and maintenance.
- Q. Install interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
- R. Install flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Arrange for electric-power connections to plumbing specialties and devices that require power. Electric power, wiring, and disconnect switches are specified in Division 26 Sections.
- C. Supply Runouts to Plumbing Specialties: Install hot- and cold-water-supply piping of sizes indicated, but not smaller than required by authorities having jurisdiction
- D. Drainage Runouts to Plumbing Specialties: Install drainage and vent piping, with approved trap, of sizes indicated, but not smaller than required by authorities having jurisdiction.

3.3 START-UP

- A. Before startup, perform the following checks:
 - 1. System tests are complete.
 - 2. Damaged and defective specialties and accessories have been replaced or repaired.
 - 3. Clear space is provided for servicing specialties.
- B. Before operating systems, perform the following steps:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open general-duty valves to fully open position.
 - 3. Remove and clean strainers.
 - 4. Verify that drainage and vent piping are clear of obstructions. Flush with water until clear.
- C. Startup Procedures: Follow manufacturer's written instructions. If no procedures are prescribed by manufacturer, energize circuits for electrically operated units. Start and run units through complete sequence of operations.
- D. Adjust operation and correct deficiencies discovered during commissioning.

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.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain, plumbing specialties.

END OF SECTION 221319

SECTION 223300 – 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 electric water heaters:
 - 1. Instantaneous electric water heaters.
 - 2. Light-commercial electric water heaters.
 - 3. Compression tanks.
 - 4. Water heater accessories.

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For electric water heaters to include in operation and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.
- E. See "Submittal Schedule" at the end of Section 230100 "General Requirements for Mechanical Systems."

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- 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 NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.
- E. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:

1. ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," for commercial water heaters.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period(s): From date of Substantial Completion:
 - a. Instantaneous Electric Water Heaters: One year.
 - b. Electric Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: One year.
 - c. Compression Tanks: One year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 INSTANTANEOUS ELECTRIC WATER HEATERS

- A. Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
 1. Manufacturers:
 - a. Chronomite Laboratories, Inc.
 - b. Controlled Energy Corporation.
 - c. Eemax, Inc.
 - d. Hot Aqua, Inc.
 - e. IMI Waterheating, Ltd.
 - f. Stiebel Eltron, Inc.
 2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.

- b. Pressure Rating: 150 psig.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: **[Flow-control fitting.] [Adjustable thermostat]**
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
3. Support: Bracket for wall mounting.

2.3 LIGHT-COMMERCIAL ELECTRIC WATER HEATERS

- A. Description: Comply with UL 174 for household, storage electric water heaters.

- 1. Manufacturers:
 - a. American Water Heater Company.
 - b. Bradford White Corporation.
 - c. Electric Heater Company (The); Hubbell Heaters Division.
 - d. GSW Water Heating Company.
 - e. Heat Transfer Products, Inc.
 - f. Lochinvar Corporation.
 - g. Rheem Water Heater Div.; Rheem Manufacturing Company.
 - h. Ruud Water Heater Div.; Rheem Manufacturing Company.
 - i. Smith, A. O. Water Products Company.
 - j. State Industries, Inc.
- 2. Storage-Tank Construction: Steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
- 3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
 - e. Jacket: Steel with enameled finish.
 - f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Screw-in immersion type; wired for simultaneous or non-simultaneous operation as indicated on drawings.
 - h. Temperature Control: Adjustable thermostat for each element.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

2.4 COMPRESSION TANKS

- A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.

1. Manufacturers:

- a. AMTROL Inc.
- b. Armstrong Pumps, Inc.
- c. Flexcon Industries.
- d. Honeywell Sparco.
- e. Myers, F. E.; Pentair Pump Group (The).
- f. Smith, A. O.; Aqua-Air Div.
- g. State Industries, Inc.
- h. Taco, Inc.
- i. Watts Regulator Co.
- j. Wessels Co.

2. Construction:

- a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
- b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
- c. Air-Charging Valve: Factory installed.

2.5 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- B. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
- C. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

PART 3 - EXECUTION

3.1 WATER HEATER 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. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- C. Install water-heater drain piping as indirect waste to spill by positive air gap 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.
- D. Fill water heaters with water.

- E. Charge compression tanks with air.

3.2 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 water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- 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.

3.3 FIELD QUALITY CONTROL

- A. Perform startup service per manufacturer's recommendations.
- B. 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.
 - 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. Test operation of safety controls, relief valves, and devices.
 - 6. Adjust hot-water-outlet temperature settings. Do not set above 140 deg F unless piping system application requires higher temperature.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain water heaters.
 - 1. Train Owner's maintenance personnel on procedures for starting and stopping, troubleshooting, servicing, and maintaining equipment.
 - 2. Review data in maintenance manuals.
 - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes plumbing fixtures and trim, faucets, other fittings, and related components.

1.3 DEFINITIONS

- A. Accessible: Plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped, disabled, and elderly people.

1.4 SUBMITTALS

- A. Product Data for each plumbing fixture category and type specified. Include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Maintenance data for plumbing fixtures and components to include in the operation and maintenance manuals.
- C. See "Submittal Schedule" located at the end of Section 230100 "General Requirements for Mechanical Systems."

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements of CABO A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; regarding plumbing fixtures for physically handicapped people.
- B. Energy Policy Act Requirements: Comply with requirements of Public Law 102-486, "Energy Policy Act," regarding water flow rate and water consumption of plumbing fixtures.
- C. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

1.6 EXTRA MATERIALS

- A. Repair kits complete with all necessary washers, springs, pins, retainers, packings, O-rings, sleeves and seats: Furnish quantity of identical units not less than 5 percent of each type and size installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Vitreous-China and Enameled Fixtures:
 - a. Kohler Co.
 - b. American Standard, Inc.
 - c. Briggs Industries, Inc.
 - d. ProFlo (Manufactured by Briggs, supplied by Ferguson)
 - e. Crane Plumbing.
 - f. Eljer Industries.
 - g. Gerber Plumbing Fixtures Corp.
 - h. Mansfield Plumbing Products, Inc.
 - i. Universal-Rundle Corp.
 - j. Sloan Valve Co.
2. Flushometer Valves:
 - a. Sloan Valve Co
 - b. Coyne & Delany Co.
 - c. Speakman Co.
 - d. TOTO KIKI USA, Inc.
 - e. Zurn Industries, Inc.; Flush Valve Operations.
3. Toilet Seats:
 - a. American Standard, Inc.
 - b. Bemis Mfg. Co.
 - c. Centoco Manufacturing Corp.
 - d. Church Seat Co.
 - e. Eljer Industries.
 - f. Kohler Co.
 - g. Olsonite Corp.
 - h. Sanderson Plumbing Products, Inc.; Beneke Industries, Ltd.
 - i. Sperzel.
4. Supply Fittings and Faucets:
 - a. American Standard, Inc.
 - b. Chicago Faucet Co.
 - c. Crane Plumbing.
 - d. Eljer Industries.
 - e. Kohler Co.
 - f. Masco Canada, Ltd.; Cambridge Brass Div.
 - g. Masco Corp.; Delta Faucet Co.
 - h. Moen, Inc.
 - i. Price Pfister, Inc.
 - j. Speakman Co.
 - k. Symmons Industries, Inc.
 - l. T & S Brass and Bronze Works, Inc.
 - m. Zurn Industries, Inc.

5. Stainless-Steel Sinks:
 - a. Elkay Manufacturing Co.
 - b. Just Manufacturing Co.
 - c. Kohler Co.
 - d. Moen, Inc.
6. Disposers:
 - a. Emerson Electric Co.; In-Sink-Erator Div.
 - b. General Electric Co.; GE Answer Center.
 - c. Kitchen Aid, Inc.
 - d. Maytag Co.
 - e. Waste King, Inc.
 - f. White Consolidated Industries, Inc.; Major Appliance Group.
7. Fitting Insulation Kit:
 - a. Brocar Products, Inc.
 - b. Engineered Brass Co.
 - c. McGuire Manufacturing Co., Inc.
 - d. Plumberex Specialty Products.
 - e. TCI Products.
 - f. TRUEBRO, Inc.
8. Mop Sinks:
 - a. Fiat Products, Inc.
 - b. Stern-Williams Co., Inc.
 - c. Aqua Glass Corp.
 - d. Mustee: E.L. Mustee & Sons, Inc.
9. Electric Water Coolers / Drinking Fountains
 - a. EBCO Manufacturing Co.
 - b. Elkay Manufacturing Co.
 - c. Halsey Taylor.
 - d. Haws Drinking Faucet Co.
 - e. Murdock
 - f. Sunroc Corp.
 - g. Oasis
10. Fixture Carriers
 - a. J. R. Smith
 - b. Josam
 - c. Zurn
 - d. Wade
 - e. Acorn

2.2 FITTINGS

- A. Fittings for Plumbing Fixtures: Refer to plumbing fixture schedules at the end of this Section for materials for supplies, supply stops, supply risers, traps, and other fittings.

1. Supply Inlets: Brass pipe or copper tube, size required for final connection.
2. Supply Stops: Chrome-plated brass, angle or straight; compression, 1/4 turn ball stop valve, wheel-handle or loose-key type; same size as supply inlet and with outlet matching supply riser. Brass ball with PTFE seat. Rated for 40-deg F to 180-deg F and 125 psi maximum.
3. Supply Risers: flexible copper tube with knob end. Use chrome-plated tube for exposed applications.
4. Traps: Tubular brass with 0.045-inch wall thickness, slip-joint inlet, cleanout, wall flange, escutcheons, and size to match equipment. Use chrome-plated tube for exposed applications.
5. Continuous Waste: Tubular brass, 0.045-inch wall thickness, with slip-joint inlet, and size to match equipment.
6. Indirect Waste: Tubular brass, 0.045-inch wall thickness, and size to match equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for potable, hot- and cold-water supply piping systems; soil, waste, and vent piping systems; and supports. Verify that locations and sizes of piping and locations and types of supports match those indicated, before installing and connecting fixtures. Use manufacturer's roughing-in data when roughing-in data are not indicated.

3.2 APPLICATIONS

- A. Include supports for plumbing fixtures according to the following:
 1. Carriers: For wall-hanging water closets and fixtures supported from wall construction.
 2. Chair Carriers: For wall-hanging urinals, lavatories, sinks, drinking fountains, and electric water coolers.
 3. Heavy-Duty Chair Carriers: For accessible urinals, lavatories, and other fixtures where indicated.
- B. Include fitting insulation kits for accessible fixtures according to the following:
 1. Lavatories: Cover hot- and cold-water supplies, stops and handles, drain, trap, and waste to wall.
 2. Sinks: Cover hot- and cold-water supplies, stops and handles, drain, trap, and waste to wall.
 3. Other Fixtures: Cover exposed fittings below fixture.

3.3 PLUMBING FIXTURE INSTALLATION

- A. Field Measurements: Coordinate roughing-in and final fixture locations and verify that plumbing fixtures can be installed to comply with original design and referenced standards.
- B. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.
- C. Install fixtures level and plumb according to manufacturers' written instructions, roughing-in drawings, and referenced standards.
- D. Install floor-mounted, floor-outlet water closets with closet flanges and gasket seals.
- E. Install toilet seats on water closets.

- F. Install wall hanging, back-outlet urinals with gasket seals.
- G. Install flushometer valves for accessible urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for handicapped people to reach.
- H. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- I. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- J. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- K. Fasten recessed, wall-mounted fittings to reinforcement built into walls.
- L. Fasten wall-mounted fittings to reinforcement built into walls.
- M. Fasten counter-mounting plumbing fixtures to casework.
- N. Secure supplies to supports or substrate within pipe space behind fixture.
- O. Set mop sink basins in leveling bed of cement grout.
- P. Install individual stop valve in each water supply to fixture. Use gate or globe valve where specific stop valve is not specified.
 - 1. Exception: Omit stop valves on supplies to emergency equipment, except when permitted by authorities having jurisdiction. When permitted, install valve chained and locked in OPEN position.
- Q. Install water supply stop valves in accessible locations.
- R. Install faucet, laminar-flow fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.
- S. Install supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- T. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.
- U. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.
- V. Install disposers in sink outlets. Install switch where indicated, or in wall adjacent to sink if location is not indicated.
- W. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.
- X. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.4 CONNECTIONS

- A. Supply and Waste Connections to Plumbing Fixtures: Refer to plumbing fixture schedules on sheet M4.2 for fitting sizes and connection requirements for each plumbing fixture. Install hot- and cold-water-supply, waste and vent piping of sizes indicated, but not smaller than required by authorities having jurisdiction.

3.5 FIELD QUALITY CONTROL

- A. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- B. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- C. Test installed fixtures after water systems are pressurized and demonstrate proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.6 ADJUSTING AND CLEANING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at electric water coolers, faucets, and flushometer valves having controls, to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities, except when approved in writing by Owner.

3.8 PLUMBING FIXTURE SCHEDULE

- A. See Sheet M4.2.

END OF SECTION 224000

SECTION 230100 – GENERAL REQUIREMENTS FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes general mechanical requirements and shall apply to all phases of the work specified, indicated on the drawings or required to provide for complete installation of all mechanical systems including: fire protection systems, plumbing systems; and heating, ventilation, and air conditioning (HVAC) systems.

1.3 WARRANTIES

- A. All materials, workmanship and equipment shall be warranted against defects or against injury from proper and usual wear for a period of one year after the date of substantial completion. Any item which becomes defective within the warranty period shall be repaired or replaced, at no additional cost to the Owner.
- B. All manufacture's warranties shall run to the benefit of the Owner. No manufacturer's warranties shall be voided or impaired.
- C. Warranty shall include repair of faulty workmanship.

1.4 ALTERNATES

- A. Alternates, if required, shall be as described in the "Alternates" section of this specification, as described on the proposal form of as indicated on the drawings.

1.5 INTERPRETATION OF DOCUMENTS

- A. Any questions regarding the meaning of any portion of the contract documents shall be submitted to the Architect/Engineer for interpretation. Definitive interpretations or clarification will be published by addenda or supplemental information. Verbal interpretation not issued by addendum or supplemental information shall not be considered part of the contract documents.
- B. The Architect/Engineer shall be the sole judge of interpretations of discrepancies within the contract documents.
- C. If ambiguities should appear in the contract documents, the Contractor shall request clarification from the Architect/Engineer before proceeding with the work. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Architect/Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have

estimated the more expensive way of doing the work unless a written clarification from the Architect/Engineer was requested and obtained before submission of proposed methods or materials.

1.6 DEFINITIONS ABBREVIATIONS

A. The following shall apply throughout the contract documents

1.	Code	All applicable national state and local codes
2.	Furnish	Supply and deliver to site ready for installation
3.	Indicated	Noted, scheduled or specified
4.	Provide	Furnish, install and connect complete and ready for final use by owner
5.	ADA	Americans with Disabilities Act
6.	ANSI	American National Standards Institute
7.	ARI	Air-Conditioning and Refrigeration Institute
8.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
9.	ASME	American Society of Mechanical Engineers
10.	ASTM	American Society for Testing and Materials
11.	HI	Hydraulic Institute
12.	NEC	National Electric Code (NFPA 70)
13.	NEMA	National Electrical Manufacturers Association
14.	NFPA	National Fire Protection Association
15.	SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
16.	UL	Underwriters Laboratories Inc.

1.7 CODES AND STANDARDS

- A. All work shall be performed by competent craftsmen skilled in the trade involved and shall be done in a manner consistent with normal industry standards.
- B. All work shall conform to the currently adopted edition of the National Electric Code (NEC), 2018 International Building Code with Omaha amendments, 2012 International Mechanical Code with Omaha amendments, 2018 Omaha Plumbing Code, 2018 International Energy Conservation Code with Omaha amendments, and all other applicable state and local codes or standards.
- C. Where there is a conflict between the code and the contract documents, the code shall have precedence only then it is more stringent than the contract documents. Items that are allowed by the code but are less stringent than those specified shall not be substituted.

1.8 PERMITS

- A. Contractor shall become familiar and comply with all requirements regarding permits, fees, licenses, etc. All permits, licenses, inspections and arrangements required for the work shall be obtained by Contractor's effort and expense. All utilities shall be installed in accordance with the local rules and regulations and all charges shall be paid by the Contractor.

1.9 SUBMITTALS

- A. Division 01 section "Submittals" shall be adhered to if more stringent than this section.
- B. Submittal Procedures

1. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - a. Email: Prepare submittals as PDF package, and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
 - 1) Engineer, Architect, through Construction Manager, will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
 - b. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
- C. Shop Drawings
 1. Shop drawings include fabrication and installation drawings, diagrams, schedules of other data specifically prepared for the project. Include dimensions and notations showing compliance with specified standards.
 2. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- D. Product Data
 1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Product data includes printed information, such as manufacture's installation instructions, catalog cuts, standard color charts, rough-in diagrams, wiring diagrams and performance curves.
 3. Each copy shall clearly indicate conformance with specified capacities, characteristics, dimensions and details. Mark all equipment with same item number as used on drawings. Mark each copy to clearly indicate applicable products and options.
 4. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 5. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 6. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- E. Samples
 1. Samples are physical examples used to illustrate materials, equipment or workmanship.
 2. Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.

