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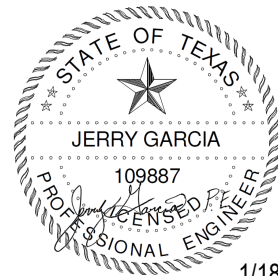
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1/18/2018

**SECTION 21 13 00
FIRE SUPPRESSION SYSTEMS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for renovation of an existing fire protection sprinkler system, coordinated with related. Section 21 13 13.

1.2 SYSTEM DESCRIPTIONS

- A. Types: The types of fire protection systems shall include, but not limited to, the following:
 - 1. Renovated sprinkler system in accordance with NFPA 13, and the requirements of the State Fire Marshall. Refer to Section 21 13 13.
- B. Dry pipe sprinkler systems: Refer to Section 21 13 13.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For fire suppression automatic sprinkler systems and standpipe system, as indicated on the floor plans. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Qualification Data: For qualified Installer and professional engineer.
- 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. Welding certificates.
- G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. Field quality-control reports.

- I. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

- A. General: All piping, fittings and valves shall be made in the USA and shall be stamped/stenciled "made in USA".
- B. Pipe: For aboveground, provide minimum schedule 40 steel pipe conforming to ASTM A795 or A53. For pipe sizes up to 2 inch, UL listed and FM approved Allied XL steel pipe rated for 300 psi may be used. Comply with applicable governing regulations and industry standards. Aboveground pipe and fittings upstream of double check valve assembly shall be schedule 40 galvanized steel conforming to ASTM A53 or ASTM A795 with grooved type joints as specified herein. For dry pipe systems and preaction systems provide schedule 40 steel pipe conforming to ASTM A53 or ASTM A795 with factory hot dipped zinc coated (galvanized) finish. Dry pipe and preaction system fittings shall also have galvanized finish. Fittings shall be threaded for pipe sizes up to 2 inch and grooved for pipe sizes over 2 inch.
- C. Threaded Fittings: Class 150 malleable iron, ANSI B16.3.

- D. Malleable Iron Threaded Unions: ANSI B16.3, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or galvanized as specified.
- E. Threaded Pipe Plugs: ANSI B16.14.
- F. Steel Flanges/Fittings: ANSI B16.5, including bolting, gasketing, and butt weld end connections. Fittings same thickness as pipe.
- G. Forged Steel Socket-welding and Threaded Fittings: ANSI B16.11, rated to match schedule of connected pipe.
- H. Wrought Steel Butt-welding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.
- I. Flanged Fittings: Comply with ANSI B16.5 for bolt-hole dimensioning, materials, and flange thickness.
- J. Flange Bolts: Bolts shall be carbon steel ASTM A307 Grade A hexagon head bolts and hexagonal nuts. Where one or both flanges are cast iron, furnish Grade B bolts. Cap screws utilized with flanged butterfly valves shall be ASTM A307 Grade B with hexagon heads.
- K. Flange Bolt Thread Lubricant: Lubricant shall be an anti-seize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.
- L. Miscellaneous Piping Materials/Products:
 - 1. Welding Materials: Comply with ASME Boiler and Pressure Vessels Code, Section 11, Part C, for welding materials.
 - 2. Brazing Materials: American Welding Society, AWS A5.B, Classification B Cup-5.
 - 3. Gaskets for Flanged Joints: 1/16 inch thick for pipe size 10 inches and smaller and 1/8 inch thick for all pipe size 12 inches and larger. Ring-type shall be used between raised face flanges and full face-type between flat face flanges with punched bolt holes and pipe opening. Gaskets shall be Garlock Style 3400 compressed non-asbestos or equal.
 - 4. Dielectric Unions: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Delvin" as made by Pipeline Seal and Insulator Company or "EPCO" as made by Epco Sales, Inc. and shall have nylon insulation.
- M. Use mechanical couplings may only be used for pipe sizes over 2 inches, to engage and lock grooved or pipe ends and to allow for some angular deflection, contraction and expansion.

1. Couplings shall be positive lock type and shall consist of ASTM A536 ductile iron housing, c-shaped composition sealing gasket and carbon steel bolts conforming to ASTM A183.
 2. Gasket Material for wet systems shall be EPDM.
 3. Gasket material for dry pipe systems shall be silicone.
 4. All couplings shall be UL listed and FM approved.
 5. Provide only full flow (no-fabricated) fittings. Snap joint couplings, outlet couplings, cut-in style couplings, reducing couplings, mechanical-T style couplings, pressfit couplings, and plain end type couplings are not allowed.
 6. When mechanical couplings are used, ONLY grooved type fittings and pipe shall be used, no plain end fittings or pipe. Grooved couplings and fittings shall be manufactured by Victaulic, "Firelock" or approved equivalent.
- N. Flanges: All flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A 181 Grade 1 or Grade 2 or A-1 05-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges will not be acceptable. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forgings or materials will not be acceptable. The flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Submit data for firm certifying compliance with these Specifications. Gaskets used shall be ring form, dimensioned to fit accurately within the bolt circle, shall be 1/16 inch thick, Manville service sheet packing Style 60. Inside diameter shall conform to the nominal pipe size. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. All-thread rods will not be an acceptable for flange bolts. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi. Flat faced flanges shall be furnished where required to match flanges on pumps, check valves, strainers, and similar items. Only one manufacturer of weld flanges will be approved for each project.
- O. Gaskets: Gaskets shall be placed between the flanges of all flange joints. Such gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16" thick Manville Service Sheet Packing Style 60. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.
- P. Unions in steel lines assembled with screwed fittings shall be malleable iron screwed pattern unions with bronze seats. Unions in copper or brass lines shall be all brass, threaded pattern unions. Where unions are required by the above in steel lines assembled by welding, they shall consist of two mating welding flanges. Dielectric unions shall be used at all junctures of dissimilar metals. Unions in 2 inch and smaller in ferrous lines shall be Class 300 AAR malleable

iron unions with iron to brass seats, and 2-1/2 inch and larger shall be ground flange unions. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

Q.

2.2 SLEEVES AND ESCUTCHEONS

- A. Pipe passing through walls, floors, and partitions shall be provided with standard weight steel pipe sleeves. Sleeves through walls in finished spaces shall be flush. Where located in the floor construction, the sleeves shall project not less than 2 inches above the floor line. Refer to Sections 22 05 00 & 22 05 29 for fire stopping and additional sleeve requirements. Refer to drawings for details. Refer to plumbing drawings for exact locations of sleeves in structural beams. Provide escutcheons for pipes passing through walls, partitions, or ceilings. Escutcheons shall be provided where pendant sprinkler heads penetrate ceilings or sidewall heads penetrate walls. Pipe escutcheons shall be chrome-plated steel. Sprinkler escutcheons shall be white-painted or chrome-plated steel as specified. Refer to Sections 22 05 00 & 22 05 26 for additional requirements.

2.3 SLEEVES AND ESCUTCHEONS

- A. Hangers and Supports: Support fire protection pipe with UL-listed and approved hangers and support devices. Provide any special hangers or supports that may be required. The design, selection, spacing, and application of horizontal and vertical pipe hangers, supports, restraints, anchors, and guides shall be a minimum in accordance with the NFPA 13, however, all pipe hangers, rods, supports, inserts and other components shall be in accordance with specifications Section 22 05 29. All anchors shall be drilled, no shot type anchors are allowed. Refer to Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment, for pipe supports, hangers. Hanger spacing shall be according to NFPA 13

PART 3 - EXECUTION

3.1 INSTALLATION OF FIRE PROTECTION PIPING SYSTEMS

- A. General: piping system materials, components and installation shall be in accordance with NFPA 13 and as specified.
- B. Piping and joints shall be full bore reamed, for all joint types.
- C. Slag shall be removed and cleaned at all welded joints.

3.2 PIPING INSTALLATION

- A. Piping shall be concealed, except in areas without ceilings. Install all piping parallel to or at right angles to the column lines of the building wherever possible.
- B. Grade piping to eliminate traps and pockets and for drainage per NFPA 13 and NFPA 14. Where air pockets or water traps cannot be avoided, provide hose bibbs for drainage.
- C. Piping system shall be cleaned and flushed in compliance with NFPA 13 NFPA 24.
- D. Changes in direction, branches, offsets etc., shall be made with standard pipe fittings. Holes in the main for branches shall be made with a hole cutting machine and a standard "Weld-O-Let" or "Thread-O-Let" fitting used. Burning holes in the fire protection System Piping will cause that section of the piping to be cut out and replaced at the Contractor's expense.
- E. Pipe shall be reamed to full pipe diameter before joining:
 - 1. Screwed joints shall be made with standard pipe thread and an approved compound applied to the male thread only.
 - 2. Welded joints shall be made in accordance with the procedure outlined in the ANSI piping code.
 - 3. Valves and specialties shall have threaded flanged or grooved joints.
 - 4. Slag, etc. shall be removed.
- F. Install unions or flanges at equipment connections and as indicated on the Drawings.
- G. Cold-springing piping will not be permitted. Install piping with adequate support to prevent strain on the equipment and to allow for piping system expansion and contraction.
- H. Piping shall be sized as required by applicable codes and as indicated on the Drawings.
- I. Install sprinkler piping so that it can be thoroughly drained, and where practicable shall be arranged to drain at the zone drain valve. The zone drain valve shall be capable of a full discharge test without allowing water to flow onto the floor. All drips and drains shall conform to Section 8.16.2.6 of NFPA No. 13.
- J. Field changes in the piping layout or pipe sizes shall not be made without the prior approval of the Engineer.
- K. Provide basket type metal guards over sprinkler heads to protect them from damage in mechanical rooms, main electrical rooms, telephone equipment, storage rooms, and all unfinished areas where the head is less than 7'06" above finished floor.