- F. Architect/Engineer will review or take appropriate action for submittals. Review is only to determine general conformance with design shown in contract documents.
- G. Architect/Engineer review of submittals shall not relieve contractor of responsibility for deviation from requirements of the contract documents or from errors or omissions within submittals.
- H. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect/Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- I. No portion of the work requiring submittals shall be commenced until the Architect/Engineer has reviewed the submittal.
- J. Electronic Floor Plan Drawings in AutoCAD format may be requested for use in preparation of shop drawings. Morrissey Engineering reserves the right to reject requests for electronic drawings. Submit written request to Morrissey Engineering or email request to info@morrisseyengineering.com. Indicate the project name, and floor plan sheets requested. The use of these drawings is intended solely for preparation of drawings required by this specification. Copyright law prohibits any other use. The user of the electronic files assumes full responsibility for the accuracy and scale of the drawings.
- K. See "Submittal Schedule" at the end of Section 230100 "General Requirements for Mechanical Systems."

1.10 OPERATION AND MAINTENANCE MANUALS

- A. Assemble (3) complete sets of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
 - 1. Operation Data:
 - a. Emergency instructions and procedures.
 - b. System, subsystem, and equipment descriptions, including operating standards.
 - c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
 - d. Description of controls and sequence of operations.
 - e. Piping and wiring diagrams.
 - 2. Maintenance Data:
 - a. Manufacturer's information, including list of spare parts.
 - b. Name, address, and telephone number of installer or supplier.
 - c. Maintenance procedures.
 - d. Maintenance and service schedules for preventive and routine maintenance.
 - e. Maintenance record forms.
 - f. Sources of spare parts and maintenance materials.
 - g. Copies of maintenance service agreements.
 - h. Copies of warranties and bonds.
- B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

- C. Provide an electronic copy of the entire Operation and Maintenance Manual.

1.11 PROJECT RECORD DOCUMENTS

- A. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.
 - 1. Mark Record Prints to show the actual installation where installation varies from that shown originally.
 - 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 - 3. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - 4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
 - 5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials and equipment used in the construction of the project shall be new unused and undamaged unless otherwise specified. Materials and equipment shall be of latest design standards of manufacturer specified.
- B. Materials and equipment are limited by the requirements of the contract documents. Material and equipment shall be provided in accordance with the following:
 - 1. Basis of Design Products: Basis of Design Products are those products around which the project was designed in terms of capacity, performance, physical size and quality. Basis of Design Products shall be provided unless substitutions are made in accordance with this specification.
 - 2. Substitutions: Substitutions are product of manufacturers other than listed as Basis of Design. Substitutions shall meet each of the following requirements:
 - a. The product shall be manufactured by one of the acceptable manufacturers listed in the contract documents.
 - b. The product shall meet or exceed the requirements of the contract documents in terms of quality, performance, suitability, appearance and characteristics.
 - c. The contractor providing the substitution shall bear the total cost of all changes due to substitutions. These may include but are not limited to redesign costs and increased work by other contractors or the owner.
 - d. The Architect/Engineer shall be the sole judge of the suitability of the substitution items.

- C. Verify installation details and requirements for materials and equipment furnished by others and installed under this contract.

PART 3 - EXECUTION

3.1 DEMONSTRATION AND TRAINING

- A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Provide instructors experienced in operation and maintenance procedures.
 - 2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
 - 3. Schedule training with Owner and Architect/Engineer with at least seven days' advance notice.
- B. Program Structure. Include instruction for the following:
 - 1. System design and operational philosophy.
 - 2. Review of documentation.
 - 3. Operations.
 - 4. Adjustments.
 - 5. Troubleshooting.
 - 6. Maintenance.
 - 7. Safety.

3.2 STARTING AND ADJUSTING

- A. Start and test all equipment and operating components to confirm proper operation. Test and adjust all systems to achieve designed capacity and performance.
- B. Provide three (3) copies of all test report to the Architect/Engineer for review prior to date of substantial completion.
- C. All equipment and systems discrepancies shall be corrected prior to final acceptance.

MECHANICAL SUBMITTAL SCHEDULE

Refer to individual specification sections for additional requirements and detail on each submittal.

Section	Section Name	Product Data	Shop Dwgs	Test Reports / Quality Control	Warranty	Extra Materials	O&M Data	Record Docs	Demonstration / Training
210100	General Requirements for Fire Suppression	X	X	X	X				X
211000	Water-Based Fire-Suppression Systems	X	X			X	X		
220100	General Requirements for Plumbing	X	X		X				
220523	Valves for Plumbing	X					X		
220720	Pipe Insulation for Plumbing	X							
221116	Water Distribution Piping			X				X	
221316	Drainage and Vent Piping	X		X				X	
221319	Plumbing Specialties	X					X		X
223300	Domestic Water Heaters	X	X	X	X		X		X
224000	Plumbing Fixtures	X		X		X	X		
230100	General Requirements for Mechanical Systems	X	X		X		X	X	X
230500	Basic Mechanical Materials and Methods	X	X				X		
230505	Basic Mechanical Piping Materials and Methods	X					X		
230593	Testing, Adjusting, and Balancing			X					
230700	Duct Insulation	X							
230960	Variable Frequency Drives	X	X			X	X		X
231123	Fuel Gas Piping	X		X			X	X	
233113	Metal Ducts and Accessories	X	X		X		X	X	
233423	Power Ventilators	X	X		X	X	X		X
235533	Gas-Fired Unit Heaters	X	X		X	X	X		X

END OF SECTION 230100

SECTION 230500 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and 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 and shall apply to all phases of the work specified, indicated on the drawings or required to provide for complete installation of mechanical systems.
 - 1. Indenting Devices and Labels
 - 2. Grout
 - 3. Sealants
 - 4. Access Doors
 - 5. Electrical Requirements
 - 6. Motors
 - 7. Mechanical Equipment Installation
 - 8. Labeling and Identifying
 - 9. Demolition
 - 10. Work in Existing Buildings
 - 11. Construction Layout
 - 12. Data and Measurements

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.

1.4 SUBMITTALS

- A. Product Data: For sealants and identification materials and devices.
- B. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
- C. See "Submittal Schedule" at the end of Section 230100 "General Requirements for Mechanical Systems."

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. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Each contractor shall make provisions for delivery and safe storage of materials. Materials shall be delivered in a timely manner to expedite the work.
- B. Protect stored piping, supplies and equipment from cold, moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.7 COORDINATION

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe, duct and equipment spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces.
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.
- H. Painting:

1. The General Contractor is to field paint exposed mechanical equipment, ductwork, piping and related materials in specified areas as noted on the mechanical plans, mechanical schedules and in the specifications. The Division 21, 22, and 23 Contractors are responsible to coordinate the painting of these items with the General Contractor. The Division 21, 22, and 23 Contractors are to provide materials in these areas that are suitable for accepting paint. The cleaning and preparation of the materials to reach paint is the responsibility of the General Contractor unless noted specifically to be responsibility of the Division 23 Contractor.
 2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.
 3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with architectural sections.
- I. Motors, equipment, controls, etc. shall be furnished, mounted and connected according to the following schedule unless otherwise noted (E =Electrical Contractor, M = Mechanical Contractor):

Item	Furnished By	Set in place or mounted by	Power wiring and connection by	Control Wiring and connection by
1) Equipment Motors	M	M	E	M
2) Disconnect switches, thermal overload switches, manual operating switches				
a) Furnished as part of factory wired mechanical equipment	M	M	E	--
b) Loose mounted	E	E	E	--
3) Transformers				
a) Serving 120 Volt and higher loads	E	E	E	--
b) Serving 24 Volt control power	M(1)	M	E	M
4) Contactors	E	E	E	E
5) Line voltage thermostats and time clocks.	M	E	E	E
6) Low voltage controls and thermostats	M	M	M	M(2)
7) Motorized control valves, damper motors, solenoid valves, etc.				
a) Line Voltage	M	M	E	M
b) Low Voltage	M	M	M	M
8) Factory pre-wired control/power panels including remote sensing devices	M	M	E	M(3)
9) Electric wall and unit heaters	E	E	E	E
10) Fire protection controls	M	M	E	E
11) Fire and smoke detectors including relays for fan shutdown	E	E	E	E(5)

Notes:

1. When control power is not available, mechanical contractor shall provide control transformers as required to power all valves, dampers, etc.
2. Conduit rough-in for thermostats by electrical contractor where indicated on plans.
3. Remote condensing units and heat pumps control wiring including wiring of remote sensors by mechanical. Control circuit feeders by mechanical unless shown otherwise.
4. Wiring from alarm contacts to alarm system by Electrical; control function wiring by Mechanical.

PART 2 - PRODUCTS

2.1 IDENTIFYING DEVICES AND LABELS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23 Sections. If more than one type is specified for application, selection is Installer's option, but provide one selection for each product category.
- B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment.
 - 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
 - 2. Location: Accessible and visible location.
- C. Engraved Plastic-Laminate 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.
 - 1. Fabricate in sizes required for message.
 - 2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
- D. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.
- E. Valve Tags: 19 gauge, 1-1/2" diameter, polished brass, stamped or engraved 1/4" high piping system abbreviation in and 1/2" high sequenced valve numbers.
 - 1. Valve tag fastener: solid brass wire link or beaded chain, or 'S'-hook or size required for proper attachment of tags to valves.
- F. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap on, color-coded, complying with ASME A13.1.
- G. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.
- H. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.

2.2 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-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.3 SEALANTS

- A. Polyurethane Sealant: Single component, chemical curing, non-staining, non-bleeding, capable of continuous water immersion, non-sagging for application in vertical and horizontal joints. Color as selected by architect.
- B. Accessories: Primer, joint cleaner, joint backing and bond breaker as recommended by sealant manufacturer to suit application.
- C. Firestopping Materials: Provide firestopping material to maintain required rating of all fire-resistive assemblies according to requirements of "Firestopping" section of this specification.

2.4 ACCESS DOORS

- A. Prime Coated 14 gauge steel, flush, with screw driver operated cam lock. Frame to accommodate construction type; size as indicated.
- B. Architectural access panel with concealed hardware and gypsum board inlay. Provide with concealed frame, latch, and hinge. Panel shall be Access Panel Solutions Inc. Bauco Plus II or approved equal.

2.5 ELECTRICAL REQUIREMENTS

- A. Compliance for HVAC Equipment
 - 1. Comply with applicable requirements of the National Electric Code (NFPA 70)
 - 2. Provide equipment and accessories that are listed and labeled as defined in NFPA 70
 - 3. Comply with applicable requirements of Underwriters Laboratory (UL)
 - 4. Comply with applicable requirements of NEMA standards
- B. Electrical Wire
 - 1. Wiring material shall be in accordance with the latest version of the National Electric Code (NFPA 70) and all applicable local codes and carry the UL label where applicable.
 - 2. All exposed wiring in return air plenums shall be rate cable for fire and smoke spread.

2.6 PAINT PRODUCTS

- A. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. Colors: As selected by Owner from manufacturer's full range.
- C. Primer: Surface-Tolerant Metal Primer: Corrosion-resistant, solvent-based metal primer formulated for use on steel pipe and metal fabrications that have been minimally prepared.
- D. Finish: Interior, Latex, Institutional Low Odor/VOC, Flat: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in occupied buildings, where the odor

and VOC levels of conventional latex products would preclude their use. Gloss and Sheen Level in manufacturer's standard flat finish in color selected by Owner.

2.7 MOTORS

A. BASIC MOTOR REQUIREMENTS

1. Motors $\frac{3}{4}$ HP and Larger shall be polyphase. Motors Smaller than $\frac{3}{4}$ HP shall be single phase unless otherwise indicated
2. Frequency Rating shall be 60 Hz. Voltage Rating is determined by voltage of circuit to which motor is connected.
3. Service Factor: According to NEMA MG 1, unless otherwise indicated.
4. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
5. Enclosure: Open dripproof, unless otherwise indicated.

B. POLYPHASE MOTORS

1. General
 - a. Design Characteristics: NEMA MG 1, Design B, Energy-Efficient Design, unless otherwise indicated.
 - b. Stator: Copper windings, unless otherwise indicated. Multispeed motors have separate winding for each speed.
 - c. Rotor: Squirrel cage, unless otherwise indicated.
 - d. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.
 - e. Temperature Rise: Match insulation rating, unless otherwise indicated.
 - f. Insulation: Class F, unless otherwise indicated.
2. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for indicated controller, with required motor leads brought to motor terminal box to suit control method.
1. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer. Inverter rated motors used in conjunction with variable speed drives shall be equipped with a shaft grounding ring. Grounding ring shall be Helwig Carbon Bearing Protector, installed per manufacturer requirements. Grounding ring may be epoxy mounted if manufacturer's recommended epoxy adhesive is used.
2. Rugged-Duty Motors: Where indicated, motors are totally enclosed with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings are insulated with nonhygroscopic material. External finish is chemical-resistant paint over corrosion-resistant primer.

C. SINGLE-PHASE MOTORS

1. Permanent-split capacitor, Split-phase start, capacitor run or capacitor start, capacitor run as indicated or selected by manufacturer, to suit starting torque and other requirements of specific motor application.
2. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.
3. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, prelubricated sleeve bearings for other single-phase motors.

D. ELECTRONICALLY COMMUTATED MOTORS (ECM)

1. Permanent magnet type motor with near-zero rotor losses designed for synchronous rotation.
2. Brushless DC motor controlled by an integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator as indicated or selected by manufacturer, to suit starting torque and other requirements of specific motor application. Coordinate input signal for speed with specific application.
3. Motor shall be designed to maintain a minimum 70 percent efficiency over the entire operating range.
4. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.
5. Bearings: Sealed, prelubricated ball bearing type for poly-phase or single-phase motors.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

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

3.2 POSITION OF DEVICES

- A. Devices shall be installed at the height indicated below unless otherwise noted. All heights of outlets are measured from finished floor to centerline of device. Locate devices mounted on finish surfaces with regards to furring, trim, etc. Heights may be adjusted as necessary to clear wall mounted cabinets, electrical devices, etc. Where installed in masonry walls, mounting heights may be adjusted to correspond to block coursing. Where thermostats are located adjacent to light switches, match light switch mounting height. In no case shall devices requiring wheelchair accessibility be mounted above 48".

- | | |
|--|-----|
| 1. Thermostats (where located adjacent to light switches, match light switch height) | 48" |
| 2. Space Sensors (where located adjacent to light switches, match light switch height) | 48" |
| 3. Temperature Control Panels (not requiring occupant interface) | 60" |

3.3 LABELING AND IDENTIFYING

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Plastic markers, with application systems. Install on insulation segment if required for hot, uninsulated piping.
 2. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior nonconcealed locations:
 - a. Near each valve and control device.
 - b. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern is not obvious.
 - c. Near locations if pipes pass through walls, floors, ceilings, or enter nonaccessible enclosures.
 - d. At access doors, manholes, and similar access points that permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced at maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.
 - g. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
- B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of mechanical equipment.
- C. Valve Tags:
1. Install valve tag at all valves in piping systems listed below
 - a. Domestic water (excluding individual fixture isolation valves)
 2. Provide reproducible set of drawings indicating all valve locations.
- D. Label duct access doors at fire and smoke damper locations per NFPA 90A.
- E. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

3.4 FIRESTOPPING

- A. Apply firestopping to all duct and pipe penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

3.5 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 3-1/2" inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive-strength concrete and reinforcement

3.6 DEMOLITION

A. DEFINITIONS

1. Remove: Detach items from existing construction and legally dispose of off-site unless indicated to be removed and salvaged or removed and reinstalled.
2. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner as indicated.

3. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage; prepare for reuse; and reinstall where indicated.
4. Existing to Remain: Existing items of construction that are not to be removed.

B. MATERIALS OWNERSHIP

1. Unless otherwise indicated, demolition waste becomes property of Contractor.

C. UTILITY SERVICES AND BUILDING SYSTEMS

1. Disconnect, demolish, and remove Work specified in Division 21, 22, and 23 Sections.
2. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment in accordance with 40 CFR 82 and regulations of authorities having jurisdiction.
3. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location and cleaned and reinstalled in their original locations after selective demolition operations are complete.
4. Existing Services/Systems to Remain: Maintain utilities and building systems and equipment to remain and protect against damage during selective demolition operations.
5. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utilities and building systems serving areas to be selectively demolished.
 - a. Owner will arrange to shut off indicated utilities when requested by Contractor.
 - b. Arrange to shut off utilities with utility companies.
 - c. If disconnection of utilities and building systems will affect adjacent occupied parts of the building, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to those parts of the building.
 - d. Demolish and remove existing building systems, equipment, and components indicated on Drawings to be removed.
 - 1) Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2) Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 3) Equipment to Be Removed: Disconnect and cap services and remove equipment and components.
6. Abandon existing building systems, equipment, and components indicated on Drawings to be abandoned in place.
 - a. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place. Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
 - b. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork and insulation and leave in place.
7. Remove and reinstall/salvage existing building systems, equipment, and components indicated on drawings to be removed and reinstalled or removed and salvaged:
 - a. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment and components; when appropriate, reinstall, reconnect, and make equipment operational.

- b. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and components and deliver to Owner.
- 8. If any mechanical piping, ductwork, insulation, or equipment not designated for demolition is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- D. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.
- E. Removal: Remove indicated equipment from Project site.
- F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- G. Where wall mounted sensors, thermostats, panels, equipment, or similar are demolished, all resultant holes shall be filled and patched and the wall shall be painted to match adjacent construction. This includes associated hangers, covers, and accessories

3.7 WORK IN EXISTING BUILDINGS

- A. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner to minimize conflicts with the Owner's operations.
- B. Schedule all work in advance with the owner. Do not proceed with work without the Owner's written approval.
- C. Notify Owner of noisy operations and schedule in advance.
- D. The Owner shall have the right to direct work to secure safe and proper progress and quality of work.
- E. Do not interrupt utilities without Owner's written approval of time and duration. Interruptions shall be minimum required for completion of work.
- F. The existing fire alarm system shall remain functional throughout the project. The Owner and the Fire Marshall shall approve required outages.
- G. The Owner shall be notified before starting welding or cutting. Fire extinguishers shall be immediately accessible when welding or cutting with an open flame or arc. Welding or cutting with an open flame or arc shall be stopped not less than one hour before leaving the premises.
- H. Existing mechanical items that interfere with the proper installation new work shall be removed or relocated as required or as directed by the Architect/Engineer.