3.3 PIPE HANGERS AND SUPPORTS

- A. Pipe supports, sway braces, hangers, and clamps shall conform to and be placed in accordance with Chapter 9 of NFPA 13 and listed by Underwriters' Laboratories, Inc., or approved by Factory Mutual.
- B. All pipe shall be supported from the building structure in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with steel pipe clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes will not be permitted. Spacing of pipe supports shall not exceed 10 feet on all piping. "Shots" or any power driven hanger supports will not be expectable.
- C. All sprinkler piping shall be adequately supported to avoid excess strain on fittings and joints. As a minimum, all vertical risers shall be supported at the bottom level, the top level and at each alternate level in between.
- D. Where pendant sprinklers are used, care shall be taken to resist upward movement of flowing sprinklers by means of rigid hangers or other restraints on the ends of branch lines or arm over exceeding 5 feet in length.

3.4 CLEANING AND STERILIZATION

- A. All fire protection piping shall be thoroughly flushed out, to remove any slag or debris prior to being tested or put into service. Comply with NFPA standards and guidelines. Underground piping extending from the water supply to the system riser and lead-in connections to the system riser shall be completely flushed before connection is made to downstream fire protection system piping. The flushing operation shall be continued for a sufficient time, as determined by Owner or Architect/Engineer to ensure thorough cleaning. The minimum rate of flow shall not be less than a flow necessary to provide a velocity of 10 feet per second in accordance with in NFPA 13 or hydraulically calculated water demand rate of the system, including fire hose requirements. Provisions shall be provided for proper disposal of water used for tested and flushing. Refer to NFPA 13 Section 8.16.3, Section 10.10.2.1 and Section A.10.10.2.1 for methods of flushing water supply connections. Owner shall be provided in writing the flushing procedure and shall witness and approve flushing of system prior to continuation of work. Flush piping system without sprinkler heads installed. Contractor is responsible for providing any pump required for flushing system at the specified velocity. Flush piping system at the ends of the cross mains. Individual sprinkler heads shall not be installed during flushing. The individual supply lines to each sprinkler head shall be capped during the flushing procedure. After the piping system has been flushed. The individual capped lines shall be drained and any debris, slag, etc. removed. The sprinkler heads shall then be installed once the system has been approved as successfully cleaned and flushed.

3.5 TESTS AND INSPECTIONS

- A. Inspections, examinations and tests required by the authorities or agencies specified shall be arranged and paid for by the Fire Protection Subcontractor, as necessary, to obtain complete and final acceptance of the system as installed. The certificates of inspection shall be in quadruplicate, and shall be delivered to the Engineer for review and distribution.
- B. Fire protection piping systems shall be hydrostatically tested by the Contractor upon completion of the installation as required by Section 10.10.2.2 of NFPA 13 in the presence of the Owners Representative.
 - 1. The fire protection piping systems shall be hydrostatically tested at 200 psi for 2 hours without loss of pressure.
 - 2. When hydrostatic and alarm tests have been completed and all necessary corrections made, a material and test certification shall be provided in accordance with Section 10.10 of NFPA 13.
 - 3. Final inspection shall include full flow testing through the inspectors test connection.
 - 4. Actuation of the flow switch shall occur within one minute of opening of the inspector's test valve.
 - 5. Final tests may be witnessed by the Engineer or Owner's Representative.
- C. Sprinkler system zone control assemblies shall be tested to demonstrate proper operation of the flow switch and valve supervisory switch.
- D. Arrange and pay for all tests and inspections required by authorities having jurisdiction.
- E. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Testing of complete sprinkler system for acceptance shall be witnessed by an Owner's Representative. Testing shall be coordinated with the Authority Having Jurisdiction.

3.6 PERIODIC INSPECTION SERVICE

- A. After completion of the fire protection system installation and at the beginning of the guarantee period, the Automatic Sprinkler Subcontractor shall execute the National Automatic Sprinkler and Fire Control Association, Inc., Standard Form of "Inspection Agreement", without change in the Contract amount, calling for four inspections of the fire protection system during the warranty period.
- B. During the warranty period, inspections shall be in accordance with the Inspection Agreement, plus the following maintenance to be performed during the course of the fourth inspection:

1. Operation of all control valves.
2. Lubrication of operating stems of all interior valves.
3. Operation of all alarms, supervisory switches, air compressors, alarm trip switches, flow switches, and similar items.
4. Cleaning of alarm valves.
5. Lubrication of Fire Department valve hose connections.
6. The standard form of the National Automatic Sprinkler and Fire Control Association, Inc., "Report of Inspection", shall be filled out in triplicate after each inspection and the copies sent to the Architect.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53, Electrical Identification.

3.8 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

END OF SECTION

**SECTION 21 13 13
AUTOMATIC SPRINKLER SYSTEMS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes labor and materials for the renovation of a hydraulically calculated automatic, dry pipe sprinkler systems in areas as specified, and as shown on the Drawings, complete in all respects and ready for operation.
 - 1. Work includes the renovation of a wet-pipe automatic sprinkler system, complete and ready for operation.
 - 2. Renovation of the sprinkler system shall be such that no parts interfere with general construction, doors, windows, heating, plumbing, air conditioning systems or electrical equipment.
- B. System components for each zone shall include, but not be limited to:
 - 1. Zone control valve and test/drain assembly.
 - 2. Drain valve.
 - 3. Waterflow switches.
 - 4. Valve supervisory switches.
 - 5. Piping.
 - 6. Sprinkler heads.

1.2 SYSTEM DESCRIPTION

- A. The sprinkler systems shall be fixed water type fire protection sprinkler system with a pressurized water supply to fusible sprinkler heads for control of fire.
- B. The sprinkler system shall be designed to meet the more stringent of the requirements of NFPA 13.
- C. All sprinkler heads in general shall be in a straight line, parallel to the lines of the building and shall be located in the approximate center of ceiling tiles.
 - 1. Sprinkler head quantities, where shown, are the minimum, which must be provided. If additional heads are required to meet NFPA 13, the location of additional heads must be approved by the Architect.
 - 2. Contractor shall submit Sprinkler Head locations to the Architect for location and type approval prior to completing the sprinkler system design, unless otherwise instructed, in writing, by the Architect.
- D. Work shall be installed in accordance with the Drawings, Specifications. Devices and equipment shall be listed by Underwriters' Laboratories, Inc. or Factory Mutual-approved, individually and as a system, as applicable.

- E. Sprinkler heads shall be spaced, located, and positioned as shown on the Architectural reflected ceiling plans, where shown, as specified and as required to suit the building partition layout according to Sections 8.5 and Section 8.6 of NFPA 13.
- F. Piping sizes and configurations shall be on the basis of hydraulic calculations. Where head layouts shown on the Drawings or requirements specified are more stringent than NFPA requirements, the more stringent requirements shall apply.
- G. Zone the sprinkler system with a maximum 52,000 sq. ft. area limitation per zone.
- H. Coordinate the location of sprinkler heads and piping such that it does not interfere with the installed ceiling configuration or other building construction and equipment.

1.3 HYDRAULIC CALCULATIONS

- A. Prepare hydraulic calculations in accordance with Chapter 14 of NFPA 13 with the following exceptions:
 - 1. Pipe friction losses may be calculated by using the nearest foot for all piping over one foot in length. Vertical length less than one foot shall be included for elevation purposes only.
 - 2. Calculate flows to the nearest whole gallon.
 - 3. Total sprinkler system flow shall not exceed 110 percent of the required flow.
 - 4. Provide a minimum safety factor of 10 percent on all hydraulically calculated sprinkler systems.
- B. Sprinkler system hydraulic calculations shall be based on the following:
 - 1. Parking Garage -- Light Hazard Occupancy with design density of 0.10 gpm over the most remote 1500 square foot, with a maximum coverage area, per head, of 225 square foot.
 - 2. Provide 250 gpm hose stream allowance.
 - 3. Maximum spacing between heads of 15-foot on center, unless extended coverage type heads are used.
 - 4. New Electrical Rooms & Switchgear Rooms do not require Sprinkler protection per NFPA 13 Section 8.15.11.3.
- C. Hydraulic calculations shall be performed by a State of Texas Licensed Responsible Managing Employee (RME) in the direct employ of the fire protection contractor.