3.8 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.

3.9 CONSTRUCTION LAYOUT

- A. Layout work in advance of installation using data and measurements from the site, the appropriate architectural and structural drawings and shop drawings.
- B. Confirm adequate clearance for installation, operation, maintenance and code required clearance including items installed by other contractors.
- C. If layout to provide clearance is not possible, promptly notify Architect/Engineer for clarification.

3.10 DATA AND MEASUREMENTS

- A. The data given herein and on the drawings is as accurate as could be secured. The existence and location of construction as indicated is not guaranteed. Before beginning work investigate and verify the existence and location of items affecting work. Obtain exact locations, measurements, levels, etc., at the site and adapt work to actual conditions.
- B. Only Architectural drawings, Structural drawings, and site measurements may be utilized in calculations. Mechanical and electrical drawings are diagrammatic or schematic.

3.11 PAINTING AND FINISHING

- A. Refer to individual sections for paint materials, surface preparation, and application of paint.
- B. Do not paint piping specialties with factory-applied finish.
- C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.12 HANGERS AND SUPPORTS

- 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 applicable codes and standards.

3.13 GROUTING

- A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix and place and cure grout according to manufacturer's written instructions.

3.14 ACCESS

- A. Provide access to all equipment, valves, controls, etc. as required for operation, repair and maintenance.
- B. Access doors shall be provided when access through ceilings, chases, etc. is not provided by others.

3.15 ELECTRICAL WIRING

- A. Install all electrical wiring in accordance with the National Electric Code and Division 26 of this specification.

- B. All line voltage and low voltage wire shall be installed in metal raceways.
- C. All low voltage wire in equipment rooms, concealed in walls, or exposed in space shall be installed in metal raceways.

END OF SECTION 230500

SECTION 230505 - BASIC MECHANICAL PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 21, 22 and 23 Sections.
 - 1. Piping materials and installation instructions common to mechanical piping systems.
 - 2. Dielectric fittings.
 - 3. Flexible connectors.
 - 4. Mechanical sleeve seals.
 - 5. Escutcheons.
 - 6. Pipe hangers and supports
 - 7. Thermal Hanger Shield Inserts
 - 8. Thermometers
- B. Pipe and pipe fitting materials are specified in Division 23 piping system Sections.

1.3 DEFINITIONS

- A. MSS: Manufacturer's 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 support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.5 SUBMITTALS

- A. Product Data: For dielectric fittings, mechanical sleeve seals, and each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated. Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.
- B. Maintenance Data: For meters and gages to include in maintenance manuals. Submit valve schedules to include in maintenance manuals for each piping system. Valve schedule shall indicate valve number, piping system and location of valve.
- C. See "Submittal Schedule" located at the end of Section 230100 "General Requirements for Mechanical Systems."

1.6 QUALITY ASSURANCE

- A. Welders shall be qualified in accordance with applicable codes. Welding procedures and testing shall comply with ANSI B31.10 "Standard for Pressure Piping, Power Piping" and AWS Welding Handbook.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

- 1. Dielectric Unions, Couplings, 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. Flexible Connectors:

- a. Nexus Valve
- b. Metraflex
- c. Hays Fluid Controls
- d. Flexicraft Industries
- e. Pro Hydronic Specialties
- f. Flex Weld Inc

- 3. Pipe Hangers and Supports:

- a. AAA Technology and Specialties Co., Inc.
- b. Anvil
- c. B-Line Systems, Inc. by Eaton
- d. Carpenter & Patterson, Inc.
- e. Grinnell Corp. B-Line Systems, Inc.
- f. Grinnell Corp.; Power-Strut Unit.
- g. GS Metals Corp.
- h. Michigan Hanger Co., Inc.; O-Strut Div.
- i. National Pipe Hanger Corp.
- j. Thomas & Betts Corp.
- k. Unistrut Corp.
- l. Wesanco, Inc.
- m. Thermal-Hanger Shield Inserts

- 4. Thermometers:

- 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. Marshalltown Instruments

- f. Miljoc Corporation
- g. Noshok, Inc.
- h. Reotemp Instrument Corp.
- i. Tel-Tru Manufacturing Co., Inc.
- j. Trerice: H. O. Trerice Co.
- k. Weiss Instruments, Inc.
- l. Winter's Thermogauges, 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. 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.
 - 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.
- F. Brazing Filler Metals: AWS A5.8.
 - 1. BCuP Series: Copper-phosphorus alloys.
 - 2. BAg1: Silver alloy.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

- H. Solvent Cements: Manufacturer's standard solvent cements for PVC Piping. ASTM D 2564. Include primer according to ASTM F 656.
- I. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.
- J. 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: Assembly or fitting of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- E. Dielectric Unions:
 - 1. Standard: ASSE 1079.
 - 2. Pressure Rating: 125 psig minimum at 180 deg F.
 - 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- F. Dielectric Flanges:
 - 1. Standard: ASSE 1079.
 - 2. Factory-fabricated, bolted, companion-flange assembly.
 - 3. Pressure Rating: 125 psig minimum at 180 deg F.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- G. Dielectric-Flange Insulating Kits:
 - 1. Nonconducting materials for field assembly of companion flanges.
 - 2. Pressure Rating: 150 psig.
 - 3. Gasket: Neoprene or phenolic.
 - 4. Bolt Sleeves: Phenolic or polyethylene.
 - 5. Washers: Phenolic with steel backing washers.
- H. Dielectric Nipples:
 - 1. Standard: IAPMO PS 66.
 - 2. Electroplated steel nipple, complying with ASTM F 1545.

3. Pressure Rating: 300 psig at 225 deg F.
4. End Connections: Male threaded or grooved.

I. Lining: Inert and noncorrosive, propylene.

2.5 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

B. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig
5. Maximum Operating Temperature: 250 deg F

2.6 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. PVC: Manufactured, permanent, with nailing flange for attaching to wooden forms.
5. PVC Pipe: ASTM D 1785, Schedule 40.

B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.

1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
2. OD: Completely cover opening.
3. Stamped Steel: One piece, with set screw, spring clips, concealed hinge and chrome-plated finish.

2.7 PIPE HANGERS AND SUPPORTS

A. Pipe Hangers, Supports, and Components: factory-fabricated components.

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.

2.8 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi, ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe. Top half shall be standard pipe insulation.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.9 MISCELLANEOUS PIPE SUPPORTING MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.

2.10 THERMOMETERS, GENERAL

- A. Scale Range: Temperature ranges for services listed are as follows:
 1. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
 2. Domestic Hot Water: 30 to 240 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.

2.11 LIQUID-IN-GLASS THERMOMETERS

- A. Case: Die-cast aluminum with hard powder-coat finish, acrylic front, 9 inches long.
- B. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

- C. Tube: Blue reading, organic-liquid filled with magnifying lens.
- D. Scale: Satin-faced nonreflective aluminum with permanently etched markings or white finished aluminum with black markings.
- E. Stem: Die-cast aluminum for separable socket; of length to suit installation.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 21, 22 and 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.
- C. Install piping at indicated slope.
- 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, wall board partitions, and suspended ceilings.
- N. 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:
- O. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials
 - Q. Verify final equipment locations for roughing-in.
 - R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
 - S. 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:
 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.
 8. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to manufacturer's recommendations.
 - T. 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. Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.2 HANGER AND SUPPORT APPLICATIONS

- A. Comply with MSS SP-69 for pipe hanger selections and applications.
- B. Comply with MSS SP-89 for fabrication and installation procedures.
- C. Horizontal-Piping Hangers and Supports: Use swivel ring or clevis type hangers.
- D. Vertical-Piping: Use riser clamps.

E. Insulated Piping:

1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems. Field assemble and install according to manufacturer's written instructions.
- C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- D. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- E. 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.
- F. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- G. 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.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- J. Support vertical piping and tubing at base and at each floor.
- K. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
 - 1. 3/4-Inch NPS and Smaller: Maximum horizontal spacing, 60 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 2. 1-Inch NPS: Maximum horizontal spacing, 72 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 3. 1-1/4-Inch NPS: Maximum horizontal spacing, 72 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 4. 1-1/2 and 2-Inch NPS: Maximum horizontal spacing, 96 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 5. 2-1/2-Inch NPS: Maximum horizontal spacing, 108 inches with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 6. 3-Inch NPS: Maximum horizontal spacing, 10 feet with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.
- L. Install hangers for steel, cast and ductile-iron piping with the following maximum spacing and minimum rod diameters:
 - 1. 1-1/4-Inch NPS and Smaller: Maximum horizontal spacing, 84 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
 - 2. 1-1/2-Inch NPS: Maximum horizontal spacing, 108 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
 - 3. 2-Inch NPS: Maximum horizontal spacing, 10 feet with 3/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
 - 4. 2-1/2-Inch NPS: Maximum horizontal spacing, 11 feet with 1/2-inch minimum rod diameter; maximum vertical spacing, 15 feet.
 - 5. 3-Inch NPS: Maximum horizontal spacing, 12 feet with 1/2-inch minimum rod diameter; maximum vertical spacing, 15 feet.
 - 6. 4- and 5-Inch NPS: Maximum horizontal spacing, 12 feet with 5/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
 - 7. 6-Inch NPS: Maximum horizontal spacing, 12 feet with 3/4-inch minimum rod diameter; maximum vertical spacing, 15 feet.

3.4 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.
- C. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- D. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.5 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors where indicated on drawings.
- B. Install connectors in strict accordance with manufacturer installation instructions

3.6 METER AND GAGE INSTALLATION, GENERAL

- A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.
- B. Install meters and gages adjacent to machines and equipment to allow service and maintenance.
- C. Calibrate meters and gauges according to manufacturer's written instructions, after installation

3.7 THERMOMETER INSTALLATION

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install thermometers at locations indicated on plans
- C. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.
- D. When thermometers are installed in piping 1" and smaller, install well in 1-1/4" with reducers to prevent restriction of flow.

END OF SECTION 230505

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives.

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. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- D. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.
- E. AABC: Associated Air Balance Council.
- F. AMCA: Air Movement and Control Association.
- G. NEBB: National Environmental Balancing Bureau.
- H. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

- A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
- B. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
- C. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.
- D. See Submittal Schedule located at the end of Section 230100 "General Requirements for Mechanical Systems."

1.5 QUALITY ASSURANCE

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.
- B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect'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, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel.
- 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 testing, adjusting, and balancing Agent's standard forms approved by the Architect/Engineer.
- E. Instrumentation Type, Quantity, and Accuracy: As described in NEBB standards.
- F. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 PROJECT CONDITIONS

- A. Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. 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. Perform testing, adjusting, and balancing after leakage and pressure tests on air systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

- B. Examine approved submittal data of HVAC systems and equipment.
- C. 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.
- D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- G. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- H. Examine automatic temperature system components to verify proper operation.
- I. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 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.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.3 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 dampers for proper position to achieve desired airflow path.
- E. Check for airflow blockages.
- F. Check condensate drains for proper connections and functioning.

3.4 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

- A. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - 2. Measure static pressure across each air-handling unit component.
 - 3. Adjust fan speed higher or lower than design with the approval of the Architect/Engineer. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes. Do not make fan-speed adjustments that result in motor overload.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.
- C. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

3.5 TEMPERATURE TESTING

- 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. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.6 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans: minus 10 to plus 10 percent.
 - 2. Air Outlets and Inlets: minus 10 to plus 10 percent.

3.7 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.
- C. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of testing, adjusting, and balancing Agent.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.

8. Report date.
 9. Signature of testing, adjusting, and balancing Agent who certifies the report.
 10. Summary of contents.
 11. Notes to explain why certain final data in the body of reports vary from design values.
 12. Test conditions for fans and pump performance forms.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems.
- E. Air-Handling Unit Test Reports: For air-handling 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. Sheave dimensions, center-to-center and amount of adjustments in inches.
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
 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. Outside airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outside-air damper position.
 - l. Return-air damper position.
 - m. Variable frequency drive setting.
- F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data: Include the following:
 - a. System identification.
 - b. Location.

- c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center and amount of adjustments in inches.
 - 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.
 - g. Number of belts, make, and size.
 - 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.
- G. 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. Duct static pressure in inches wg.
 - d. Duct size in inches.
 - e. Duct area in sq. ft..
 - f. Design airflow rate in cfm.
 - g. Design velocity in fpm.
 - h. Actual airflow rate in cfm.
 - i. Actual average velocity in fpm.
 - j. Barometric pressure in psig.
- H. Air Outlet Reports:
- 1. Air outlet data
 - a. Make and type.
 - b. Model number and size.
 - 2. Test data: Include design and actual data for the following:
 - a. Airflow rate in cfm.
- I. 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.

3.8 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.

END OF SECTION 230593

SECTION 230700 - 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 semi-rigid and flexible duct insulation; acoustical duct liner; accessories and attachments; and sealing compounds.

1.3 SUBMITTALS

- A. Product Data: Include product data description, list of materials, thickness, density, k-values and r-values for each product type, locations, manufacturer's installation instructions, flames spread and smoke developed ratings.
- B. See "Submittal Schedule" located at the end of Section 230100 "General Requirements for Mechanical Systems."

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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Insulation:
 - a. CertainTeed
 - b. Armaflex
 - c. Rubatex
 - d. Knauf
 - e. Owens-Corning
 - f. Halstead

- g. Armstrong
- h. Manville
- i. Pittsburgh Corning

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type I, 0.75 pcf density, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
- B. Acoustical duct liner: ASTM C 518 with resin and black mat coated surface exposed to air stream to prevent erosion of glass fibers. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature. Nominal Density 1.5 lbs per cubic foot, minimum noise reduction characteristic shall be 0.55 for 1" thickness; rated for 6000 fpm air velocity; air friction multiplier less than 1.6 at 2000 fpm.

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, pre-sized a minimum of 8 oz./sq. yd..
- B. Bands: 3/4 inch wide, materials compatible with jacket:
- 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.
- 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.

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 AND PREPARATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 MINERAL-FIBER BLANKET INSULATION APPLICATION

- 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. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- D. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- E. Apply insulation with the least number of joints practical.
- F. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- G. 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.
- H. 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.
- I. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- J. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- K. Secure insulation with adhesive and anchor pins and speed washers.

3.3 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness are prohibited.
- B. Butt transverse joints without gaps and coat joint with adhesive.
- C. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- D. Do not apply liners in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

- E. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- F. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profile or are integrally formed from duct wall.
- G. Ductwork sizes indicated on drawings are the free area size. Ductwork sizes shall be increased to accommodate the addition of liner to maintain the plan indicated free area size.

3.4 DUCT AND PLENUM APPLICATION SCHEDULE

- A. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Fibrous-glass ducts.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
 - 4. Flexible connectors.
 - 5. Vibration-control devices.
 - 6. Testing agency labels and stamps.
 - 7. Nameplates and data plates.
 - 8. Access panels and doors in air-distribution systems.
- B. See "Ductwork Insulation Schedule" on Sheet M4.1.

END OF SECTION 230700

SECTION 230960 – VARIABLE FREQUENCY DRIVES

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 variable frequency drives for use on ac circuits rated 600 V and less.

1.3 SUBMITTALS

- A. Product Data: For products specified in this Section. Include dimensions, ratings, and data on features and components.
- B. Shop Drawings: For each variable frequency drive specified in this Section. Include dimensioned plans, elevations, and component lists.
 - 1. Schedule of features, characteristics, ratings, and factory settings of individual motor-control center units.
 - 2. Wiring Diagrams: Interconnecting wiring diagrams pertinent to class and type specified for drive. Schematic diagram of each type of controller unit indicated.
- C. Maintenance Data: For products to include in maintenance manuals.
- D. See “Submittal Schedule” located at the end of Section 230100 “General Requirements for Mechanical Systems.”

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Source Limitations: Obtain variable frequency drives through one source from a single manufacturer.
- C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store so condensation will not occur on or in variable frequency drives. Provide temporary heaters as required to prevent condensation.