1.4 SUBMITTALS

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

- B. Shop Drawings: Provide total hydraulically designed sprinkler system with plans, elevations, sections, details, and related attachments including Wiring Diagrams for power, signal, and control wiring.
- C. All submittals shall be provided to Owner and A/E for review and approval prior to any work.
- D. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Qualification Data: For qualified Installer and Professional Engineer.
- F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- G. Welding certificates.
- H. 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."
- I. Field quality-control reports.
- J. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

PART 2 - PRODUCTS

2.1 SPRINKLERS

- A. Manufacturers: Design of Sprinkler heads is based on model numbers manufactured by Viking Corporation unless otherwise indicated. Subject to compliance with requirements, provide named product or approved equivalent.
- B. Unless otherwise specified, sprinkler heads shall be a quick response type with standard (155°F) temperature rated fusible link, 1/2 inch orifice and a 5.6 K factor.
 1. Heads located within the air streams of heat emitting equipment, Gas Fired water heater Rooms, and in the Gym (High Bay Areas) and similar areas shall have an intermediate (200°F) temperature rated fusible link.
 2. Install corrosion-resistant sprinkler heads where they are exposed to weather, moisture, or corrosive vapors.
 3. Heads installed where they might receive mechanical injury, such as in gym type areas or in areas where heads are less than 7 feet above the floor level shall be protected with approved guards in accordance with Section 6.2.8 of NFPA 13.
 4. Sprinklers in areas with suspended ceilings shall have pipe and fittings located above the suspended ceiling.
 5. Sprinkler heads in finished areas, with ceilings, shall be Quick Response semi-recessed type sprinkler head, manufactured by Victaulic Model V2708 or approved equivalent. Where specifically indicated on drawings to use concealed heads, the heads shall have white finish.
- C. Sprinkler heads in unfinished areas shall be Quick Response upright or sidewall with brass finish, manufactured by Victaulic Model D2710 sidewall and Victaulic V2704 upright or approved equivalent.
- D. Provide recessed type dry type sprinkler head with white finish and escutcheon, to protect freezers, manufactured by Victaulic Model V36 dry pendant or approved equal
- E. Sprinkler heads shall be UL Listed and FM approved.
- F. The use of extended coverage heads is acceptable.

- G. The use of UL listed and FM approved flexible type head assemblies is permitted. Flex type head assembly shall consist of 304 stainless steel braided hose with zinc plated steel 1" NPT male threaded nipple, factory tested at 400 psi, complete with one piece head securing bracket assembly, tamper resistant screws, The drop shall include a UL approved Series AH2 braided hose with a bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for [(4) bends at 31" length] [(5) bends at 36" length] [(8) bends at 48" length] [(10) bends at 60" length] [(12) bends at 72" length]. Manufactured by Victaulic "Aquaflex".
- H. Sprinklers with o-rings are not acceptable.

2.2 PIPE, VALVES AND FITTINGS

- A. Refer to Section 21 13 00.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- F. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

3.2 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than

system's pressure rating for aboveground applications unless otherwise indicated.

- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes full bore and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to paragraph 1.5, "Quality Assurance".
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

- L. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. For installation of flex head assemblies follow flex sprinkler assembly manufacturer recommendations. Flex head assemblies shall not connect to cross mains from the bottom of the pipe, only from the side or top.
- C. Coordinate the location of sprinkler system piping around all other trades, such as HVAC, plumbing and electrical, prior to installation.
- D. In exposed areas with ductwork 48" and wider, provide sprinkler heads both above and below ductwork as outlined in NFPA 13.
- E. Provide sprinkler heads both above and in ceilings constructed of wood, as required by NFPA 13.
- F. Provide sprinkler heads 2'-0" from the bottom of the elevator shafts as required by NFPA 13.
- G. Provide sprinkler head guards on sprinkler heads in gym areas.

3.4 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.

3.5 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.

- F. For wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section, Joint Sealants.
- G. Seal space outside of sleeves in concrete slabs and walls with grout.
- H. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section, Penetration Firestopping.

3.6 SLEEVE SEAL INSTALLATION

- A. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53, Electrical Identification.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Start and run excess-pressure pumps.
 - 6. Coordinate with fire-alarm tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire-department equipment.
 - 8. Sprinkler system zone control assemblies shall be tested to demonstrate proper operation of the flow switch and valve supervisory switch.
 - 9. Arrange & pay for all tests and inspections required by authorities having jurisdiction.

- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

END OF SECTION

**SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the common work results requirements for Division 22, Plumbing. Applicable provisions of this Section apply to all Sections of Division 22.

1.2 GENERAL

- A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements and provide coordination drawings.
- B. Prior to starting work, Contractor shall provide 1/4 inch scale coordination drawings for all areas of the buildings for approval by Architect/Engineer.
 - 1. Drawings shall show all equipment, ductwork, cable trays, fire protection systems, coil pull spaces, chilled water, heating water, and condensate piping and trap, electrical conduit, electrical control panels, etc. installed to verify space allocation and coordination of trades.
 - 2. Provide plan and elevation views detailing installation.
 - 3. Do not proceed with construction of plumbing systems until Drawings have been approved by Architect, Engineer, and Owner.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 CODE REQUIREMENTS AND PERMITS

- A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
- B. Resolve code violations discovered in contract documents with Engineer prior to award of Contract. After award of Contract, make correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. Obtain and pay for all permits and inspections.

1.5 SUBMITTALS

- A. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.
- B. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data at one time for review for items of equipment and for principal materials proposed for installation. Include identifying symbols and equipment numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.
- C. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.
- D. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.

1.6 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall furnish five copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Detailed requirements for these items are as follows:
 - 1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:

- a. Recommended procedures and frequencies for preventive maintenance, inspection, adjustment, lubrication, cleaning, etc.
 - b. Special tools and equipment required for testing and maintenance.
 - c. Parts lists reflecting the true manufacturer's name, part number, and nomenclature.
 - d. Recommended spares by part number and nomenclature and spare stocking levels.
 - e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
 - f. Troubleshooting, checkout, repair, and replacement procurement procedures.
 - g. Operating instructions including start-up and shutdown procedures.
 - h. Safety considerations including load limits, speed, temperature, and pressure.
- B. Provide O&M manuals for all plumbing equipment. Coordinate O&M manuals with Division 01.
- C. Upon completion of work, and at time designated by the Architect/Engineer, provide services of a competent representative of the Contractor for a period of at least 40 hours to instruct the Owner's Representative in the operation and maintenance of the entire system.

1.7 PROJECT RECORD DOCUMENTS

- A. Preparation:
- 1. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.
 - 2. Mark the drawings with a colored pencil.
 - 3. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed
 - 4. Include flow-line elevation of sewer lines.
 - 5. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.
 - 6. Coordinate requirements for Project Record Documents with Division 01.
- B. Deliver: At conclusion of project, obtain without cost to Owner, reproducibles of original mechanical drawings and transfer as-built changes to these. Delivery of as-built prints and reproducibles is a condition of final acceptance.

1.8 GUARANTEE

- A. Guarantee work for 1 year from the date of final acceptance of the project, and during that period make good any faults or imperfections that may arise due to defects or

omissions in materials or workmanship. Coordinate requirements for Warranty with Division 01.

1.9 SERVICE

- A. Perform service work required during the guarantee period including lubrication of bearings. Perform service monthly, and provide the Owner with a written report. Cleaning of air filters and pipe strainers is not included.

1.10 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions (except where specified otherwise in individual sections), revisions, amendments or supplements in effect on date bids are received.
 - 1. Requirements in reference specifications and standards are minimum for all equipment, material and work.
 - 2. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.

1.11 CUTTING AND PATCHING

- A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.
- B. Methods of Cutting:
 - 1. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer.
 - 2. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer.
 - 3. Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.
- C. Restoration:
 - 1. All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.
- D. Masonry:
 - 1. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.
 - 2. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation.
 - 3. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

- E. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

1.12 EXCAVATION, TRENCHING AND BACKFILL

- A. Excavation: See Divisions 00, 01, and 31 for special requirements related to excavation and trenching.
- B. The Mechanical and Electrical subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc.
- C. All exterior lines shall be installed with a minimum cover of 24 inches, unless otherwise indicated.
 - 1. Generally, more cover shall be provided if grade will permit.
 - 2. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector.
 - 3. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced.
 - 4. Trenches shall be not less than 12 inches wider or more than 16 inches wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6 inches or more than 8 inches in width is provided on each side of the pipe.
 - 5. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.
- D. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints.
- E. Bell holes shall be dug after the trench bottom has been graded.
 - 1. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used.
 - 2. Bell holes for pipe joints shall be 12 inches in depth below the trench bottom and shall extend from a point 6 inches back of the face of the bell.
 - 3. Such bell holes shall be of sufficient width to provide ample room for caulking.
 - 4. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench.
 - 5. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used.

6. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole.
 7. Special pipe beds shall be provided as specified hereinafter.
- F. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work.
1. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place.
 2. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required.
 3. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6 inches below the trench depths specified.
 4. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand.
 5. Whenever wet or otherwise unstable soil incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.
- G. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Refer to appropriate Sections of Division 31.
- H. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided. Refer to appropriate Sections of Division 31.
- I. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12 inches for a distance of 24 inches on either side. Edges of such excavations shall slope at an angle of not over 45° with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.
- J. Trenches for drain, storm water, and sewer lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped, and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.
- K. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site.
- L. Backfilling:
1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's

inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. Refer to appropriate Sections of Division 31 for additional requirements.

2. Backfill under concrete slabs-on-fill shall be as per appropriate Sections of Division 31.

M. Opening and Reclosing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. Refer to Division 31. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished.

N. Excavation in Vicinity of Trees: Refer to Division 31.

O. Welding Certificates: Provide current welding certificates.

1.13 QUALITY ASSURANCE

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

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

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

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

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacturer where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are listed in individual Sections of Division 22. Manufacturer's names and catalog numbers specified under Sections of Division 22 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified,

manufactured by a manufacturer named in the acceptable manufacturer's list will be accepted upon approval.

B. Substitutions:

1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.
2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
3. The Architect/Engineer will not give approval to material salesmen or subcontractors and only in writing to the successful Contractor after the project has been awarded.
4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.
6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest.
7. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.
8. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural, or architectural, which may result from the substitution.
9. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.

2.3 PIPE STRAINERS

- A. Immediately prior to final acceptance of project, inspect, clean and service piping system strainers.
- B. Turn over to Owner additional sets of spare parts as specified.

2.4 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

2.5 PIPE, TUBE, AND FITTINGS

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

2.6 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8" Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- E. Welding Filler Metals: Comply with AWS D10.12.
- F. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.

2.7 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180°F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225°F.

2.8 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.9 SLEEVES

- A. Through Floors: Galvanized schedule 40 steel pipe sleeve with water ring, as detailed.
- B. Through Walls in Crawl Space: Galvanized schedule 40 steel pipe sleeve with water ring, as detailed.
- C. Sleeves Through Interior Walls: 22 gauge galvanized steel snap lock. No screws through vapor barrier.

2.10 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.

2.11 GROUT

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

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe

and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section, Penetration Firestopping, for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections for roughing-in requirements.
- S. Provide fire rated type access panels in fire rated walls where indicated in drawings. Access panel to match or exceed to wall rating.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 OBSTRUCTIONS

- A. Drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.
- C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- D. Assume total responsibility for and repair any damage to existing utilities or construction.

3.6 OPENINGS

- A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.7 PROTECTION

- A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.
- B. Cover all equipment stored exposed to elements with waterproof tarps. Provide adequate ventilation. At work completion, all work must be clean and in like new condition.
- C. Storage of all mechanical equipment and piping materials shall be in strict accordance with manufacturers written installation instructions.
- D. Provide factory installed pipe caps for all pipes to be installed on the project.

3.8 CONCRETE BASES

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

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section, Cast-in-Place Concrete.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section, Metal Fabrications, for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.11 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.

- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.12 LUBRICATION AND OIL

- A. Provide a complete charge of correct lubricant and/or oil for each item of equipment requiring lubrication.

3.13 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

- A. All equipment utilized will be checked out by a factory representative, serviced, lubricated, checked for rotation, pressure, amp draw and vibration isolation, adjusted and certified. Record of this service must be provided monthly to the Owner. Submit appropriate reports to the University prior to submitting a written request for service.
- B. All equipment operated shall be serviced on a regular basis by the Contractor.
- C. Prior to final inspection, clean all equipment inside and out to a like new condition, remove temporary filters, install new permanent filters in preparation for final inspection by Owner.
- D. All warranties will be commenced at the time of final acceptance.

3.14 OPERATING TESTS

- A. After all plumbing systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner's Representative.
- B. Prove operations of control systems and all safeties, and alarms. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual Sections.
- C. Functional Performance Testing is part of the Commissioning Process. Functional performance testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 019113, General Commissioning, for functional performance testing and commissioning requirements.

3.15 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall furnish five copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Detailed requirements for these items are as follows:

1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
2. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
3. Special tools and equipment required for testing and maintenance.
4. Parts lists reflecting the true manufacturer's name, part number and nomenclature.
5. Recommended spares by part number and nomenclature and spare stocking levels.
6. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
7. Troubleshooting, checkout, repair and replacement procurement procedures.
8. Operating instructions including start up and shutdown procedures.
9. Safety considerations including load limits, speed, temperature and pressure.
10. Provide O&M manuals for all plumbing equipment. Coordinate requirements for O&M Manuals with Division 01.

3.16 OPERATING INSTRUCTIONS

- A. Upon completion of work, and at time designated by the Owner's Representative, provide services of a competent representative of the Contractor for a period of at least 40 hours to instruct the Owner's Representative in the operation and maintenance of the entire system. The training sessions will be video taped for instructing future technicians.
- B. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 019113, General Commissioning, for contractor training requirements.
- C. Coordinate requirements for training with Division 01.

END OF SECTION

**SECTION 22 05 26
PIPE AND PIPE FITTINGS**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for pipe and pipe fittings for all piping systems. This Section applies to all Plumbing Sections of Division 22 which employ pipe and pipe fittings. Fabricate and erect all piping in accordance with ASME/ANSI B31.9 except as otherwise indicated.

1.2 RELATED SECTIONS

- A. Division 07 – Thermal and moisture protection for firestopping requirements.
- B. Division 09 – Finishes for painting requirements.
- C. Section 22 05 00, Common Work Results for Plumbing
- D. Section 22 05 53, Identification for Plumbing Piping and Equipment.
- E. Section 22 11 16, Domestic Water Piping.
- F. Section 22 13 16, Sanitary Waste and Storm Drain Piping.

1.3 SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 paragraphs where titles below introduce lists or manufacturers, the following requirements apply to product selection:
 - 1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the manufacturer specified.

2.2 PIPE AND FITTINGS

- A. The particular type of pipe and fittings for each system is specified in the Section for that system. All piping and fittings shall be of U.S. Manufacturer. All pipe shall be shipped capped. Shipped and store on job site with ends capped from the factory.

2.3 JOINTS

- A. Screwed: Make screwed joints using machine-cut ANSI taper pipe threads. Apply a suitable joint compound, such as Teflon tape, to the male threads only. Ream the pipe to full inside diameter after cutting. All-thread nipples are not permitted.
- B. Dissimilar Metals: Make joints between copper and steel pipe and equipment along with steel pipe and ductile iron pipe using insulating unions such as Crane Company No. 1259; EPCO as manufactured by EPCO Sales, Inc.; or an approved equal.
- C. Solder Joints:
1. Prior to making joints, cut pipe square and ream to full diameter. Clean exterior of pipe and socket. Apply a thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.
 2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.
 3. Utilize lead free solder. Use silver brazing alloy or Sil-Fos and on underground piping.
- D. Welded Joints:
1. Make welded joints as recommended by the standards of the American Welding Society.
 2. Ensure complete penetration of deposited metal with base metal.
 3. Provide filler metal suitable for use with base metal.
 4. Keep inside of fittings free from globules of weld metal.
 5. Do not use mitered joints.
 6. Use standard weld elbow fittings for changes of direction or cut a standard elbow for odd angles.
- E. Flanged Joints:
1. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64 inch per foot inclination of the flange face from true alignment.
 2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.
 3. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Red rubber gaskets are not acceptable. Garlock gaskets or EPDM shall be used. Apply non-stick clean surface lubricant coating to both sides of gaskets.

4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use Coreten or galvanized steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets. Use anti-seize compound on all bolts above and below grade. Bolt threads not to protrude more than 2 threads past nut.
 5. Use carbon steel flanges conforming to ANSI B16.5 with materials conforming to ASTM A 105, Grade II or ASTM A 108, Grade II. Use welding neck type flanges at all fittings and on all pipe.
 6. Flanges for ductile iron pipe are specified in Sections using that pipe.
 7. Keep flange covers on equipment and shop-fabricated piping until ready to install in system.
- F. No Hub: Install according to manufacturer's recommendations, using recommended tools.
- G. Bell and Spigot: Use neoprene compression gaskets for sanitary and storm.
- H. Push-on Joints (Ductile Iron Pipe): Restrained joints and gaskets for ductile iron pipe are specified in Sections using that pipe.