1.6 COORDINATION

- A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Spare Indicating Lights: Furnish 6 of each type required.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 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. Asea Brown Boveri (ABB)
 - 2. Allen Bradley
 - 3. Danfoss
 - 4. Reliance Electric HVAC Drive
 - 5. Siemens Industry
 - 6. Yaskawa Electric America

2.2 VARIABLE-FREQUENCY CONTROLLERS

- A. Description: NEMA 1, variable-frequency controller, listed and labeled as a complete unit and arranged to provide variable speed of a energy efficient NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency.
- B. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Starting Torque: 100 percent of rated torque or as indicated.
- D. Speed Regulation: Plus or minus one percent.
- E. Ambient Temperature: 0 to 40 deg C.
- F. Efficiency: 95 percent minimum at full load and 60 Hz.
- G. Isolated control interface allows controller to follow 1 of the following over an 11:1 speed range:
 - 1. Electrical Signal: 4 to 20 mA at 24 V, 0 to 5 VDC, 0 to 10 VDC

- H. Internal Adjustability: Include the following internal adjustment capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 2 to 22 seconds.
 4. Deceleration: 2 to 22 seconds.
 5. Current Limit: 50 to 110 percent of maximum rating.
- I. Self-protection and reliability features include the following:
1. Input transient protection by means of surge suppressors.
 2. Snubber networks to protect against malfunction due to system voltage transients.
 3. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 10 performance.
 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 5. Instantaneous overcurrent trip.
 6. Loss of phase protection.
 7. Reverse phase protection.
 8. Under- and overvoltage trips.
 9. Overtemperature trip.
 10. Short-circuit protection.
 11. Under load supervision (belt loss detection).
 12. Ground Fault.
- J. Automatic Reset/Restart: Attempt 3 restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Restarting during deceleration will not damage controller, motor, or load.
- K. Power-Interruption Protection: Prevents motor from reenergizing after a power interruption until motor has stopped.
- L. Status: Front panel mounted LED screen to provide selectable readouts to indicate the following conditions:
1. Power on.
 2. Run status.
 3. Output voltage.
 4. Output current.
 5. Output frequency.
 6. DC buss voltage.
 7. Motor current.
 8. Speed (RPM).
 9. kWH.
 10. Calculated motor power (kW)
 11. Overvoltage.
 12. Line fault.
 13. Overcurrent.
 14. External fault
- M. Front Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control adjustment and lapsed time meter.
- N. Integral fused disconnect.
- O. Phase loss protection relay.

- P. EMI and RFI Filters for harmonics control.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Select features of each motor 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.

3.2 INSTALLATION

- A. Furnish Variable frequency drives to electrical contractor for installation.
 - 1. Fuses: Furnish fuses for each fusible disconnect.
- B. All Power wiring shall be by electrical contractor per Division 26 specifications.

3.3 CONTROL WIRING INSTALLATION

- A. Temperature control contractor shall install wiring between variable frequency drives and control devices or energy management system.
- B. Bundle, train, and support wiring in enclosures.

3.4 FIELD QUALITY CONTROL

- A. Provide factory authorized representative to start drive and set operating parameters.
- B. Training: Engage a factory-authorized service representative to demonstrate variable-speed controllers and train Owner's maintenance personnel.
 - 1. Provide videotape of training session to Owner.
 - 2. Schedule training with at least 7 days' advance notice.

END OF SECTION 230960

SECTION 231123 - FUEL 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 Pressures: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2.0 psig, and is reduced to secondary pressure of 0.5 psig or less.
- B. Design values of fuel gas supplied for these systems are; Nominal Heating Value of 1000 Btu/cu. ft. and Nominal Specific Gravity: 0.6.

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.
- C. See "Submittal Schedule" located at the end of Section 230100 "General Requirements for Mechanical Systems."

1.5 QUALITY ASSURANCE

- A. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ANSI Standard: Comply with ANSI Z223.1, "National Fuel Gas Code."
- C. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Pressure Regulators:
 - a. Fisher Controls International, Inc.
 - b. Maxitrol Co.

2.2 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. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

B. Drawn-Temper (Hard) Copper Tube: ASTM B 88, Type L.

1. Copper Fittings: ASME B16.22, wrought copper, streamlined pattern.
2. Brazing Filler Metals: AWS A5.8, Silver Classification BAg-1. Filler metal containing phosphorus is prohibited.
3. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
4. Gasket Material: Thickness, material, and type suitable for natural gas.

C. Transition Fittings: Type, material, and end connections to match piping being joined.

D. Common Joining Materials: Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.3 PIPING SPECIALTIES AND VALVES

A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

C. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.

D. Electrically Operated Gas Valves: UL 429, bronze, aluminum, or cast-iron body solenoid valve; 120-V ac, 60 Hz, Class B, continuous-duty molded coil. Include NEMA ISC 6, Type 4, coil enclosure and electrically opened and closed dual coils. Valve position shall normally be closed.

2.4 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 2-psig- minimum inlet pressure rating.
 - 4. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 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 psig or Less: Use the following:
 - 1. NPS 1 and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 1 and Smaller: Hard copper tube, copper fittings, and brazed joints.
 - 3. NPS 1-1/4 to NPS 2: Steel pipe, malleable-iron threaded fittings, and threaded joints.
- C. Fuel Gas Piping 2 psig: Use the following:
 - 1. NPS 2 and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.
- D. No other pipe, conduit or electrical conductor should be located within 12 inches horizontally of underground natural-gas piping.

3.2 PIPING INSTALLATION

- A. Refer to Division 23 Section "Basic Mechanical Piping Materials and Methods" for basic piping installation requirements.
- B. Install fuel gas piping per NFPA 54 "National Fuel Gas Code" and Metropolitan Utilities District Rules and Regulations.
- C. Concealed Locations: Except as specified below, install concealed gas piping in airtight Schedule 40 PVC conduit.
 - 1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, without containment conduit. Do not locate valves above ceilings.
 - 2. In Floors: Do not install gas piping in concrete floors.
 - 3. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls. Piping may pass through partitions or walls.
 - 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.

5. Conduit with One End Terminating Outdoors: Conduit shall extend into an accessible portion of the building be sealed to prevent gas leakage from entering the building. The other end shall extend at least 4 inches outside the building, and be vented outdoors above finished grade with a weatherproof cap and insect screen.
 6. Conduit with Both Ends Terminating Indoors: Where the conduit originates and terminates within the same building, it shall extend not less than 2 inches beyond the point where the pipe emerges from the floor and shall not be sealed at either end.
- D. 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.
- E. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.
- F. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.
- G. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- H. Connect branch piping from top or side of horizontal piping.
- I. 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. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.
- J. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.
- K. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.
- L. Install piping adjacent to appliances to allow service and maintenance.
- M. 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.

3.3 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. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 231123

SECTION 233113 - METAL DUCTS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes metal ducts and accessories for heating, ventilating, and air-conditioning systems, diffusers, registers and grilles, and gas vents.

1.3 DEFINITIONS

- A. Pressure Classification for Ductwork: As defined by to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and applicable codes.
 - 1. Low Pressure: Maximum 2500 fpm velocity; maximum 2.0" WG positive or -2.0" WG negative static pressure class.

1.4 SUBMITTALS

- A. Product data including product construction, installation instructions and performance data for the following:
 - 1. Sealing materials.
 - 2. Backdraft dampers.
 - 3. Manual-volume dampers.
 - 4. Duct-mounted access doors and panels.
 - 5. Flexible ducts
 - 6. Double Wall Insulated Ductwork
 - 7. Diffusers, Registers & Grilles
 - 8. Roof Hoods
 - 9. Gas Vents
 - 10. Hangers and Supports
- B. No requirement for shop drawings if after examining the contract documents and actual conditions, contractor agrees system can be installed as shown.
- C. Shop Drawings: Show details of the following:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Duct layout indicating pressure classifications and sizes on plans.
 - 3. Fittings.
 - 4. Reinforcement and spacing.
 - 5. Seam and joint construction.

6. Penetrations through fire-rated and other partitions.
7. Terminal unit, coil, and humidifier installations.
8. Hangers and supports, including methods for building attachment, vibration isolation, seismic restraints, and duct attachment.

- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.
- F. See "Submittal Schedule" located at the end of Section 230100 "General Requirements for Mechanical Systems."

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Backdraft and Volume Dampers
 - a. Greenheck
 - b. Air Balance
 - c. American Warming
 - d. Cesco
 - e. Louvers and Dampers, Inc.
 - f. Penn
 - g. Prefco
 - h. Carnes
 - i. Ruskin
 - j. Vent Products
2. Flexible Ducts
 - a. Flexible Air Products
 - b. Flexmaster
 - c. Thermaflex
 - d. Certainteed
 - e. Wiremold
 - f. General Flex Corp
 - g. H.K. Porter
3. Duct Access Doors
 - a. Air Balance
 - b. American Warming
 - c. Cesco

- d. Ventfabrics
 - e. Penn
 - f. Prefco
 - g. Carnes
 - h. Ruskin
 - i. Kees
 - j. United McGill
 - k. Nailor Industries
4. Diffusers, Registers, Grilles
- a. Carnes
 - b. J & J Register
 - c. Krueger
 - d. Reliable
 - e. Price
 - f. Tuttle and Bailey
 - g. Metal-Aire
 - h. Titus
 - i. Hart and Cooly
 - j. Anemostat
 - k. Nailor Industries
5. Roof Hoods
- a. Acme
 - b. Greenheck
 - c. Cook
 - d. Louvers and Dampers, Inc.
 - e. Carnes
 - f. ILG
 - g. Penn
6. Gas Vents:
- a. American Metal Products; a Masco Company.
 - b. General Products Co.; Air-Jet Div.
 - c. Hart & Cooley, Inc.
 - d. Metal Fab
 - e. Selkirk Metalbestos.
 - f. Simpson Dura-Vent Co., Inc.
 - g. United McGill Corp.; Airflow Group.
 - h. Van-Packer Co.
7. Duct Hangers & Supports:
- a. Ductmate Industries, Inc.
 - b. Duro Dyne
 - c. Eberl Iron Works, Inc.
 - d. Gripple
 - e. Miro Industries, Inc.
 - f. The Pate Company
 - g. PHP Systems / Design

2.2 SHEET METAL MATERIALS

- A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
- B. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT MATERIALS

- A. Duct Sealant: UL classified, non-combustible, flame spread 25 or less, smoke developed rating of 540 or less, resistant to water, pressure rupture rating of 16" WG minimum, suitable for use alone or with tape, application an operational temperature ranges appropriate for usage.

2.4 MANUFACTURED DUCT JOINTS

- A. Manufactured duct joining system to consist of roll formed angles, corner pieces, metal cleats and gasket material. Construct and join ductwork in accordance with the latest SMACNA test data and joint reinforcement schedule corresponding to duct gauge used. Corners to be down set design, no bolt design except bolting is required for medium pressure applications. Reinforcement requirement for sheet metal to comply with latest SMACNA for manufactured duct joining technique appropriate to get to pressure class.

2.5 BACKDRAFT DAMPERS

- A. Dampers to be multi-blade, parallel action, counter-balanced backdraft dampers of galvanized steel or extruded aluminum, with center pivoted blades linked together with blade edge seals, brass or steel bearings, and plated steel pivot pin.

2.6 MANUAL-VOLUME DAMPERS

- A. Fabricate in accordance with latest edition of SMACNA HVAC Duct Construction Standards – Metal and Flexible and as indicated.
- B. Fabricate single blade dampers for duct sizes 9 1/2" high x 30" width maximum. Single blade dampers to have spring end bearing regulator. Provide end brace for static pressure greater than 2.0" WG. Provide end brace for static pressure greater than 2.0".
- C. Fabricate multi-blade damper of opposed blade pattern using minimum 16 gauge steel with maximum blade sizes 6" x 48". Where width exceeds 48", provide regulator at both ends. Assemble center and edge crimped blades in 16 gauge channel frame with suitable hardware. Blades and frame to be galvanized or prime coated steel except where indicated for special application.
- D. Provide end bearings with end seals for pressure class required except in round duct 12" in diameter and smaller.
- E. Provide with locking quadrant actuator unless scheduled for remote actuation.

2.7 DUCT-MOUNTED ACCESS DOORS AND PANELS

- A. General: Fabricate doors and panels airtight and suitable for duct pressure class.
- B. Frame: Galvanized, sheet steel, with bend-over tabs and foam gaskets.
- C. Door: Double-wall, galvanized, sheet metal construction with insulation fill and thickness, and number of hinges and locks as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- E. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.
- F. Label: Label access doors at fire and smoke damper locations per NFPA 90A.

2.8 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- B. Neoprene double-coated woven glass fiber fabric in accordance with NFPA 90A, suitable for temperatures and pressures of application, approximately 6" wide, crimped into metal edge strip.

2.9 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1.
- B. Factory-fabricated, insulated, round duct, with an outer jacket enclosing glass-fiber insulation around a continuous inner liner.
 - 1. Reinforcement: Steel-wire helix encapsulated in inner liner.
 - 2. Outer Jacket: Polyethylene film or 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: 4-inch wg positive, 3/4-inch wg negative.
- D. Minimum R-value: R-6 for ducts inside building envelope. R-8 for ducts in unconditioned spaces.

2.10 DOUBLE-WALL ROUND DUCTS AND FITTINGS

- A. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 - 2. For ducts exposed to weather, construct outer duct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
- B. Transverse Joints: Select joint types and fabricate in accordance with 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.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with 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.
- D. Tees and Laterals: Select types and fabricate in accordance with 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."
- E. Inner Duct: Minimum 24-gauge perforated galvanized sheet steel having 3/32-inch diameter perforations, with overall open area of 23 percent
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.
 4. Cover insulation with polyester film complying with UL 181, Class 1.
- G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2.11 DIFFUSER, REGISTERS AND GRILLES

- A. General: Sizes, types and capacities as indicated. Verify ceiling and wall frame types and dimensions from architectural drawings. Factory baked enamel finish with color selected by Architect unless otherwise indicated.
- B. Diffusers: Circular, square, or rectangular air distribution outlet comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air. Opposed blade dampers.
- C. Grilles: Streamlined blades, single or double deflection as indicated.
- D. Registers: Combination grille and opposed damper assembly.

2.12 ROOF HOODS

- A. Aluminum construction; 19 gauge x 1/2" galvanized mesh screen; motorized damper, 18" roof curb. Intake shall be 20" minimum above roof.
- B. Intake hoods shall be designed for intake velocity of 50% or neck. Relief hoods shall be designed for equal velocity to neck.

2.13 TYPE B GAS VENTS

- A. Description: Double-wall gas vents complying with NFPA 211, Type B. Inner pipe of sheet aluminum, outer pipe of galvanized-steel sheet, each with the following minimum thicknesses:
 - 1. Round, 6-Inch and Smaller ID: 0.012-inch inner pipe, 0.0187-inch outer pipe.
 - 2. Round, 7- to 18-Inch ID: 0.014-inch inner pipe, 0.0187-inch outer pipe.
- B. Accessories: Tees, elbows, increasers, draft hood connectors, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, firestop spacers, and fasteners; fabricated of similar materials and designs as vent-pipe straight sections.

2.14 ACCESSORY HARDWARE

- A. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.15 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for building materials.
- B. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT FABRICATION

- A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized, sheet steel, according to SMACNA'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.

- B. Low Pressure duct
1. Seams and Joints (Rectangular Ducts): Longitudinal seams shall be Pittsburgh lock, grooved seams or button punch snap lock. Transverse joints shall be drive slip. Joints 36" and larger shall be manufactured duct joining system with downset corners, or SMACNA T-25 formed on flanges with corner and cleat. Contractor option on smaller sizes
 2. Seams and Joints (Concealed Round Duct): Transverse joints in low velocity concealed round ducts shall be slip type secured with sheet metal screws equally spaced on 6" centers maximum with a minimum of three screws per joint. Joints shall be sealed with mastic during joining. Exposed inside edge of duct at joint shall point in direction of airflow. All duct joints exposed to weather shall be caulked weathertight.
 3. Seams and joints (Exposed Round Duct): Longitudinal seams shall be lock type spiral or grooved seams rolled spirally. Transverse joints shall be slip type up to 36" in diameter and shall be sealed with mastic during joining. Flanged and gasketed joints shall be used on size larger than 36" diameter.
- C. Double-Wall (Insulated) Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner liner. Dimensions indicated on internally insulated ducts are inside dimensions.
- D. Rectangular fittings: Construct tees, bends and elbows with centerline radius of 1-1/2 times width of duct.
- E. Round Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate bend radius of die-formed, gored, and pleated elbows one and one-half times elbow diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
- F. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to low pressure standards:
- G. 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.
- H. Sizes shown on plans are inside clear dimensions. Ductwork utilizing duct liner shall be increased in size to accommodate the duct liner thickness.

3.2 DUCT INSTALLATION

- A. Drawings indicate general arrangement of ducts, fittings, and accessories. Minor modifications to route, size and shape of duct may be required to meet structural and other interference. Changes which could affect system performance shall be reviewed by Architect/Engineer prior to fabrication or installation of duct.
- B. Construct and install each duct system for the specific duct pressure classification indicated.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, changes in size and shape, and connections.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct.
- F. Install ducts, unless otherwise indicated, vertically and horizontally, 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. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.
- M. Roof penetrations by ducts should have curbs. Ducts that are interrupted at the curb should overhang the top of the curb or be flashed to divert water over the curb. Ducts that are continuous through the curb should have flashing that slopes over the curb and is sealed to the duct with caulking or suitable tape.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 PROTECTION OF DUCTWORK ON SITE

- A. Ductwork stored on site as well as installed ductwork that is left open to construction activities shall be covered. Provide protective coverings on open ends of ductwork to prevent excessive accumulation of

dust and debris on interior surfaces. Protection and storage of ductwork shall be in accordance to SMACNA's 'Duct Cleanliness for New Construction'.

3.5 SEAM AND JOINT SEALING

- A. Low Pressure Ductwork: Seal per SMACNA Seal Class "C". Sealant material shall be installed per manufacturer's recommendations.
- B. Seal externally insulated ducts before insulation installation.

3.6 HANGING AND SUPPORTING

- A. Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- C. Support vertical ducts at a maximum interval of 16 feet and at each floor.

3.7 DUCT ACCESSORY INSTALLATION

- A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- B. Install volume dampers at locations indicated and at all branch take-offs to air outlets and inlets.
- C. Provide fire and smoke dampers at locations indicated and where required by applicable codes. Install fire and smoke dampers according to manufacturer's UL-approved written instructions.
- D. Provide turning vanes in all mitered elbows and duct turns.
- E. Install duct access panels for access to inlet side of coils, equipment, control dampers, fire dampers, and smoke dampers.
- F. Final connections to air outlets and terminal units may be made with flexible duct. Install flexible ducts with metal collars or sleeves with draw bands. Length of flexible duct shall not exceed 36", path shall not exceed 0°.
- G. Provide flexible connections to motor driven equipment. Secure fabric to duct or fan collar with 3/16" rivets space not more than 5" on center. Provide thrust restraints so that connections are not in tension with equipment in operation.
- H. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards. 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.
- I. Install gas vents, chimneys, and stacks according to manufacturer's written instructions and NFPA 54. Locate to comply with minimum clearances from combustibles.

3.8 ADJUSTING

- A. Adjust volume-control dampers in ducts, outlets, and inlets to achieve design airflow. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed procedures.
- B. Adjust duct accessories for proper settings and actions.

3.9 CLEANING

- A. After completing system installation, inspect the system. Vacuum ducts before final acceptance to remove dust and debris.
- B. 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 233113

SECTION 233423 - 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 the following:
 - 1. Centrifugal roof ventilators.

1.3 SUBMITTALS

- A. Product Data: For each type of product include the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Certified fan performance curves with system operating conditions indicated.
 - 4. Certified fan sound-power ratings.
 - 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 6. Material gages and finishes, including color charts.
 - 7. Dampers, including housings, linkages, and operators.
 - 8. Prefabricated roof curbs.
 - 9. 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. Differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For power ventilators to include in operation and maintenance manuals.
- D. See "Submittal Schedule" at the end of Section 230100 "General Requirements for Mechanical Systems."

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.
- 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.

1.5 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.6 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. Centrifugal Roof Ventilators:
 - a. Acme Engineering & Mfg. Corp.
 - b. Carnes Company HVAC.
 - c. Cook, Loren Company.
 - d. Greenheck Fan Corp.
 - e. ILG Industries, Inc./American Coolair Corp.
 - f. Penn Ventilation Companies, Inc.
 - g. York.

2.2 CENTRIFUGAL ROOF VENTILATORS

- A. Description: 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, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Direct Drive:
 - 1. Electronically Commutated Motor
 - 2. Motor enclosures: Open type
 - 3. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
 - 4. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.

5. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
6. Motor shall be speed controllable down to 20% of full speed (80% turndown).
7. Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal from the building control system.
8. Provide a separately mounted air flow balancing controller that can be operated in hand-off-auto mode with a fan speed potentiometer for balancing of fan operating in hand mode. Controller shall be rated for 110 volt power input and include an internal transformer to provide 0–10 volt output control signal to motor. Controller shall include input connections for remote on/off signal and 0-10 volt input for remote speed control from building control system.
9. Motor shall be a minimum of 85% efficient at all speeds.

E. 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.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Motorized Dampers: Parallel-blade dampers mounted in curb base with 120 volt damper electric actuator; wired to close when fan stops.
4. Hinged curb cap with cables.
5. See Schedule for additional accessories.

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. Overall Height: 18 inches
2. Pitch Mounting: Manufacture curb for roof slope.

2.3 MOTORS

- A. Comply with requirements in Division 23 Section "Basic Mechanical Materials and Methods."
- B. Enclosure Type: Guarded dripproof.

2.4 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 power ventilators level and plumb.
- B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware.
- C. Install units with clearances for service and maintenance.

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.
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Connect wiring according to Division 26.
- D. Ground equipment according to Division 26.
- E. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1. Install control and electrical power to field-mounted control devices.

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. Verify lubrication for bearings and other moving parts.
 - 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 7. Disable automatic temperature-control operators.
- 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. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- F. Replace fan and motor pulleys as required to achieve design airflow.
- G. 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. 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. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.
 - 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.
 - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 233423

SECTION 23 5533

GAS-FIRED UNIT 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. Section includes gas-fired unit heaters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of gas-fired unit heater.
 - 1. Include rated capacities, operating characteristics, and accessories.
- B. Shop Drawings: For gas-fired unit heaters. Include plans, elevations, sections, and attachment details.
- C. Sample Warranty: For special warranty.
- D. Operation and Maintenance Data: For gas-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.4 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. Fan Belts: One for each belt-driven fan size.

1.5 QUALITY ASSURANCE

- A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of gas-fired unit heater that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 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. [Lennox International, Inc.](#)
 - 2. [Modine Manufacturing Company.](#)
 - 3. [Reznor/Thomas & Betts Corporation.](#)
 - 4. [Sterling HVAC Products; Div. of Mestek Technology Inc.](#)
 - 5. [Trane; a brand of Ingersoll Rand.](#)

2.2 PERFORMANCE REQUIREMENTS

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

2.3 MANUFACTURED UNITS

- A. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.
- B. Gas Type: Design burner for natural gas having characteristics same as those of gas available at Project site.
- C. Type of Venting: Indoor, separated combustion, power vented.
- D. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
 - 1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.
 - 2. Discharge Louvers: Independently adjustable, horizontal blades.
- E. Accessories:
 - 1. Four-point suspension kit.
 - 2. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.

3. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.
- F. Heat Exchanger: Aluminized steel.
- G. Burner Material: Aluminized steel with stainless-steel inserts.
- H. Propeller Unit Fan:
 1. Formed-steel or Aluminum propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
 2. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
- I. Motors:
 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 0513 "Common Motor Requirements for HVAC Equipment."
 2. Enclosure Materials: Rolled steel.
 3. Efficiency: Premium efficient.
- J. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
 1. Gas Control Valve: Single stage.
 2. Ignition: Electronically controlled electric spark with flame sensor.
 3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
 4. Vent Flow Verification: Flame rollout switch.
 5. Control transformer.
 6. High Limit: Thermal switch or fuse to stop burner.
 7. Wall-Mounted Thermostat:
 - a. Single stage.
 - b. Fan on-off-automatic switch.
 - c. 24-V ac.
 - d. 50 to 90 deg F operating range.
- K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written instructions.

3.2 EQUIPMENT MOUNTING

- A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.
- C. Gas Piping: Comply with Section 23 1123 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
- D. Vent Connections: Comply with Section 23 5100 "Breechings, Chimneys, and Stacks."
- E. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 2. Verify bearing lubrication.
 3. Verify proper motor rotation.

- C. Gas-fired unit heater will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- 3.5 ADJUSTING
- A. Adjust initial temperature and humidity set points.
 - B. Adjust burner and other unit components for optimum heating performance and efficiency.
- 3.6 DEMONSTRATION
- A. Train Owner's maintenance personnel to adjust, operate, and maintain gas-fired unit heaters.

END OF SECTION

SECTION 260100 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes general electrical requirements and shall apply to all phases of the work specified, indicated on the drawings or required to provide for complete installation of electrical systems.

1.3 WARRANTIES

- A. All materials, workmanship and equipment shall be warranted against defects or against injury from proper and usual wear for a period of one year after the date of substantial completion. Certain equipment shall be warranted beginning at the time of final acceptance or for longer periods of time as specified in those sections of the Project Manual. Any item which becomes defective within the warranty period shall be repaired or replaced, at no additional cost to the Owner.
- B. All manufactures warranties shall run to the benefit of the Owner. No manufacturer's warranties shall be voided or impaired.
- C. Warranty shall include repair of faulty workmanship.

1.4 INTERPRETATION OF DOCUMENTS

- A. Any questions regarding the meaning of any portion of the contract documents shall be submitted to the Architect/Engineer for interpretation. Addenda or supplemental information will publish definitive interpretations or clarification. Verbal interpretation not issued by addendum or supplemental information shall not be considered part of the contract documents.
- B. The Architect/Engineer shall be the sole judge of interpretations of discrepancies within the contract documents.
- C. If ambiguities should appear in the contract documents, the Contractor shall request clarification from the Architect/Engineer before proceeding with the work. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Architect/Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Architect/Engineer was requested and obtained before submission of proposed methods or materials.

1.5 DEFINITIONS ABBREVIATIONS

- A. The following shall apply throughout the contract documents

1.	Code	All applicable national state and local codes
2.	Furnish	Supply and deliver to site ready for installation
3.	Indicated	Noted, scheduled or specified
4.	Provide	Furnish, install and connect complete and ready for final use by Owner
5.	ADA	Americans with Disabilities Act
6.	ANSI	American National Standards Institute
7.	ASTM	American Society for Testing and Materials
8.	FM	Factory Mutual System
9.	IRI	HSB Industrial Risk Insurers
10.	NEC	National Electric Code (NFPA 70)
11.	NEMA	National Electrical Manufacturers Association
12.	NFPA	National Fire Protection Association
13.	UL	Underwriters Laboratories Inc.

1.6 CODES AND STANDARDS

- A. All work shall be performed by competent craftsmen skilled in the trade involved and shall be done in a manner consistent with normal industry standards.
- B. All work shall conform to the currently adopted edition of the National Electric Code (NEC), Local Building Code, and all other applicable state and local codes or standards.
- C. Where there is a conflict between the code and the contract documents, the code shall have precedence only when it is more stringent than the contract documents. Items that are allowed by the code but are less stringent than those specified shall not be substituted.

1.7 PERMITS

- A. Contractor shall become familiar and comply with all requirements regarding permits, fees, licenses, etc. All permits, licenses, inspections and arrangements required for the work shall be obtained by Contractor's effort and expense. All utilities shall be installed in accordance with the local rules and regulations and all charges shall be paid by the Contractor. Capital facilities fees will be paid by Owner.

1.8 SUBMITTALS

- A. Division 1 section "Submittals" shall be adhered to if more stringent than this section.
- B. Shop drawings shall be submitted to Architect/Engineer for review when required by other sections of this specification and for all equipment scheduled or specified on drawings.
 - 1. A letter of transmittal shall accompany each submittal. Submittals shall be numbered consecutively and list products covered.
- C. Shop Drawings
 - 1. Shop drawings include fabrication and installation drawings, diagrams, schedules of other data specifically prepared for the project. Include dimensions and notations showing compliance with specified standards.
- D. Product Data

1. Product data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, rough-in diagrams, wiring diagrams and performance curves.
 2. Each copy shall clearly indicate conformance with specified capacities, characteristics, dimensions and details. Mark all equipment with same item number as used on drawings. Mark each copy to clearly indicate applicable choices and options.
- E. Architect/Engineer will review or take appropriate action for submittals. Review is only to determine general conformance with design shown in contract documents.
- F. Architect/Engineer review of submittals shall not relieve contractor of responsibility for deviation from requirements of the contract documents or from errors or omissions within submittals.
- G. No portion of the work requiring submittals shall be commenced until the Architect/Engineer has reviewed the submittal.
- H. See "Submittal Schedule" at the end of Section 260100 – General Electrical Requirements.

1.9 OPERATION AND MAINTENANCE MANUALS

- A. Assemble three (3) complete sets of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
1. Operation Data:
 - a. Emergency instructions and procedures.
 - b. System, subsystem, and equipment descriptions, including operating standards.
 - c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
 - d. Description of controls and sequence of operations.
 - e. Piping and wiring diagrams.
 2. Maintenance Data:
 - a. Manufacturer's information, including list of spare parts.
 - b. Name, address, and telephone number of installer or supplier.
 - c. Maintenance procedures.
 - d. Maintenance and service schedules for preventive and routine maintenance.
 - e. Maintenance record forms.
 - f. Sources of spare parts and maintenance materials.
 - g. Copies of maintenance service agreements.
 - h. Copies of warranties and bonds.
- B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

1.10 PROJECT RECORD DOCUMENTS

- A. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.

1. Mark Record Prints to show the actual installation where installation varies from that shown originally.
 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 3. Mark important additional information that was either shown schematically or omitted from original Drawings.
 4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
 5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials and equipment used in the construction of the project shall be new unused and undamaged unless otherwise specified. Materials and equipment shall be of latest design standards of manufacturer specified.
- B. Materials and equipment are limited by the requirements of the contract documents. Material and equipment shall be provided in accordance with the following:
1. Basis of Design Products: Basis of Design Products are those products around which the project was designed in terms of capacity, performance, physical size and quality. Basis of Design Products shall be provided unless substitutions are made in accordance with this specification.
 2. Substitutions: Substitutions are product of manufacturers other than listed as Basis of Design. Substitutions shall meet each of the following requirements and shall be subject to prior approval. Submissions requesting prior approval shall be received by the engineer no less than ten (10) days prior to project bid date.
 - a. The product shall be manufactured by one of the acceptable manufacturers listed in the contract documents.
 - b. The product shall meet or exceed the requirements of the contract documents in terms of quality, performance, suitability, appearance and characteristics.
 - c. The contractor providing the substitution shall bear the total cost of all changes due to substitutions. These may include but are not limited to redesign costs and increased work by other contractors or the Owner.
 - d. The Architect/Engineer shall be the sole judge of the suitability of the substitution items.
- C. Verify installation details and requirements for materials and equipment furnished by others and installed under this contract.

PART 3 - EXECUTION

3.1 DEMONSTRATION AND TRAINING

- A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system. Provide 2 hours training in up to two separate sessions.
 - 1. Provide instructors experienced in operation and maintenance procedures.
 - 2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
 - 3. Schedule training with Owner and Architect/Engineer with at least seven days' advance notice.

3.2 STARTING AND ADJUSTING

- A. Start and test all equipment and operating components to confirm proper operation. Test and adjust all systems to achieve designed capacity and performance.
- B. Provide three (3) copies of all test report to the Architect/Engineer for review prior to date of substantial completion.
- C. All equipment and systems discrepancies shall be corrected prior to final acceptance.

3.3 TEMPORARY POWER AND LIGHTING

- A. Electric Power Service: Provide temporary electric power from Owner's electric system without payment of use charges.
- B. Electric Distribution: Provide receptacle outlets adequate for connection of power tools and construction equipment.
- C. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations and traffic conditions.

ELECTRICAL SUBMITTAL SCHEDULE [EDIT SCHEDULE FOR REQUIRED TEST REPORTS, O&M's AND TRAINING]

Refer to individual specification sections for additional requirements and detail on each submittal.

Section	Section Name	Prod uct Data	Shop Dwgs	Test Reports / Quality Control	Warranty	Extra Materials	O&M Data	Record Docs	Demonstration / Training
260100	General Electrical Requirements	√	√						
260500	Basic Electrical Materials and Methods	√	√						
262200	Dry Type Transformers	√			√		√		
262413	Switchboards	√	√		√		√		√
262416	Panelboards	√	√		√		√		
262726	Wiring Devices	√	√				√		
262816	Disconnect Switches and Circuit Breakers	√			√		√		
264313	Surge Protective Devices (SPD's)	√			√		√		
265100	Lighting	√	√		√		√		
265200	Lighting Control	√	√		√		√		√
268100	Fire Alarm	√	√		√		√		√

END OF SECTION 260100

SECTION 260500 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following basic electrical materials and methods and shall apply to all phases of the work specified, indicated on the drawings or required to provide for complete installation of electrical systems.
 - 1. Conduits.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Outlet boxes.
 - 5. Electrical identification.
 - 6. Electrical demolition.
 - 7. Work in existing buildings.
 - 8. Cutting and patching for electrical construction.
 - 9. Fire Stopping.
 - 10. Touchup painting.

1.3 MATERIAL 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. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing of electrical materials and equipment with other trades.
- C. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
- D. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

- E. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.
- F. Motors, equipment, controls, etc. shall be furnished, mounted and connected according to the following schedule unless otherwise noted (E =Electrical Contractor, M =Mechanical Contractor):

Item	Furnished By	Set in place or mounted by	Power wiring and connection by	Control Wiring and connection by
1) Equipment Motors	M	M	E	M
2) Magnetic Motor Starters:				
a) Automatically controlled, with or without HOA switches.	E	E	E	M
b) Automatically controlled, with or without HOA switches and furnished as part of factory-wired mechanical equipment	M	M	E	M
3) Variable Frequency Drives	M	M	E	M
4) Disconnect switches, thermal overload switches, manual operating switches				
a) Furnished as part of factory wired mechanical equipment	M	M	E	--
b) Loose mounted	E	E	E	--
5) Transformers				
a) Serving 120 Volt and higher loads	E	E	E	--
b) Serving 24 Volt control power	M(1)	M	E	M
6) Contactors	E	E	E	E
7) Line voltage thermostats and time clocks.	E	E	E	E
8) Low voltage controls and thermostats	M	M	M	M (2)
9) Motorized valves, and float controls for tanks and sumps	M	M	E	M
10) Temperature control panels	M	M	E	M
11) Motorized control valves, damper motors, solenoid valves, etc.				
a) Line Voltage	M	M	E	M
b) Low Voltage	M	M	M	M
12) Factory pre-wired control/power panels including remote sensing devices	M	M	E	M(3)
13) Electric wall and unit heaters	E	E	E	E
14) Fire protection controls	M	M	E	E
15) Fire Smoke Dampers				
a) At air handling unit (24 Volt)	M	M	M	M
b) In space (120 Volt)	M	M	E	E(4)
16) Fire and smoke detectors including relays for fan shutdown	E	E	E	E(5)

Notes:

- When control power is not available, mechanical contractor shall provide control transformers as required to power all valves, dampers, etc.
- Conduit rough-in for thermostats by electrical contractor.