2.4 UNIONS

- A. Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping larger than 2-1/2 inches.

2.5 BRANCH CONNECTIONS

- A. For Pipe 2 inches and smaller, use threaded fittings for steel pipe. For threaded piping, use straight size of reducing tee.
- B. For 2-1/2 Inches through 14 Inches: For welded piping, when branch size is the same as and one size smaller than header size, use welding tee. Use Weld-O-Let when branch is two or more sizes smaller than header. For threaded branch connections, use thread-o-let welded to header.
- C. All changes in direction, branches, offsets etc., shall be made with standard pipe fittings. Holes in the main for branches shall be made with a hole cutting machine and a standard "Weld-O-Let" or "Thread-O-Let" fitting used. Burning holes in the system piping will cause that section of the piping to be cut out and replaced at the Contractor's expense

2.6 GASKETS

- A. Provide gaskets between flanges of all flanged joints. Inside diameter of gaskets shall conform to nominal pipe size. Gaskets shall be ring type between raised face flanges and full face between flat face flanges with punched bolt holes and pipe opening.

- B. Gaskets shall be cut from 1/8 inch thick non-metallic, non-asbestos gasket material suitable for operating temperatures from -150°F to +750°F. Garlock or equal. For pipe smaller than 6 inches, use 1/16-inch-thick gasket.

2.7 FLOOR AND CEILING PLATES

- A. Provide chrome-plated floor and ceiling plates around pipes exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Size plates to fit pipe or insulation and securely lock in place.

PART 3 - EXECUTION

3.1 PIPE FABRICATION AND INSTALLATION

- A. Make piping layout and installation in the most advantageous manner possible with respect to headroom, valve access, opening and equipment clearance, and clearance for other work.
- B. Give particular attention to piping in the vicinity of equipment. Preserve the maximum access to various equipment parts for maintenance. Install piping plumb and parallel with building walls.
- C. Do not cut or weaken any structural member.
- D. Cut all pipes accurately to measurement determined at the site. After cutting pipe, ream it to remove burrs.
- E. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make all changes in direction. Field bending and mitering are prohibited. Make all connections to equipment using flanged joints or unions. Make reducing connections with reducing fittings only.
- F. All water piping installed above ground or below ground and in trenches, including preinsulated piping, must be installed by a licensed Mechanical Contractor at building rates. The wage rates for building trades apply only to the extent of work required to be installed by licensed Plumbing or Mechanical Contractors.

3.2 WELDING

- A. Weld and fabricate piping in accordance with ANSI Standard B31.9, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
- B. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

- C. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.
- D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.
- E. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

3.3 OFFSETS AND FITTINGS

- A. Because of the small scale of Drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.
- B. Install all piping close to walls, ceilings, and columns so piping will occupy the minimum space. Provide proper space for covering and removal of pipe, special clearances, and for offsets and fittings.

3.4 PIPE SLEEVES

- A. Fit with sleeves all pipes passing through gyp board, masonry, and concrete construction, refer to specification section 22 05 00 and the following:
 - 1. Provide 22 gauge wall sleeves for pipes passing through gyp board walls.
 - 2. Fabricate floor sleeves of schedule 40 weight galvanized steel pipe and masonry wall sleeves of 40 gauge galvanized steel.
 - 3. Size sleeve for minimum clearance between pipe or insulation and sleeve.
 - 4. All sleeves in wet lab areas to have a welded waterstop.
 - 5. All sleeves shall be hot dipped galvanized after fabrication.
- B. Extend each sleeve through the floor or wall. Cut the sleeve flush with each surface, except that in exposed locations, extend floor sleeves 2 inches above finished floor line.
- C. Seal all sleeves water and airtight. Seal annular space between pipes and sleeves with compound with flame and smoke spread rating of minimum 25/50 in accordance with ASTM E 84 test.
- D. Sleeves below grades in outside walls are detailed on drawings. Except as shown otherwise, provide Thunderline Link-Seal or approved equivalent with stainless steel nuts and bolts, with cast iron pressure plate.

3.5 ISOLATION VALVES

- A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor and at branch takeoffs serving all equipment, and at other locations as indicated and required for isolation of piping or equipment.

3.6 DRAIN VALVES AND VENTS

- A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained. Install a 2 inch drain for 2-inch pipes and larger. Install a line size drain valve for pipes smaller than 2 inches. Provide hose adapter and cap on all drain lines.
- B. Provide automatic vents with isolation valves or manual vents at locations as indicated on drawings and all high points in piping systems.

3.7 CLEANING OF PIPING SYSTEMS

- A. Cleaning of piping system must be performed by an independent agency specializing in this type of work:
 - 1. The agency must have a minimum of 5 years experience with at least three projects of similar size.
 - 2. Submit project names for review.
- B. Minimum velocity of 10 feet per second must be maintained in the pipes during flushing period:
 - 1. Do not use building pumps for circulating water.
 - 2. Provide temporary pumps as required to achieve minimum velocities.
 - 3. Remove flow meters from building piping during flushing operation.
 - 4. Provide means (instrumentation) during flushing period to prove to the Owner that the minimum velocities are maintained in the pipes.
- C. Submit a detailed plan for the Engineer's and Owner's review and approval describing in full detail the individual steps associated with this process before any piping is installed:
 - 1. Plan must include a drawing indicating GPM's required to provide minimum velocity required in the piping, phasing of systems being cleaned, locations of drains or other temporary connections required for cleaning system, and cutsheet of temporary pump proposed.
- D. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the systems in service. Provide temporary connections and valves as required for cleaning, purging and circulating.
- E. Install temporary strainers in front of pumps, tanks, water still, solenoid valves, control valves, and other equipment where permanent strainers are not indicated. Keep these strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blowoff valve.
- F. Domestic Water Piping:

1. All potable water piping and tanks shall, after successful pressure testing, be thoroughly flushed with clear water and then sterilized.
 2. Sterilization shall be with either liquid chlorine or chlorine gas of adequate volume to give a concentration of 50 ppm based upon the volume of the system being treated.
 3. The solution will be allowed to stand for a period of 24 hours.
 4. A minimum residual chlorine level of 5 ppm shall remain in each system for a minimum of 24 hours.
 5. After sterilization, all piping shall be thoroughly flushed.
 6. The above are minimum requirements and all sterilization procedures shall be in strict accordance with all local codes and authorities having jurisdiction.
 7. Under no circumstances shall the Contractor permit the use of any portion of the domestic water system until it has been properly sterilized and certified by the authorities having jurisdiction.
- G. Special requirements, if any, are specified in the Sections for each type of piping.
- H. After systems have been flushed, cleaned and sterilized; as required by specifications, provide written certification from the cleaning contractor that the systems are clean and ready for use.

3.8 LEAK TESTS

- A. All piping systems shall demonstrate leak tightness. This requirement shall be met by a water hydrostatic leak test or a pneumatic leak test, whichever is called for under specific piping Sections.
- B. Piping Systems:
1. Test Preparation: Expansion joints shall be provided with temporary restraint, for the additional pressure load under test or shall be isolated from the test. Equipment and valves which are not rated for the pressure test shall be either disconnected from the piping or isolated by a blind flange or similar means.
 2. Test Pressure: The water hydrostatic test pressure shall be 1.5 times the design pressure. The pressure test shall be maintained for sufficient time to inspect all joints, with a minimum time of four hours.
 3. Special requirements, if any, for each system are specified in the Section for that system.

3.9 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

- A. Provide service connections to items of equipment furnished by others:
1. Detailed shop drawings of equipment will be furnished indicating the exact number and location of rough-in points.
 2. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions.
 3. Making adjustments to field conditions is considered a part of the work required.

B. Roughing-In:

1. When roughing-in, extend service piping to various items of equipment.
2. Temporarily terminate at proper points as indicated on detailed equipment shop drawings or as directed.
3. Do not use contract drawings accompanying these specifications for rough-in locations but only for pipe sizing and general routing.

C. Stop Valves:

1. Provide stop valves for each service at rough-in locations, except for drains.
2. Stop valve locations are subject to approval, and in all cases must be accessible from the same room in which the furniture or equipment is located.

3.10 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

- A. Refer to Specification 22 05 00, Common Work Results for Plumbing, for requirements that must be completed prior to requesting the Owner to provide chilled water or hot water from the building distribution system.