3. Fan coil units, electric duct heaters, chillers, remote condensing units and heat pumps control wiring including wiring of remote sensors by mechanical. Control circuit feeders by mechanical unless shown otherwise.
4. Smoke dampers will be specified as 115 volt (verify) with wiring by Electrical Contractor and control from the fire alarm panel. Smoke detectors furnished by electrical contractor are required to make dampers operate.
5. Wiring from alarm contacts to alarm system by Electrical; control function wiring by Mechanical.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Each contractor shall make provisions for delivery and safe storage of materials. Materials shall be delivered in a timely manner to expedite the work.
- B. Protect stored piping, supplies and equipment from cold, moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

PART 2 - PRODUCTS

2.1 CONDUITS

- A. Electrical metallic tubing (EMT): ANSI C80.3 and UL 797, zinc-coated steel with steel or die cast, set-screw or compression type fittings.
 1. Color coded exterior for system identification:
 - a. Fire Alarm – Red.
 - b. Power – Silver.
 - c. Security – Orange.
 - d. Communications – Blue.
- B. Flexible metal conduit (FMC): UL 1, Zinc-coated steel.
- C. Intermediate metal conduit (IMC): ANSI C80.6 and UL 1242, zinc-coated steel, with threaded fittings.
- D. Liquidtight flexible metal conduit (LFMC): Flexible steel conduit with PVC jacket and complying with UL 360.
- E. Rigid nonmetallic conduit (RNC): NEMA TC 2 and UL 651, EPC-40 (schedule 40) PVC, with NEMA TC3 fittings.
- F. Installation location shall determine conduit type permitted.
 1. For indoor installations:
 - a. Exposed: EMT.
 - b. Concealed: EMT.
 - c. Connection to vibrating equipment: FMC; except in wet or damp locations, use LFMC.
 - d. Boxes and enclosures: NEMA 250, Type 1, unless otherwise indicated.
 2. Use the following conduits for outdoor installations:
 - a. Exposed: IMC.

- b. Underground: RNC.
 - c. Boxes and enclosures: NEMA 250, Type 3R or Type 4.
- 3. At motors:
 - a. Connect motors and equipment subject to vibration, noise transmission, or movement with FMC of 72-inch maximum length.
 - b. Damp locations: LFMC.
- G. Conduit fittings: Specifically designed for the conduit type with which used. Comply with NEMA FB 1 and UL 514B.

2.2 CONDUCTORS

- A. Conductors and conductor insulation: Comply with NEMA WC 70.
- B. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
- C. Conductors, larger than No. 10 AWG: Stranded copper.
- D. Insulation: thermoplastic, rated at 75 deg C minimum.
 - 1. Feeders: Type THHN/THWN insulated conductors in conduit.
 - 2. Underground Feeders and Branch Circuits: Type THWN in conduit.
 - 3. Branch Circuits: Type THHN/THWN insulated conductors in conduit.
 - 4. Circuits over 100 feet from GFCI devices and all circuits from line isolation panels: Low-leakage XHHW in conduit.
- E. Wire connectors and splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.
- F. Unless otherwise indicated on the drawings, circuits are to be 20 amps with #12 AWG wire.
- G. A green ground shall be installed with all branch and feeder circuits. Unless otherwise indicated on the drawings, ground wires are to be #12 AWG.
- H. Provide a dedicated neutral conductor for each 120V and 277V branch circuit unless otherwise indicated on drawings.

2.3 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal items for use outdoors or in damp locations: Hot-dip galvanized steel.
- C. Slotted-steel channel supports: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches o.c., in webs.
- D. Conduit and cable supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
 - 1. In general, use the following support methods for outdoor conduit installations:

- a. Individual exposed conduit: 1" and smaller; 2 hole straps.
- b. Individual exposed conduit: 1-1/4" and larger; Minerallac.
- c. Paired individual exposed conduit: Minerallac.
- d. Rack exposed conduit: Unistrut with strut straps.
- e. Concealed in concrete pour: Approved iron tie wire.

2. In general, use the following support methods for indoor conduit installations:

- a. Individual exposed conduit: 1" and smaller; 2 hole straps.
- b. Individual exposed conduit: 1-1/4" and larger; Minerallac.
- c. Individual lighting and power above lay-in ceilings: Dedicated ceiling wire with Caddy clips.
- d. Racked exposed or concealed conduit: Unistrut with strut straps.

E. Pipe sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

F. Expansion anchors: Carbon-steel wedge or sleeve type.

G. Toggle bolts: All-steel springhead type.

H. Powder-driven threaded studs: Heat-treated steel.

2.4 BOXES

- A. Hollow wall and ceiling spaces: Outlet boxes for concealed applications shall be 4" square with single or multiple gang plaster ring in round or square configuration to match the device or fixture being installed. Depth of ring shall be selected so that face of ring is recessed back from face of finished surface by approximately 1/8".
- B. Masonry walls: Outlet boxes in masonry walls shall be 4" square with single or multiple gang masonry rings with square edges. Masonry boxes may also be used where 4" square boxes are impractical. Slush boxes in place to prevent movement within walls. Flush mounted boxes and conduit are to be used unless otherwise indicated.
- C. Exposed exterior boxes: Where exposed boxes are required, they shall be the cast type with threaded hubs and gasketed covers. Use of these boxes is by approval only. Flush mounted boxes and conduit are to be used unless otherwise indicated.
- D. Interior junction boxes: Interior junction boxes shall be 4" square minimum with knock outs as required. Larger boxes may be required and shall be sized per NEC. Provide a flat steel coverplate.
- E. Specialty junction boxes larger than 4 11/16": Junction and pull boxes shall be sized per NEC and arranged to facilitate pulling or splicing. Boxes shall be steel without knock outs, with hinged or screw on cover plates.

2.5 ELECTRICAL IDENTIFICATION

- A. Underground warning tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.

- 4. Printed legend that indicates type of underground line.
- B. Tape markers for wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- C. Engraved-plastic labels, signs, and instruction plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in black letters on white background.

2.6 ACCESS DOORS

- A. Prime coated 14 gauge steel, flush, with screw driver operated cam lock. Frame to accommodate construction type; size as indicated.

PART 3 - EXECUTION

3.1 UTILITY COORDINATION

- A. Utility locations indicated on drawings are approximate and the most accurate information available at the time of design. Prior to equipment and conduit installation, the contractor shall coordinate exact installation details and modify work plan accordingly to meet utility requirements. Correspond with utility company prior to any site development that may impact the installation such as irrigation installation, concrete or asphalt installation, landscaping, etc.
- B. Contact utility locating services prior to digging.

3.2 ELECTRICAL EQUIPMENT INSTALLATION

- A. Quality of workmanship: A neat and workmanlike installation shall be provided as defined in the National Electrical Installation Standards (NEIS) established by the National Electrical Contractors Association (NECA). NEIS standards shall be followed for all work including that which is concealed by construction.
- B. Neatness and craftsmanship shall be a priority. Installations shall be subject to regular observations performed by the Engineer or the Engineer's Representative. If an installation is deemed unsatisfactory by the Engineer or the Engineer's Representative due to quality of workmanship, code conflicts or deviations from the Construction Drawings or Specifications, the Contractor shall remedy the installation to the satisfaction of the Engineer.
- C. Inspect installed components for damage and faulty work, including the following:
 - 1. Conduits.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electrical identification.
 - 5. Cutting and patching for electrical construction.
 - 6. Touchup painting.
- D. Headroom maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

- E. Materials and components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- G. Right of way: Give to conduits and piping systems installed at a required slope.

3.3 CONDUIT AND CABLE INSTALLATION

- A. Conceal conduit and cables, unless otherwise indicated, within finished walls, ceilings, and floors.
- B. Install conduit and cables at least 6 inches away from parallel runs of flues or hot-water pipes. Locate horizontal conduit runs above water piping.
- C. Use temporary conduit caps to prevent foreign matter from entering.
- D. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- E. Use conduit and cable fittings compatible with conduit and cables and suitable for use and location.
- F. Conduits may be installed embedded in concrete under the following conditions:
 - 1. Contractor shall receive approval from a structural engineer if conduit is to be located in structural concrete.
 - 2. Leave at least 2-inch concrete cover.
 - 3. Do not displace more than 1/3 of the concrete thickness of the slab. For example, if the slab thickness is 3", maximum conduit size is to be 1" OD.
 - 4. Secure conduit to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 5. Where multiple conduits are run in an area, space conduit laterally to prevent voids in concrete. Fan out conduit runs for a minimum spacing of no less than 3 times the diameter of the larger conduit in a group. Do not place conduits within 12" of supporting beams, walls and columns.
 - 6. Install conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.
 - 7. Where floor finish is to be exposed concrete, avoid excessive underfloor conduits and maximize cover over conduits to avoid floor cracking.
 - 8. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.
- G. Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows where elbows can be installed parallel; otherwise, provide field bends for exposed parallel conduits.
- H. Install pull wires in empty conduits. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.
- I. Install interior telephone and signal system conduits in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements, in addition to requirements above.
- J. Install exterior telephone and signal system conduits in maximum lengths of 500 feet and with a minimal number of 90-degree bends.

- K. Utilize sweep elbows for all telephone and signal system conduits 2" and larger.
- L. All conduits routed through unfinished spaces shall be routed as high as allowable to avoid future conflicts with build out.
- M. All conduits routed exposed in finished spaces shall be painted to match the surroundings. Unless otherwise required by Code, this shall include fire alarm, communication, or other color-specific conduits.
- N. Route conduits parallel to building structural members in a neat and orderly manner.

3.4 CONDUIT SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple conduit hangers and riser clamps to support conduits. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Size supports for multiple conduits so capacity can be increased by a 25 percent minimum in the future.
- D. Install 1/4-inch diameter or larger threaded steel hanger rods, unless otherwise indicated.
- E. Simultaneously install vertical conductor supports with conductors.
- F. Separately support cast boxes that are threaded to conduits and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to conduits on opposite sides of the box and support the conduit with an approved fastener not more than 24 inches from the box.
- G. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength. Use factory hardware for all connections and assemblies including 45 and 90 degree attachment hardware.
- H. Install sleeves for cable and conduit penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and conduit penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- I. Install PVC sleeves for grounding cable riser penetrations of concrete slabs. Where ground wires are run through metal sleeves use grounding bushings on both ends of the conduit or sleeve.
- J. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 2. New concrete: Concrete inserts with machine screws and bolts.
 - 3. Light steel: Sheet-metal screws.
 - 4. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.5 WIRING INSTALLATION

- A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- B. Install wiring at outlets with at least 12 inches of slack conductor at each outlet.
- C. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values.

3.6 POSITION OF DEVICE OUTLETS

- A. Outlets shall be installed at the height indicated below unless otherwise noted. All heights of outlets are measured from finished floor to centerline of device. Heights may be adjusted as necessary to clear wall mounted cabinets, fin tube convectors, unit heaters, etc. Where installed in masonry walls, mounting heights may be adjusted to correspond to block coursing. In no case shall outlets be mounted below 15" or switches above 48":

1.	Wall switches	44"
2.	Receptacle outlet (general)	16"
3.	Receptacle outlet serving countertops	4" above counter or top of backsplash unless otherwise noted.
4.	Exterior receptacles	24"
5.	Communications outlet	Match adjacent outlets.
6.	Fire alarm signals	84" or 6" below ceiling (whichever is lower).
7.	Fire alarm pull stations	44"
8.	Exit lights	4" between top of door frame and bottom of exit light where possible.

3.7 ELECTRICAL IDENTIFICATION

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying.
- D. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- E. Install warning markers directly above power and communication lines during trench backfilling for underground power, control, signal, and communication lines. Locate marker 6 to 8 inches below finished grade unless required otherwise by NEC. Markers shall be continuous and detectable with a metal detector from above ground after backfilling. Provide one strip of marker for each 16 inches of width if multiple lines are installed in a common trench or concrete envelope.
- F. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
 - 1. Phase A: Black.
 - 2. Phase B: Red.

3. Phase C: Blue.
4. Neutral: White.
5. Ground: Green.

G. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Brown
2. Phase B: Orange
3. Phase C: Yellow
4. Neutral: White with a colored stripe or gray
5. Ground: Green.

3.8 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly and to resist passage of smoke and other gases. Products designed to achieve a fire or smoke resistance rating shall not be used in locations where such ratings are not required by AHJ. Coordinate location requirements with other disciplines and AHJ prior to installation.

1. Limit air leakage to 5.0cfm per square foot tested in accordance with UL 1479.
2. Materials labeled by a qualified testing agency acceptable to AHJ.
3. Comply with manufacturer's written installation instructions and published drawings
4. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - a. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - b. Contractor's name, address, and phone number.
 - c. Designation of applicable testing and inspecting agency.
 - d. Date of installation.
 - e. Manufacturer's name.
 - f. Installer's name.

B. All firestopping assemblies shall be from one manufacturer. Match manufacturer used by other trades or as directed by general contractor.

C. Where electrical outlets are to be installed in fire rated walls, provide FlameSafe FSP1077 putty pads or equal to maintain adequate fire rating.

D. Where lighting fixtures or other electrical devices are to be installed in fire rated ceilings, provide Tenmat Fire Rated Light Covers or equal to maintain adequate fire rating.

3.9 HOUSEKEEPING PADS

A. Provide a 3-1/2 inch tall concrete housekeeping pad for all floor mounted interior electrical equipment as follows:

1. Pad shall extend 4-6" beyond all sides of equipment, except in the back for switchboards mounted tight against the wall.

2. Constructed of 3000 psi concrete.
3. Provide 6" x 6" #4 welded wire mesh.
4. Securely bond pad to floor by roughing the floor and coating with cement grout.

3.10 DEMOLITION

- A. Disconnect, demolish, and remove construction indicated in specifications and drawings.
- B. The Owner shall have first salvage rights to all fixtures, devices and equipment removed. Present removed materials to owner's representative. Materials not retained by owner's representative shall be removed from project site.
- C. If equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- D. Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.
- E. Remove all accessible conduit unless otherwise noted.
- F. Remove branch circuit conductors and low voltage cable in area of demolition not reused in new work or planned for future use. Where left for future use, label wire at both ends and at each junction box.
- G. Power to existing areas not being remodeled shall be maintained at all times except for short term outages necessary for reconnection of existing circuits. Coordinate and schedule outages with owner.
- H. Coordinate demolition with the work of other trades. Provide temporary power as required to allow the work of other trades to proceed or as required to allow the owner to occupy the space.
- I. See architectural plans to determine project phasing requirements. Electrical circuits serving areas not under construction shall remain active until those areas are turned over to the contractor for construction.
- J. Work abandoned in place: Cut and remove underground conduit a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.

3.11 WORK IN EXISTING BUILDINGS

- A. Full Owner Occupancy: The Owner will occupy the site and existing building during the construction period. Cooperate with the Owner to minimize conflicts with the Owner's operations.
- B. Schedule all work in advance with the owner. Do not proceed with work without the Owner's written approval.
- C. Notify Owner of noisy operations and schedule in advance.
- D. The Owner shall have the right to direct work to secure safe and proper progress and quality of work.
- E. Do not interrupt utilities without Owner's written approval of time and duration. Interruptions shall be the minimum required for completion of work and performed during the hours of 10:00 PM-6:00 AM Monday through Friday or 6:00 PM Saturday through 6:00 AM Monday.
- F. The existing fire alarm system shall remain functional throughout the project. The Owner and the Fire Marshal shall approve required outages.

- G. The Owner shall be notified before starting welding or cutting. Fire extinguishers shall be immediately accessible when welding or cutting with an open flame or arc. Welding or cutting with an open flame or arc shall be stopped not less than one hour before leaving the premises.
- H. Existing electrical items that interfere with the proper installation new work shall be removed or relocated as required or as directed by the Architect/Engineer.
- I. Maintain downstream circuit continuity to equipment to remain active.
- J. Where breakers are indicated to be installed in existing panelboards, remove panel covers and verify all connection details prior to ordering of breakers. Provide all required hardware for installation of breakers in existing panels.

3.12 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.

3.13 CONSTRUCTION LAYOUT

- A. Layout work in advance of installation using data and measurements from the site, the appropriate architectural and structural drawings and shop drawings.
- B. Confirm adequate clearance for installation, operation, maintenance and code required clearance including items installed by other contractors.
- C. If layout to provide clearance is not possible, promptly notify Architect/Engineer for clarification.

3.14 DATA AND MEASUREMENTS

- A. The data given herein and on the drawings is as accurate as could be secured. The existence and location of construction as indicated is not guaranteed. Before beginning work investigate and verify the existence and location of items affecting work. Obtain exact locations, measurements, levels, etc., at the site and adapt work to actual conditions.
- B. Only Architectural drawings, Structural drawings, and site measurements may be utilized in calculations. Mechanical and electrical drawings are diagrammatic or schematic.

3.15 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint.
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.16 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 260500

SECTION 262200 - DRY-TYPE TRANSFORMERS (1000 V AND LESS)

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 dry-type distribution and specialty transformers rated 1000 V and less.

1.3 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance for each type of transformer specified including the following:
 - 1. Outline dimensions
 - 2. Weight
 - 3. Impedance
 - 4. Temperature rating
 - 5. Quantity of voltage taps
 - 6. Noise levels
- B. Maintenance Data: For transformers to include in the maintenance manuals specified in Division 1.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide transformers by one the following:
 - 1. Acme Electric Corp.; Transformer Division.
 - 2. Challenger Electrical Equipment Corp.
 - 3. Cutler-Hammer/Eaton Corp.
 - 4. GE/ABB.
 - 5. MagneTek Inc.
 - 6. Siemens Energy & Automation, Inc.
 - 7. Square D; Groupe Schneider.

2.2 TRANSFORMERS, GENERAL

- A. Description: Factory-assembled and -tested, air-cooled units of types specified, designed for 60-Hz service.
- B. Cores: Grain-oriented, nonaging silicon steel.
- C. Coils: Continuous windings without splices, except for taps.
- D. Internal Coil Connections: Brazed or pressure type.
- E. Enclosure: Class complies with NEMA 250 for the environment in which installed.
- F. Energy Efficiency: DOE 2016 rated.
- G. Sound levels (measured at 1 foot):
 - 1. 25 to 50 kva, 45 db
 - 2. 51 to 150 kva, 50 db

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

- A. Comply with NEMA ST 20 and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Windings: One coil per phase in primary and secondary.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Aluminum.
- D. Enclosure: Indoor, ventilated.
- E. Insulation Class: 185 or 220 deg C class for transformers 15 kVA or smaller; 220 deg C class for transformers larger than 15 kVA.
 - 1. Rated Temperature Rise: 115 deg C maximum rise above 40 deg C. for transformers 300 kVA and smaller.
- F. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:
 - 1. Taps, 3 through 15 kVA: Two 5-percent taps below rated high voltage.
 - 2. Taps, 15 through 300 kVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.
- G. Electrostatic Shielding: Each winding is independently single shielded with a full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Coil leads and terminal strips are arranged to minimize capacitive coupling between input and output connections.
 - 2. Shield Terminal: Separate; marked "Shield" for grounding connection.
 - 3. Capacitance: Shield limits capacitance between primary and secondary to a maximum of 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - 4. Common-Mode Noise Attenuation: Minus 120 dB minimum, 0.5 to 1.5 kHz; minus 65 dB minimum, 1.5 to 100 kHz.

5. Normal-Mode Noise Attenuation: Minus 52 dB minimum, 1.5 to 10 kHz.

H. Drive isolation transformers shall be designed for use with variable frequency drives.

I. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 75 kVA.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2 windings.

2.5 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All connections to transformers shall be made with flexible metal conduit. Do not connect conduits to the top of transformers.

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

C. Label transformers in accordance with Basic Materials and Methods.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.2 GROUNDING

A. Separately Derived Systems: Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

B. Ground core of transformer to enclosure using braided grounding strap sized in accordance with NEC.

3.3 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.4 ADJUSTING

- A. After installing and cleaning, touch up scratches and mars on finish to match original finish.
- B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in readjusting transformer tap settings to suit actual occupied conditions. Provide up to 2 visits to Project site for this purpose without additional cost.
 - 1. Voltage Recordings: Contractor performed. Provide up to 48 hours of recording on the low-voltage system of each medium-voltage transformer.
 - 2. Point of Measurement: Make voltage recordings at load outlets selected by Owner.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

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 service and distribution switchboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less.
- B. Related Sections include the following:
 - 1. Division 26 Section "General Electrical Requirements."
 - 2. Division 26 Section "Basic Electrical Materials and Methods."
 - 3. Division 26 Section "Surge Protective Devices (SPDs)."

1.3 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 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 for types other than NEMA 250, Type 1.
 - b. Bus materials, configuration, current, and voltage ratings.
 - c. Short-circuit current rating of switchboards and overcurrent protective devices.
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices, and auxiliary components.
 - f. SPD devices when integrated into equipment.
 - 2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For switchboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in sections of lengths that can be moved past obstructions in delivery path.
- B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. 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/Engineer not less than seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
 2. Indicate method of providing temporary utilities.
 3. Proceed with utility interruptions only after receiving Architect/Engineer's written authorizations.

1.7 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCT

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Switchboards, Overcurrent Protective Devices, and Accessories:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. GE/ABB

- c. Siemens Energy & Automation, Inc.
- d. Square D Co.

2.2 MANUFACTURED UNITS

- A. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.
- B. Nominal System Voltage: 480Y/277 V.
- C. Main-Bus Continuous: 1200 A.

2.3 FABRICATION AND FEATURES

- A. Enclosure: Steel, NEMA 250, Type 1
- B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- C. Service Equipment Label: Labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.
- D. Barriers: Between adjacent switchboard sections.
- E. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- F. Buses and Connections: Three phase, four wire, unless otherwise indicated. Include the following features:
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
 - 2. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.
 - 3. Ground Bus: 1/4-by-2-inch minimum size, drawn-temper copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4. Contact Surfaces of Buses: Silver plated.
 - 5. Horizontal Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 6. Vertical Main Phase Buses, Neutral Buses: Extend vertical bus from top to bottom of each distribution section to allow maximum mounting of current and future devices.
 - 7. Neutral Buses: 100 percent of the ampacity of the phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus is braced.

- G. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.4 SURGE PROTECTIVE DEVICE (SPD)

- A. Panelboard configured to physically accommodate integration of a SPD.
- B. Panelboard phase, neutral, and ground busses configured to accommodate an integral SPD with leads for each mode no longer than 12”.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Main Device: Molded-Case Circuit Breaker.
- B. Branch Devices: Molded-Case Circuit Breakers.
- C. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Electronic Trip Unit Circuit Breakers for breaker frame sizes 800 A and larger: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 - 3. Molded-Case Circuit-Breaker Features and Accessories:
 - a. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 - b. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- D. Arc Energy Reducing Maintenance Switch: For each circuit breaker rated 1200A or higher, provide a selector switch to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity. Switch shall be lockable in either the OFF or ON (maintenance mode) position. Provide with an LED indicator light to indicate that switch is in maintenance mode. Provide with NO and NC contact for connection to building management or alarm system.

2.6 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
 - 1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound or bushing type; single or double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems equal to GE Power Leader Panel-Mount EPM and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Kilowatts: Plus or minus 2 percent.
 - e. Kilovars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Kilowatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - i. Accumulated Energy, Kilowatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
2. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Support switchboards on concrete bases, 3 1/2-inch nominal thickness. Bases should be sized to extend no more than 6" in front of equipment.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."
- B. Switchboard Nameplates: Label each switchboard compartment and overcurrent protective device with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

- A. Install equipment grounding connections for switchboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.5 FIELD QUALITY CONTROL

- A. Perform acceptance tests as follows:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Test performance of ground-fault protection system per NEC 230.95(C).

3.6 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
 - 1. Settings are based off of Square D PE and PX circuit breakers. Equivalent settings should be provided for other manufacturer's equipment.
 - a. Long Time Setting = 1.0
 - b. Long Time Delay = 20
 - c. Short Time Pickup = 8
 - d. Short Time Delay = 0.5
 - e. Instantaneous = 8
 - f. Ground Fault = Set to comply with requirements of NEC 230.95(A).

3.7 CLEANING

- A. On completion of installation, interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

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 load centers and panelboards, overcurrent protective devices and associated auxiliary equipment rated 600V and less for the following types:
 - 1. Lighting and appliance branch-circuit panelboards.
- B. Related Sections include the following:
 - 1. Division 26 Section "General Electrical Requirements."
 - 2. Division 26 Section "Basic Electrical Materials and Methods."

1.3 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 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 for types other than NEMA 250, Type 1.
 - b. Panel designation (same as on drawings).
 - c. Bus configuration, current, and voltage ratings.
 - d. Short-circuit current rating of panelboards and overcurrent protective devices.
 - e. UL listing for series rating of installed devices.
 - f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices, and auxiliary components.
 - g. SPD devices when integrated into equipment.
 - h. Accessories (ground bar, contactor, door lock, etc.)
 - i. Mounting (flush or surface).
 - 2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," 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.

1.4 COORDINATION

- 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, and encumbrances to workspace clearance requirements.

1.5 EXTRA MATERIALS

- A. Keys: Four spares of each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. GE/ABB.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.

2.2 FABRICATION AND FEATURES

- A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.
- B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- C. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
- D. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.
- E. Bus: Tin-plated aluminum.
- F. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.
- G. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- H. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- I. Feed-through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- C. Load center construction shall not be acceptable.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. GFCI Circuit Breakers: Single- and two-pole configurations with 5mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Appropriate for application; Type HACR for heating, air-conditioning, and refrigerating equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mounting Heights:
 - 1. General: Top of trim 74 inches above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- E. Install filler plates in unused spaces.
- F. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods"
- B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

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 receptacles, connectors, switches, and finish plates.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. DL: Damp location as defined in NFPA 70, Article 100.
- C. WP: Weatherproof for wet locations as defined in NFPA 70, Article 100.

1.4 SUBMITTALS

- A. Product Data: For each product specified.

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.
- B. Comply with NEMA WD 1.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Other Wiring Devices

- a. Bryant Electric, Inc.
- b. Cooper Wiring Devices.
- c. Hubbell, Inc.; Wiring Devices Div.
- d. Leviton Manufacturing Co., Inc.
- e. Pass & Seymour/Legrand; Wiring Devices Div.

2.2 RECEPTACLES

- A. Description: Impact-resistant nylon face with finger groove, thermoplastic back body, and one-piece triple-wipe power contacts. Side and back wired, back wire terminals use screw pressure plates.
- B. Duplex Straight-Blade Receptacles: Specification grade; 20 ampere, 125 volt rated.
 - 1. Equal to: Pass & Seymour #5362
- C. GFCI Receptacles: Design units for installation in a 2-3/4-inch deep outlet box without an adapter.
 - 1. Equal to: Pass & Seymour #2097.
- D. Weather-Resistant Duplex Receptacle: Specification grade, 20 ampere, 125 volt rated.
 - 1. Equal to: Pass & Seymour #WR5362

2.3 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with type SOW-A jacket. Green-insulated grounding conductor, and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.4 SWITCHES

- A. Snap Switches: Specification grade; 20 ampere, 120/277 volt rated; side and back wired; quiet type.
 - 1. Poles: Provide switches in single-pole, double-pole, three-way, and four-way configurations as indicated on the drawings.
 - 2. Equal to: Pass & Seymour #20AC

2.5 WALL PLATES

- A. Single and combination types match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Select one of five subparagraphs below. Coordinate with Division 9 Section "Painting."
 - 3. Material for Finished Spaces: 0.04-inch thick, Type 302, satin-finished stainless steel.
 - a. Ceiling mounted wall plates to match ceiling color.

4. Material for Unfinished Spaces: Galvanized steel.
5. Weatherproof while-in-use plates in wet locations (WP): Self-closing white non-metallic flat flush cover integral to one-piece non-metallic backbox for full recess mounting in building exterior, the integrity of which is not affected when the attachment plug cap is inserted. Equal to Arlington Industries Low Profile In-Box, select box and trim types to coordinate with building materials at installed location.

2.6 FINISHES

A. Color:

1. Gray, unless otherwise indicated for normal circuits.
 - a. Ceiling mounted devices to match ceiling color.

2.7 CIRCUIT LABELS FOR RECEPTACLES

- ### A. Brother PC clear adhesive with Arial #14 black lettering for normal circuits.

PART 3 - EXECUTION

3.1 INSTALLATION

- ### A. Install devices and assemblies plumb and secure.
- ### B. Install wall plates when painting is complete.
- ### C. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.
- ### D. Protect devices and assemblies during painting.
- ### E. Provide a GFCI receptacle for each device indicated on the drawings. Do not connect GFCI receptacles to protect downstream devices.

3.2 IDENTIFICATION

- ### A. Comply with Division 26 Section "Basic Electrical Materials and Methods."
1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
 2. Receptacles: Identify serving panelboard and circuit number on faceplate of all receptacles.
 3. Conductors Serving Receptacles: Identify serving panelboard and circuit number. Use durable wire markers or tags within outlet boxes.

3.3 CONNECTIONS

- ### A. Connect wiring device grounding terminal to outlet box with bonding jumper.

- B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.
- C. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values.

3.4 FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity and ground continuity.
- B. Test GFCI operation with fault simulations according to manufacturer's written instructions.
- C. Replace damaged or defective components.

3.5 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 262726

SECTION 262816 - DISCONNECT 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 Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes enclosed individually mounted switches and circuit breakers used for the following:
 - 1. Feeder and equipment disconnect switches.
 - 2. Feeder branch-circuit protection.
 - 3. Motor disconnect switches.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 26 Section "Wiring Devices" for attachment plugs and receptacles, and snap switches used for disconnect switches.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes. Include data for overcurrent protective device coordination:
 - 1. Descriptive data and time-current curves.
 - 2. Let-through current curves for overcurrent protective devices with current-limiting characteristics.
 - 3. Coordination charts and tables and related data.
- C. Shop Drawings: For each switch, circuit breaker, and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices and accessories, equipment features, and ratings. Include the following:
 - a. Enclosure types and details.
 - b. Bus materials, configuration, current, and voltage ratings.
 - c. Short-circuit current rating of switches and circuit breakers.
 - d. Descriptive documentation of options or accessories such as auxiliary devices, controls, interlocks, etc.
 - e. UL listing for series rating of installed devices.
 - f. Features, characteristics, ratings, and factory settings of overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
 - D. Field test results indicating and interpreting test results.
 - E. Maintenance Data: For switches and circuit breakers to include in operation and maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:
 1. Routine maintenance requirements for switches, circuit breakers, and all installed components.
 2. Manufacturer's written instructions for testing and adjusting switches and overcurrent protective devices.
 3. Time-current curves, including selectable ranges for each type of overcurrent protective device.
- 1.4 QUALITY ASSURANCE
- A. Source Limitations: Obtain switches and circuit breakers from one source and by a single manufacturer.
 - B. Comply with NFPA 70 for components and installation.
 - C. Listing and Labeling: Provide switches and circuit breakers specified in this Section that are listed and labeled.
 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide switches and circuit breakers by one of the following:
 1. Enclosed Disconnect Switches and Enclosed Molded Case Circuit Breakers:
 - a. GE/ABB.
 - b. Siemens Energy & Automation, Inc.
 - c. Square D Co.
 - d. Eaton Corp.; Cutler-Hammer Products.

2.2 ENCLOSURES

- A. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
 1. Outdoor Locations: Type 3R.

2.3 ENCLOSED DISCONNECT SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD Heavy Duty, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD Heavy Duty, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
- C. Features and Accessories:
 - 1. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

2.4 FUSES

- A. Fuses shall be dual element time delay Bussman Low Peak Class RK-1 or approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All disconnect switches shall be non-fused type unless otherwise indicated on the drawings.
- B. Install switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
- C. Install switches and circuit breakers level and plumb.
- D. Install wiring between switches and circuit breakers, control, accessories, and indication devices.
- E. Connect switches, circuit breakers, and components to wiring system and to ground as indicated and instructed by manufacturer.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."
- B. Switch and Circuit-Breaker Nameplates: Label each switch and circuit breaker with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 FIELD QUALITY CONTROL

- A. Testing: After installing switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

- B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.4 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.5 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 262816

SECTION 264313 – SURGE PROTECTIVE DEVICES (SPD’S)

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 permanently installed, factory or field mounted, 1kV or less surge protective device (SPD) equipment.

1.3 DEFINITIONS

- A. Type 1 SPD: Referred to as secondary surge arrestors prior to the 2008 NEC. These devices are designed for installation on the line side of the service entrance disconnect and must have integrated overcurrent protection.
- B. Type 2 SPD: Referred to as hardwired transient voltage surge suppressors (TVSS) prior to the 2008 NEC. These devices are designed for installation at any location on the load side of the service disconnect. External overcurrent protection is allowed.
- C. Type 4 SPD: SPD components intended to be part of a complete SPD.
- D. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- C. Comply with UL 1283 2nd Edition.

- D. Comply with UL 1449 3rd Edition.
- E. Comply with NFPA 70, 2008 Edition.

1.7 PROJECT CONDITIONS

- A. Service Conditions: Rate SPDs for continuous operation under the following conditions unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 125 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F.
 - 3. Humidity: 0 to 85 percent, noncondensing.
 - 4. Altitude: Less than 20,000 feet above sea level.

1.8 COORDINATION

- A. Coordinate location of field-mounted SPDs to allow adequate clearances for maintenance.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Designed for integration into selected switchgear/switchboard/panelboard manufacturer's equipment.
 - 1. Panel arrangement allowing maximum lead length to phase, neutral, and ground bus connection points of 8".
- B. Subject to compliance with requirements, provide product by one of the following:
 - 1. Advanced Protection Technologies, Inc. (APT).
 - 2. Cutler-Hammer; Eaton Business Unit.
 - 3. GE/ABB Zenith.
 - 4. Innovative Technology; Eaton Business Unit.
 - 5. LEA International.
 - 6. Liebert; Emerson Network Power Business Unit.
 - 7. Siemens.
 - 8. SurgeLogic/Square D; Schneider Electric Business Unit.
- C. SPD for Service Entrance Equipment Location (Primary Protection)
 - 1. UL listed to UL 1449 3rd Edition
 - 2. Type 1 (installed downstream of main breaker) or Type 2.

3. 20kA nominal discharge (In).
4. Short-circuit current rating (SCCR) complying with UL 1449, and matching or exceeding the connected equipment short-circuit rating.
5. 7 modes of protection (L-N, L-G, N-G).
6. Peak surge current rating: 200kA per phase.
7. VPR: Not to exceed 700V for 208Y/120V systems, 1200V for 480Y/277V systems.
8. System voltage: match service entrance equipment.
9. EMI/RFI noise rejection filter: Noise attenuation of 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
10. LED indicator lights for power and protection status.
11. Audible alarm, with silencing switch, to indicate when protection has failed.
12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
13. Six-digit transient-event counter set to totalize transient surges.