3.11 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

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

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.
- B. Division 03 Section, Concrete, for concrete requirements.
- C. Division 05 Section, Metal Fabrications, for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- D. Division 09 Section, Painting, for painting requirements.
- E. Section 21 13 00, Fire-Suppression Systems, for pipe hangers for fire-suppression piping.
- F. Section 22 05 00, Common Work Results for Plumbing
- G. Section 22 05 48, Vibration Isolation for Plumbing Piping and Equipment, for vibration isolation devices.

1.02 DEFINITIONS

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

1.03 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.04 SUBMITTALS

- A. Product Data: For the following:

1. Steel pipe hangers and supports.
 2. Thermal-hanger shield inserts.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze pipe hangers. Include Product Data for components.
 2. Metal framing systems. Include Product Data for components.
 3. Equipment supports.
- C. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Anvil
- B. Cooper B-Line
- C. Erico
- D. Unistrut
- E. Nibco
- F. PHP

2.02 CLEVIS TYPE HANGERS

- A. Adjustable steel clevis hangers (MSS1 Type 1)

2.03 METAL FRAMING SYSTEMS

- A. Provide fabricated cadmium plated steel framing members and appurtenances for interior pipe supports as shown:
1. Mult-A-Frame, Unistrut, Cooper B-Line and Power-Strut pipe support systems also are acceptable.
 2. Support piping from precast and pan joist structure as detailed on Drawings.
 3. Powder actuated anchors are not permitted.
 4. Sleeves penetrating beams must be submitted through Structural Engineer. Refer to plumbing drawings for locations.

- B. Framing channel type support systems shall be 12-gauge cold-formed carbon steel conforming to ASTM A570 GR33:
 - 1. Fittings for framing channel system shall be punch pressed electro-galvanized carbon steel conforming to ASTM A575, A576, A635 and A36.
 - 2. Bolts and nuts shall have unified coarse screw threads with standard 1/2 inch nuts, conforming to ASTM A576 GR1015 AND ASTM A307.
 - 3. Components shall have a pre-galvanized zinc coating conforming to ASTM A525, except where indicated.

2.04 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.05 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier with vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06 FASTENER SYSTEMS

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

2.07 EQUIPMENT SUPPORTS

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

2.08 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Concrete: Provide 3,000 psi concrete. Reinforce slab with No. 4 rebar on 12 inch center each way centered in slab unless indicated otherwise on Drawings.
- C. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Metallic coatings for piping and equipment that will not have field-applied finish. All hangers and supports shall be cadmium plated. Hangers and supports in crawl space shall be hot dipped galvanized
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120°F to 450°F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- J. 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.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.02 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified herein for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers,

NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 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.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- N. Do not support piping from other piping.
- O. Where uninsulated (bare) copper pipe is supported by clevis hangers and riser clamps. The hangers shall be plastic coated or copper.
- P. Where uninsulated (bare) copper pipe is clamped to a dissimilar metal, such as steel, the copper pipe shall be installed with a felt isolator or Vibra Cushion No. B1999 manufactured by B-Line, Erico "Caddy" Cushion Clamp, or approved equal.

- Q. Isolation tape wrap is only acceptable where a clamp or support does not occur and where pipe is in connect with a building element.
- R. Place hangers not more than 6 feet apart on 1/2 inch and 3/4 inch pipes, or 10 feet apart on larger pipes unless noted otherwise on plans. Place hangers not more than 6 feet apart for all sizes of polyvinyl chloride pipe. Refer to manufacturer's recommendations for supporting polypropylene piping. For copper piping, place hangers as follows:
 - 1. For sizes up to 1 inch – maximum 5 feet - 0 inches O.C.
 - 2. For sizes 1-1/4 inch to 1-1/2 inch – maximum 7 feet - 0 inches O.C.
 - 3. For sizes 2 inches to 3 inches and larger – maximum 9 feet - 0 inches O.C.
- S. Support vertical risers as detailed on drawings at every floor:
 - 1. All water piping 2 inches or smaller shall be supported with galvanized steel strap pipe clamps of approved designed and sizes, properly supported at every floor.
 - 2. Support piping assemblies in chases adequately enough to be rigid and self-supporting before the chase is closed.
 - 3. Provide adequate structural support for piping penetrating chase walls to fixtures.
- T. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified in the appropriate insulation Section.
- U. Perforated bar hangers, straps, wires or chains are not permitted.
- V. For cast iron piping, refer to specification section 22 13 16.

3.03 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

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

3.05 ADJUSTING

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

3.06 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

**SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Marking Services, Inc.
 3. Seton Identification Products.

2.2 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Minimum Label Size: Length and width vary for required label content, but not less than 1-1/2 inch X 3/4 inch.
 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: Black.
 3. Background Color: Background to contrast with letter color.
 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 4 inches wide X 1-1/2 inches high.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Section number and title where equipment is specified.

- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11 inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Background to contrast with letter color.
- D. Maximum Temperature: Able to withstand temperatures up to 160°F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

- A. General requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include Identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inch high.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Brass.
2. Paint: Standardized colors for the entire natural gas piping system painted per Division 09 painting specification. Paint material is based on colors and model numbers manufactured by Glidden unless otherwise indicated. Entire natural gas piping system shall be primed and painted where outdoors. Subject to compliance with requirements, provided named color or comparable product as approved. Use the following colors for banding of all piping and conduit:

SYSTEM	COLOR
Domestic Water, Cold, Hot or Hot Water Return	Blue, comparable to ICI/Glidden #1330
Natural Gas	Yellow, comparable to ICI/Glidden #9400
Drain Lines (other than Acid Waste)	Black, comparable to ICI/Glidden #1484

3. Standardized Sizes: Tags shall be at least 1-1/2 inches in diameter, with depressed block characters 1/4 inch high. Titles shall be lettered on bands. Uppercase letters and Arabic numerals shall be used. Where pipes or conduits are too small or not readily accessible for such application securely fasten a brass identification tag at appropriate locations. Identification of the material contained in piping and conduits in accordance with the table below:

BAND AND LETTER SIZE ALL DIMENSIONS IN INCHES		
Outside Diameter of Pipe Covering	Width of Color Band	Size of Letters and Numerals
1/2 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/4 to 3-1/4	10	1
3-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

4. Pipe Identification: Identify pipe at wall penetrations, machine or tank connections, and at not over 50 foot intervals. Marker identification shall be legible and should be visible from the floor. Mark each pipe circuit with stencil. Stencil shall include flow arrow and identification marks as follows:

SERVICE	MARK
Domestic Water Supply	Dom-W-S

SERVICE	MARK
Domestic Hot Water Supply	Dom-HW-S
Domestic Hot Water Return	Dom-HW-R
Non-Potable Makeup Water	Non-Potable-W
Natural Gas	Nat-Gas
Storm Sewer	Storm
Overflow Drain	Overflow
Sanitary Sewer	San
Sanitary Vent	San-V
Acid Waste	Acid-W
Acid Vent	Acid-V

2.6 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4 inch letters for piping system abbreviation and 1/2 inch numbers.
1. Tag Material: Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2 X 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
1. Size: 3 X 5-1/4 inches minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Equipment to be identified with plastic nameplates includes but is not limited to water heaters, filters, plumbing equipment, tanks, and water treatment devices.
- B. Identify small devices, such as in-line pumps with metal tags.
- C. Identify valves with tags.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 painting sections
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment. For natural gas provide labels maximum every 15 feet - 0 inches.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units.
- B. List tagged valves in a valve schedule in aluminum frame with clear plastic shield. Install at location as directed by Owner's Representative.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION

**SECTION 22 07 19
PLUMBING PIPING INSULATION**

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section Includes:
1. Insulation Materials:
 - a. Fiberglass insulation.
 2. Sealant, adhesives and finishes.
 3. Jackets:
 - a. PVC jackets.
 - b. Canvas or glass jackets.
 - c. Aluminum type jackets.
- B. Related Sections include the following:
1. Section 22 05 00, Common Work Results For Plumbing
 2. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
 3. Section 22 11 16, Domestic Water Piping Systems
 4. Section 22 13 16, Sanitary Waste Storm Drain Piping

1.02 REFERENCES

- A. ASHRAE 90.1 – Energy-Efficient design of New Buildings Except Low-Rise Residential Buildings; 2010.
- B. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2004.
- C. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2000.
- D. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2000.
- E. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation, 2006.
- F. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials, 2005.

- G. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association, 2009.
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc., 2003.

1.03 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thicknesses for equipment scheduled.
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.
- C. Samples: Submit samples of each type of insulation to display the material, quality, and application method.
 - 1. Obtain approval of sample application before proceeding with work.
- D. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.
- E. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface Burning Characteristics: Flame spread/smoke developed index of 25/50 maximum when tested in accordance with ASTM E 94, NFPA 255, or UL 723.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified with minimum 5 years experience.