2.2 ENCLOSURES

- A. Indoor Enclosures: NEMA 250 Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install SPD devices at service entrance on load side of main disconnect, with ground lead bonded to service entrance ground.
- B. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 1. Comply with manufacturer's written recommendation for conductor and circuit-breaker size for connecting SPD devices to distribution system.
- C. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
 3. Complete startup checks according to manufacturer's written instructions.
 4. Coordinate with commissioning agent. Supply requested product documentation.
- D. SPD device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.2 STARTUP SERVICE

- A. Do not energize or connect service entrance equipment or panelboards to their sources until SPDs are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.3 DEMONSTRATION

- A. Train Owner's maintenance personnel to maintain SPD devices.

END OF SECTION 264313

SECTION 265100 - LIGHTING

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.
- B. See 26 05 00 "Basic Electrical Materials and Methods" for electrical materials and methods.
- C. See 26 27 26 "Wiring Devices" for manual light switches and device finishes.
- D. See 26 52 00 "Lighting Control" for lighting control devices.

1.2 SUMMARY

- A. This Section includes luminaires, drivers, emergency lighting units, exit signs, luminaire supports, and accessories.

1.3 SUBMITTALS

- A. Product Data: For each luminaire type arranged in order of type designation. Include data on features, accessories, and the following:
 - 1. Physical description including dimensions, construction, and finish.
 - 2. Lamp and ballast data indicating rated life, output, CCT, CRI, and energy use.
 - 3. LED and driver data indicating rated life, output (delivered), CCT, CRI, and energy use.
 - 4. Photometric report including IES files.
 - 5. Emergency lighting units, including batteries and chargers.
- B. Maintenance Data: For luminaires to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with NFPA 70 and 101.
- C. Emergency lighting units, exit signs, and batteries: Comply with UL 924.
- D. Exterior Lighting: Comply with UL 1598 and listed for wet location.
- E. Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.5 COORDINATION

- A. Luminaires, Mounting Hardware, and Trim: Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Coordinate layout and installation of devices with other construction including structural members, underground utilities, above-grade utilities, site design, and building elements.

1.6 WARRANTY

- A. Include labor allowance required for replacement on-site at no extra cost to the Owner within 1-year construction warranty. Transfer remainder of the manufacturer's warranty including ballast manufacturer's labor stipend to owner after 1-year construction warranty.
- B. Driver Warranty: 5-year replacement warranty.
- C. Emergency Battery Warranty: 3-year pro-rated warranty.
- D. LED System Warranty: 5-year replacement warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Luminaires: Subject to compliance with requirements, provide one of the products indicated for each designation in the Luminaire Schedule on the drawings.

2.2 LUMINAIRE AND LUMINAIRE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping and when secured in operating position.
- D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated.
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
 - 1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
 - 2. Lens Thickness: 0.125 inch (3 mm) minimum, unless greater thickness is indicated.

F. Finishes: Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
2. Metallic Finish: Corrosion resistant.

2.3 LED LIGHT SOURCES

A. LED Light Source Requirements:

1. Rated life (L70): Minimum 50,000 hours as defined by IES LM80 and TM21.
2. Color Rendering Index (CRI): 80 CRI minimum.
3. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

B. LED Driver Requirements:

1. 0-10V Dimming
2. Total Harmonic Distortion Rating: Less than 20 percent.
3. Ambient temperature rating: -40° to +55° C
4. Power Factor (100% output): >0.95
5. Flickering: LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Submit % flicker in 1% increments for full range of dimming starting at 500 mA for full output reading. Systems that do not meet IEEE P1789 will not be considered.

2.4 EXIT SIGNS

A. General Requirements:

1. Comply with NFPA 101, UL924, and local AHJ for sign colors, visibility, luminance, and lettering size.
2. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.

B. Internally Lighted Signs (AC type or Battery type):

1. Light Source: Light-emitting diodes with 70,000 hour minimum rated lamp life.
2. Battery type - Integral automatic charger in a self-contained power pack.

2.5 EMERGENCY LIGHTING UNITS

A. General Requirements: Self-contained units, wall or ceiling mounted. Comply with UL 924. Units include the following features:

1. Battery: Sealed, maintenance-free, lead-acid type with minimum 5-year nominal life and warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps, and battery is automatically recharged and floated on charger.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods," for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Twin-Stem Hangers: Two, 1/2-inch (12-mm) steel tubes with single canopy arranged to mount a single luminaire. Finish same as luminaire.
- C. Rod Hangers: 3/8-inch minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Luminaires: Set level, plumb, and square with ceiling and walls. Secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each luminaire.
- C. Align luminaires for optimum directional alignment of light distribution.
- D. Remote Mounting of Ballasts or Drivers: Distance between the ballast/driver and fixture shall not exceed that recommended by manufacturer. Verify wire size and maximum distance between ballast/driver and luminaire with manufacturer.
- E. Support for luminaires in or on Grid-Type Suspended Ceilings:
 - 1. Utilize grid for support where ceiling system is appropriate rated. Contractor to coordinate luminaire weights with ceiling contractor.
 - 2. At all other locations install a minimum of two ceiling support system rods or wires for each luminaire. Locate not more than 6 inches (150 mm) from luminaire corners.
 - 3. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner.
 - 4. Luminaires of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Continuous Rows: Suspend from cable installed according to luminaire manufacturer's written instructions and details on Drawings.
- G. Burn-In: Continuously illuminate (burn-in) lamps per manufacturer's recommendations. Continuously illuminate LED light sources for 100 hours prior to substantial completion.

3.2 CONNECTIONS

- A. Ground equipment: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

- B. Provide instruments to make and record test results.
- C. Test as follows:
 - 1. Verify normal operation of each luminaire after installation.
 - 2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
 - 3. Verify normal transfer to battery source and retransfer to normal.
- D. Malfunctioning Luminaires and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.4 CLEANING AND ADJUSTING

- A. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.

END OF SECTION 265100

SECTION 265200 - LIGHTING CONTROL

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.
- B. See 26 05 00 "Basic Electrical Materials and Methods" for electrical materials and methods.
- C. See 26 27 26 "Wiring Devices" for manual light switches and device finishes.
- D. See 26 51 00 "Lighting" for luminaires, lamps, ballasts, drivers, emergency lighting units, emergency battery packs, exit signs, luminaire supports.

1.2 SUMMARY

- A. This Section includes lighting control devices and accessories.

1.3 SUBMITTALS

- A. Product Data: For each lighting control device.
 - 1. Include features, performance, electrical ratings, operating characteristics, furnished options, and accessories.
 - 2. Dimensions of devices.
 - 3. Lighting control one line diagrams.
- B. Occupancy Sensor Layout Drawings: Scaled floor plans with lighting control manufacturer's layout of occupancy sensors. Sensor layout and quantity shall completely cover each area indicated, show coverage patterns for each sensor.
- C. Maintenance Data: For lighting control devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with NFPA 70, NFPA 101, and UL924.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace devices that fail in materials or workmanship within two years from date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Lighting Control Equipment: Subject to compliance with requirements, provide lighting control equipment from one of the following manufacturers, all equipment should be from one consistent manufacturer:
1. Acuity Controls (Sensor Switch / nLight)
 2. Hubbell Control Solutions
 3. WattStopper

2.2 OCCUPANCY SENSORS

A. Low Voltage Ceiling Sensors:

1. Passive Dual Technology: Infrared and microphonic sensors integrated into one housing.
2. Performance and Coverage: Passive Infrared (PIR) shall engage sensor and PIR or microphonic shall detect continued occupancy. 360 degree field of view. Minimum coverage of 20 foot radius at 9' mounting height, with sensor centered in coverage area. Provide accessory power packs and connect to power sensor.
3. Mounting: Sensor shall flush horizontal mount tight to ceiling surface. Sensors that protrude from ceiling or utilize drop-down mounting brackets shall not be acceptable.
4. Load Rating: Provide accessory power packs with relay; connect to switch load. Relay in power packs shall be rated 20A for ballast loads.
5. Sensor Switch CM PDT 10 or approved equivalent. Provide associated power packs with sensor power supply and load switching relay.
6. Finish: White unless noted otherwise.

B. Line Voltage Single Pole Wall Box Sensors:

1. Passive Dual Technology: Infrared and microphonic sensors integrated into one housing.
2. Performance and Coverage: Passive Infrared (PIR) shall engage sensor and PIR or microphonic shall detect continued occupancy. 180 degree field of view. Capable of sensing small motion up to 20' at 4' mounting height.
3. On Modes
 - a. Automatic on - Sensor turns load on based on sensing occupancy of monitored area.
 - b. Manual on - sensor requires pressing the pushbutton on sensor face to turn load on.
4. Switch Off Modes
 - a. Predictive off mode - occupant can turn lights off manually or lights automatically turn off after time out period. If lights are manually turned off, the sensor shall revert to automatic on after sensor sees no motion during time out period.
 - b. Permanent off mode - pressing the switch turns the lights off, lights will not turn on until switch is pressed again.
5. Mounting: Sensor shall mount in wall box with decorator style faceplate.
6. Load Rating: Switch integral in sensor housing
 - a. Rated for 800 watt load at 120V
 - b. Rated for 1200 watt load at 277V
 - c. Rated for ¼ horsepower motor load at 120V

7. Sensor Switch WSX PDT or approved equivalent.
8. Finish: Coordinate finish of devices with section 262726 "Wiring Devices".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Occupancy Sensors: Provide required power packs with sensor power supply and load switching relay. Connect power packs per manufacturer's instructions. Adjust settings of occupancy sensors, tailor to configuration and use of room served.
- D. Lighting Control System Cabling:
 1. 0-10v Dimming Devices: Provide #14 control wiring to luminaires controlled by device.
 2. Provide J-Hook style supports for low voltage cabling above accessible ceilings. Where exposed structure occurs run low voltage cabling concealed in conduit.
 3. Provide plenum rated pre-terminated low voltage cabling as manufactured by lighting control manufacturer. Provide lengths necessary for installation, cables shall be as short as practical with a minimum 10' cable length.
- E. After Substantial Completion, but not more than 60 days after Final Acceptance, re-adjust occupancy sensors for Owner's actual pattern of use.

3.2 FIELD QUALITY CONTROL

- A. Test to verify normal operation of each lighting control device.
- B. Repair or replace all malfunctioning lighting controls then re-test devices. Repeat procedure until all devices operate properly.
- C. Prepare test and inspection reports.

3.3 PROGRAMMING AND DEMONSTRATION

- A. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
- B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.
- C. When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 265200

SECTION 268100 – FIRE ALARM

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 fire alarm systems with control panel, manual stations, detectors, signal equipment, controls, and devices.

1.3 DEFINITIONS

- A. FACP: Fire alarm control panel.
- B. LED: Light-emitting diode.
- C. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

- A. General: Noncoded, analog-addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Drawings: Prepare project specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed media.
 - 2. Wiring Diagrams: Detail wiring and differentiate between manufacturer-installed and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified.
- C. Operating Instructions: For mounting at the FACP.
- D. Submissions to Authorities Having Jurisdiction: Submit to authorities having jurisdiction. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Engineer for review.
- E. Certificate of Completion: Comply with NFPA 72.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of the FACP manufacturer for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those indicated for this Project and with a record of successful in-service performance.
- C. Source Limitations: Obtain fire alarm system components through one source from a single manufacturer.
- D. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.
- E. Comply with NFPA 72.

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. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
 - 3. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
 - 4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
 - 5. Keys and Tools: One extra set for access to locked and tamperproofed components.
 - 6. Audible and Visual Notification Appliances: One of each type installed.
 - 7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cerberus Pyrotronics.
 - 2. Notifier; Div. of Pittway Corp.
 - 3. Simplex Time Recorder Co.
 - 4. Edwards Systems Technology; Unit of General Signal.
 - 5. Fire Lite Alarms, Inc.
 - 6. Fire Control Instruments
 - 7. Silent Knight

2.2 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 72.
- B. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Smoke detectors.
3. Automatic sprinkler system water flow.

C. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Unlocking of electric door locks in designated egress paths.
6. Release of fire and smoke doors held open by magnetic door holders if alarm was initiated by a detector on either side of the door.
7. Shutdown of individual fans and other air handling equipment if alarm was initiated by duct detector(s) installed at unit(s).
8. Shutdown of terminal unit fans serving zone where alarm was initiated.
9. Closing of smoke dampers in air ducts of system serving zone where alarm was initiated by opening a fire alarm relay to interrupt power to smoke dampers located in air supply ducts across smoke partitions in the area of the alarm.
10. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.

D. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper.

E. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.

F. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators.

2.3 MANUAL PULL STATIONS

A. Description: Fabricated of metal or plastic, and finished in red or brushed aluminum with molded operating instructions of contrasting color.

1. Single-action mechanism initiates an alarm. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Station Reset: Key or wrench operated.

2.4 SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Piezoelectric sounder rated at 88 dBA at 10 feet according to UL 464.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.

B. Photoelectric Smoke Detectors:

1. Detector style: Low Profile
2. Sensor: LED or infrared light source with matching silicon-cell receiver.
3. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:
 - a. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and when required by code.
7. Each sensor shall have multiple levels of detection sensitivity.
8. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
9. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.5 NOTIFICATION APPLIANCES

A. Description: Equip for mounting as indicated and have screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
2. All alarm devices shall be semi-flush mounted unless otherwise indicated.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns produce a sound-pressure level of 90 dB, measured 10 feet from the horn.

- C. Visible Alarm Devices: Synchronized Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.

- 1. Rated Light Output: Per NFPA.

2.6 CENTRAL FACP

- A. General Description:

- 1. Modular, power-limited design with electronic modules, UL 864 listed.
 - 2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 - 3. Addressable control circuits for operation of mechanical equipment.

- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

- 1. Annunciator and Display: Liquid-crystal type.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

- C. Circuits:

- 1. Signaling Line Circuits: NFPA 72, Class B, Style 4.
 - a. System Layout: Install no more than 50 addressable devices on each signaling line circuit.
 - b. Furnish system with a minimum of 10% spare device capacity.
 - 2. Notification-Appliance Circuits: NFPA 72, Class B.
 - 3. Actuation of alarm notification appliances, annunciation, and actuation of suppression systems shall occur within 10 seconds after the activation of an initiating device.

- D. Smoke-Alarm Verification:

- 1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
 - 2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
 - 3. Sound general alarm if the alarm is verified.
 - 4. Cancel FACP indication and system reset if the alarm is not verified.

- E. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

- F. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.

- 1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 - 2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.

3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- G. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.
 - H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.
 - I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.
 1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
 2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."
 - J. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
 1. Batteries: Sealed lead calcium.
 2. Battery and Charger Capacity: Comply with NFPA 72.
 - K. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.7 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

2.8 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Listed and labeled under UL 864 and NFPA 72.
- B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.
- C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

- D. Self Test: Conducted automatically every 24 hours with report transmitted to central station.

2.9 REMOTE ANNUNCIATOR

- A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications.
 - 1. Mounting: Surface cabinet, NEMA 250, Class 1.
- B. Display Type and Functional Performance:
 - 1. Alpha Numeric display for each device, same as the FACP.
 - 2. Lamp test button.
 - 3. Keyed controls shall permit acknowledging, silencing, resetting, and testing functions, same as the FACP.

2.10 WIRE

- A. NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.
- B. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Connect the FACP with a disconnect switch or breaker with breaker lock.
- B. Mount FACP and annunciator with top of cabinets not more than 72" above the finished floor.
- C. Manual Pull Stations: Mount semi-flush in recessed back boxes.
- D. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.
- E. Ceiling Mounted Fire Alarm Devices in Accessible Ceilings: Use flexible metal conduit whip from EMT conduit to ceiling tile to facilitate device relocation in the future and allow device to mount flush to ceiling tile.
- F. Ceiling-Mounted Smoke Detectors: Not less than 4 inches from a sidewall to the near edge.
- G. Wall-Mounted Smoke Detectors: At least 4 inches, but not more than 12 inches, below the ceiling.
- H. Smoke Detectors near Air Registers: Install no closer than 60 inches.
- I. Provide an exterior horn.
- J. Provide connection to fire sprinkler PIV valve.
- K. Provide 120 volt circuit for fire sprinkler bell.

- L. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.

3.2 INTERCONNECTION TO OTHER SYSTEMS

- A. Alarm Indicating: Provide 18/2 cables in ¾" conduit as required for alarm and trouble contacts in fire alarm control panel to security panel. Coordinate with Security Contractor.
- B. Alarm Transmitting: Provide CAT 3 telephone cables in ¾" conduit as required from Digital Alarm Transmitter in fire alarm control panel to telephone board.
- C. Damper control: Provide all necessary wiring to smoke dampers.
- D. Access/Security Control: Provide a relay for each electrically locked exit door. Connect so relay will interrupt power to the locking device under alarm condition.

3.3 WIRING INSTALLATION

- A. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- B. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- C. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- D. Free air wiring: It shall be acceptable to run fire alarm wiring without conduit when concealed above accessible ceilings. Provide conduit stub ups from wall-mounted devices to above accessible ceilings. Install fire alarm wiring in conduit where wiring would otherwise be exposed such as in storage and mechanical rooms, rooms with exposed ceilings, or similar.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Basic Electrical Materials and Methods."
- B. Install instructions frame in a location visible from the FACP.
- C. Paint power-supply breaker red and lock. Label "FIRE ALARM."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.
- B. Final Test Notice: Provide a minimum of 10 days' notice in writing when the system is ready for final acceptance testing.
- C. Minimum System Tests: Test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
 - 2. Test all conductors for short circuits using an insulation-testing device.
 - 3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawings.
 - 4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
 - 5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
 - 6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
 - 7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones.
 - 8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
- D. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.

3.6 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 2 hours training.
 - 2. Schedule training with Owner with at least seven days' advance notice.

3.8 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to two requested visits to Project site for this purpose.

END OF SECTION 268100