- C. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.01 INSULATION

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CertainTeed Corp.
 - 2. Johns Manville.
 - 3. Knauff Insulation.
 - 4. Owens Corning.
 - 5. Foster
 - 6. Childers
- B. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- C. Insulation Type A: Fiberglass Insulation to comply with ANSI/ASTM C 547 with k factor of 0.23 BTU/ft²/F/hr/inch at 74°F.
 - 1. Minimum 5-pound density insulation.
 - 2. Factory applied aluminum foil reinforced inner and paper outer factory covering. (All Service Jacket - ASJ).
 - 3. Additionally provide hard aluminum metal jacket or reinforced aluminum foil jacket where indicated herein.

2.02 SEALANT, ADHESIVE, AND FINISH

- A. Acceptable Manufacturer: Subject to compliance with requirements, provide products manufactured by Foster or Childers Products, unless otherwise specified.

- B. Fiberglass – Low Temperature (below 100°F):
1. Sealant: Childers CP-76 or Foster 95-44 elastomeric sealant at valve covers, anchors, and hangers.
 2. Adhesive: Childers CP-82 or Foster 85-20/85-60 adhesive to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers.
 3. Finish: Childers CP-34 or Foster 30-65 vapor barrier coating and Childers Chil Glas No. 10 glass or Foster Mast a Fab polyester cloth.
- C. Fiberglass – High Temperature (above 100°F):
1. Adhesive: Childers CP-82 or Foster 85-20/85-60 adhesive to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers.
 2. Finish: Childers CP-10/11 or Foster 46-50 breather master with Childers Chil Glas No. 10 glass or Foster Mast a Fab polyester cloth..
 3. Cement: Ryder One Coat on insulated fittings, flanges, and valves.
 4. Piping: Childers CP-50AMV1 or Foster 81-42/30-36 lagging adhesive diluted 50% to prime dusty surfaces (calcium silicate or mineral fiber) prior to applying breather mastic.

2.03 JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Canvas or Glass Jackets, Indoor Only: UL listed cotton fabric, 6 ounce/square yard or low odor glass cloth, Childers 50AMV1 or Foster 81-42/30-36 lagging adhesive or approved equal.
- C. Hard Aluminum Metal Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
1. Piping: Prefabricated jacket of ASTM B 209 aluminum, 0.020 inches thick with factory applied 2 mil moisture barrier for finishing interior insulated pipe.
 2. Valves, Fittings, and Flanges: ASTM B 209 aluminum covers, 0.020 inches thick providing complete coverage of all valves, fittings, and flanges.
 3. Straps and Seals: 1 inch x 0.010 inch ASTM B 209 aluminum strapping and seals for applying aluminum jacket and covers to provide weather-tight covering of all insulation including caps, flanges, and end of lines.
- D. Reinforced Aluminum Foil Jacket: Provide service reinforced vapor barrier jacket with integral laminated aluminum vapor barrier manufactured by Foster Vaporfas 62-05 or Venture Clad 1577CW.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install materials in accordance with manufacturer's instructions.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to

- structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3 inch wide strips of same material as insulation jacket.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere and seal patches similar to butt joints.
- Q. For piping systems being heat traced, provide insulation one pipe size larger to accommodate the heat tracing cable.
- R. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

- S. On piping where tracing will be installed the insulation size shall be 1 pipe size larger to accommodate the heat trace cable. Strictly follow the heat tracing system manufacturer's recommendations where insulating the piping system.

3.03 PIPING INSTALLATION

- A. Complete pressure testing of piping systems prior to application of insulation.
- B. Fiberglass Pipes: Butt insulation joints firmly together. Seal longitudinal laps and butt strips with sealant.
- C. Fiberglass Low Temperature (below 100°F): Where piping is interrupted by fittings, flanges, valves or hangers, and at intervals not to exceed 25 feet on straight runs, form an isolating seal between the vapor barrier jacket and the bare pipe by liberal application of the sealant to the exposed joint faces carried continuously down to and along 4 inches of pipe and up to and along 2 inches of the jacket. Not required for storm piping or domestic water piping.

3.04 VALVES, FLANGES, AND FITTINGS

- A. Fiberglass – Low Temperature (below 100°F):
 - 1. Insulate valves, flanges, and fittings with pre-molded fitting secured with wire. Thickness of insulation shall be equal to that adjoining piping and shall match density or greater.
 - 2. Finish with 1/4-inch layer of Foster 30-65 or Childers CP-34 reinforced with Foster Mast a Fab or Childers Chil Galss No. 10 glass/polyester fabric.
- B. Fiberglass – High Temperature (above 100°F):
 - 1. Omit insulation at screwed unions and at valves smaller than 1-1/2 inches.
 - 2. On concealed (other than mechanical and pump rooms) piping, insulate fittings and valves 2-1/2 inches IPS and larger, with pre-molded or gored fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with coating reinforced with white 10 inch x 10 inch glass fabric.
 - 3. On concealed piping, insulate fittings and valves 2 inches IPS and smaller with mineral wool and insulating cement to a thickness equal to or greater than adjoining straight pipe. At Contractor's option, provide molded or mitered fittings, finished with Foster 46-50 or Childers CP-10/11 breather coating reinforced with glass fabric.
 - 4. In exposed (mechanical, pump and equipment rooms) area, insulate all fittings, flanges and valves with molded or mitered fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with breather coating reinforced with white glass fabric.

3.05 CONTROL VALVE COVERS - LOW TEMPERATURE SERVICE ONLY

- A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.
- B. Seal covers to valve insulation proper with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve. Finish valve cover with glass cloth and two coats of finish.

3.06 SHIELDS AND HANGERS

- A. Where piping hangers or anchors must be in direct contact with pipe, seal off the pipe insulation on both sides of the hanger by carrying the vapor seal down to the bare pipe.
 - 1. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe.
 - 2. Draw wire loops tight over the vapor barrier jacket, with ends of wire bent down. Take care to avoid puncturing the vapor seal.
 - 3. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.07 ALUMINUM TYPE JACKETING

- A. Apply aluminum type jacketing jacket and covers according to manufacturer's recommendations, completely encapsulate insulation on all piping, valves, flanges, reducers, etc.
- B. Hard aluminum metal jacketing shall be installed using aluminum strapping and seals to provide complete weathertight covering.
- C. Provide aluminum foil jacketing on piping located in equipment rooms where piping is below 84" from finished floor. Provide aluminum jacketing for outdoor locations.

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. All insulation applications will be considered defective Work if inspection reveals noncompliance with requirements.

3.09 INSULATION SCHEDULE

- A. Provide insulation with thickness and conductivity values in compliance with ASHRAE Standard 90.1, but not less than thicknesses scheduled below:

	TYPE	PIPE SIZES	INSULATION THICKNESS- INCHES
AHU Condensate Drains	A	All Sizes	1
All Horizontal Storm and Overflow Drain Piping. Roof drain and overflow drain bodies with piping extending to downspout. Insulate downspouts in Music Related Rooms.	A	All sizes	1
All Domestic Cold Water and Domestic Hot Water serving single fixtures.	A		1/2
Domestic Hot Water Supply and Return	A	1-1/2" and smaller	1
Domestic Hot Water Supply and Return	A	2" and larger	1-1/2
Drinking Fountain Drains	A	All sizes	1
Floor Drain Bodies and Drain Lines receiving AHU Condensate. Insulate from floor drain to connection to vertical sanitary piping or to below slab on grade.	A	All sizes	1
All Domestic Cold Water serving more than 1 fixture, and Makeup Water	A	All sizes	1

1. Refer to floor plans for any additional locations for insulating piping due to acoustical concerns.
2. Insulate storm system from and including roof drain and overflow drain body extending to the vertical downspout. The storm system vertical downspouts do not need to be insulated except where in chases adjacent to Music related rooms. Concealed outdoor storm piping and overflow piping and associated drain bodies shall be insulated.

END OF SECTION

**SECTION 22 11 16
DOMESTIC WATER PIPING SYSTEMS**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for furnishing and installing domestic hot and cold water piping, including hot water return within buildings.

1.2 RELATED SECTIONS

- A. Section 22 05 00, Common Work Results For Plumbing
- B. Section 22 05 53, Identification for Plumbing Piping and Equipment.
- C. Section 22 07 19, Plumbing Piping Insulation.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components.
- C. Comply with UL classified in accordance with ANSI/NSF 61 for hot and cold potable water service and shall be certified to the low lead requirements of NSF-372 for potable domestic water piping and components. Manufacturer must provide written documentation of compliance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements provide indicated products by manufacturers listed.
 - 1. Valves:
 - a. Apollo.
 - b. Crane.
 - c. Nibco.
 - d. Keystone.

- e. Watts.
 - f. Milwaukee.
 - g. Hammond.
2. Vacuum Breakers and Backflow Preventers:
- a. Watts.
 - b. Febco.
 - c. Wilkins.
 - d. Conbraco
3. Expansion Tanks:
- a. Amtrol.
 - b. Watts.
 - c. Taco.
4. Water Meters:
- a. Sensus
 - b. Badger
 - c. Neptune
5. Thermostatic Mixing Valves:
- a. Lawler.
 - b. Bradley.
 - c. Powers

2.2 PIPING AND FITTINGS

A. Underground Piping:

1. Sizes 4 inch and smaller: Provide ASTM B 88, hard-drawn, Type K copper water tube with wrought copper fittings with socket ends, ANSI B16.22. Provide Sil-Fos lead-free solder for all solder joints. Under slab (buried) trap primer piping (tubing) shall be ASTM B88 annealed type K soft copper, without joints below slab or in slab. Underground copper piping shall have a protective flexible poly material sleeve fully encasing pipe and fittings, similar to IPS Protect-O-Sleeve.
2. Sizes over 4 inch: Provide Class 300 ductile iron pipe cement lined interior with compression joints, ANSI A21.6 and ANSI/AWWA C151/A21.51.
 - a. Cement-lined ductile iron fittings, conforming to ANSI A21.10 and A21.4 with mechanical joints with rubber gaskets.
 - b. Asphaltic outside coating on pipe and fittings.
 - c. Factory applied asphaltic coating on outside of pipe and fittings.

- B. Aboveground (Including Trap Primer Piping): Provide seamless, ASTM B 88, Type L copper water tube with ANSI B16.22 wrought copper fittings with socket ends. Lead-free solder for all solder joints, Alloy Grade E in accordance with ASTM B32, similar to Engelhard Silvacore 100. Joints for pipe fittings 2" and larger may be grooved type joints. Grooved End Fittings: All grooved end fittings shall be ANSI B16.18 cast bronze or ANSI B16.22 wrought copper, with copper-tube dimensioned grooved ends. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.) Couplings shall consist of two ductile iron housing segments cast with offsetting angle-pattern bolt pads, pressure responsive grade EHP gasket, and zinc-electroplated steel bolts and nuts. Couplings shall be installation-ready, for direct stab installation without field disassembly. Victaulic Style 607. Flange Adapter Victaulic Style 641 roll grooved copper-tube dimensioned fittings sized 2" and larger. 3/8" diameter copper tube is allowed only where serving a single lavatory with a 0.5 gpm flow control device. Joints may also be Viega Pro-Press, Apollo X-Press or Nibco Presssystem joining method with a non-toxic synthetic rubber elastomer seal (EPDM O-RINGS) with the fitting socket. The fitting shall be pressed under substantial pressure by power tool forming a joint rated for 200 psi and tested for 600 psi, approved by IAPMO IGC 137-99/PS 117-2000 & ANSI/NSF 61, fitting material shall conform to ANSI/ASM B16.22 & B16.18, approved by Uniform Plumbing Code.
- C. Unions: ANSI B16.22 Class 150, 300-pound water-oil-gas service wrought solder joint fitting such as NIBCO 633/733 union C x C, or approved equal.
1. Flange joints larger than 2 inches shall be brass.
 2. Provide dielectric isolating unions or connections between metallic piping of dissimilar metal.
 3. Dielectric waterway fittings with grooved and/or threaded ends, as manufactured by Victaulic Company, Series 647, for sizes 1/2" through 8

2.3 VALVES

- A. Ball Valves (pipe sizes through 2 inches): 600 psi WOG, cast silicone bronze body, ASTM B584 Alloy C87600, two piece reinforced Teflon seats, full port, blowout proof stem, quarter turn handle with stainless steel ball and stem with threaded ends, manufactured by NIBCO No. T-585-66-LF or approved equal.
- B. Check Valves:
1. 2 inches and smaller: Class 125, horizontal swing silicone bronze disc, with bodies and caps conforming to ASTM B 584 Alloy 87850 cast silicone bronze material, threaded ends, manufactured by NIBCO No. T-413-Y-LF or approved equal.
 2. 2-1/2 inches and larger: Class 125, iron body, bronze mounted, with body and cap conforming to ASTM A 126, Class B cast iron, horizontal swing bronze disc, manufactured by NIBCO No. F-918-B, or approved equal.
- C. Gate Valves (2-1/2 inch and larger): For 2-1/2 inches and larger, provide Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A 126, Class B

cast iron, with graphite reinforced synthetic fibers and two-piece packing gland assembly, flanged ends, OS&Y, manufactured by Nibco F-617-0, or approved equal.

- D. Butterfly Valves (2-1/2 inch and larger): Class 150, ductile iron body conforming to ASTM A-395, fully lugged, drilled body, lever operated, blow out proof type 316 stainless steel disc and stem, EPDM seat, suitable for bi-directional dead end service with downstream flange removed, minimum 175 psi bubble tight shut-off, manufactured by Nibco No. LD-2000, Kitz No. 6123E or approved equal. For grooved systems Victaulic Series 608 is acceptable.

2.4 STRAINERS

- A. Y type, for pipe sizes 2 inch and less, class 125 rated for working pressure through 200 psig at 200°F, threaded ends, threaded cap, ASTM B62 cast bronze body and cap, 20 mesh stainless steel screen, openings not larger than 1/32 inch, tapped blowout outlet with minimum size of 1/4 inch, similar to NIBCO No. T-221-B, or approved equal.
- B. Y type, for pipe sizes over 2 inch, class 125 rated for working pressure of 200 psig at 150 degrees F, flanged ends, ASTM A126-B cast iron body, ASTM A36 carbon steel cover, non-asbestos gasket, type 304 perforated stainless steel screen, 1/16 inch perforations for pipe sizes up through 4 inch and 1/8 inch perforations for pipe sizes over 4 inch, with FDA approved internal lining. Manufactured by NIBCO No. F-721, or approved equal.

2.5 VACUUM BREAKERS AND BACKFLOW PREVENTERS

- A. Atmospheric Vacuum Breakers: Full line size, manufactured of brass or bronze with full size orifice, dry guide out of the liquid pressure area and disc float closing vent with minimum flow. Manufactured by Watts Regulator, No. 288A Series, or approved equal by Wilkens or Conbraco.
- B. Pressure Type Vacuum Breaker: Full line size, with full size orifices, manufactured of brass or bronze with double poppit (check valve) stainless steel screen and vent. Manufactured by Watts Regulator, No. 90, or approved equal by Wilkens or Conbraco.
- C. Reduced Pressure Backflow Preventer: Size as indicated on Drawings, manufactured of bronze, rated for 175 psi, and shall include strainer, gate or ball valves based on size, pressure differential relief valve, check valves, test cocks, and relief vent and funnel drain.
 - 1. Unit shall meet the requirements of ASSE 1013, and AWWA, University of Southern California tested and approved.
 - 2. Manufactured by Watts Regulator No. 909, or approved equal.
- D. Vacuum Relief Valve: 3/4 inch bronze with high temperature resisting disc, and disc guide located out of water.
 - 1. Tested up to 200 psi and 250°F and shall be open on a vacuum of not more than 1/2 inch of mercury.

2. Manufactured by Watts Regulator No. N36g, or approved equal by Wilkens or Conbraco.
- E. High hazard, anti-siphon, anti-spill, vacuum breaker designed for indoor applications, featuring bronze body, one-piece modular check valve and float assembly, stainless steel springs, bronze quarter turn ball valves at inlet and discharge, University of Southern California tested and approved. Manufactured by Watts No. 008QT, or approved equal by Wilkens or Conbraco.
- F. Dual Check Valve: Tested and certified to meet ANSI/ASSE Standard 1024, testable, cast bronze body, silicone discs, stainless steel springs, manufactured by Watts Series L7, or approved equal.

2.6 AIR RELIEF VENTS

- A. Float operated, constructed of cast iron with stainless steel float and trim and isolating valve:
 1. 1/2 inch, rated at 300 psi at 150°F.
 2. Vents shall be designed to eliminate air from the system automatically without permitting the passage of water.
 3. Minimum 3/4 inch system connection (inlet), minimum 1/2 inch drain connection (outlet), 1/4 inch drilled, tapped and plugged test connection.
 4. Manufactured by Clark-Reliance, Model No. 6-V, or approved equal.
- B. For sizes under 2" (Point of Use at Equipment Connections): Automatic in operation, adjustable, renewable stainless steel seat, bronze body, adjustable from 25-75 psi outlet pressure, with stainless steel strainer screen, with gauge tappings, manufactured by Watts No. U5B, or approved equal.

2.7 TRAP PRIMERS

- A. Electronic Type: Electronic trap priming manifold, surface mounted, complete with resettable timer, factory assembled, pre-piped bronze body, 3/4" NPT, 3/4" solenoid valve, Type "L" copper manifold with brass 1/2" compression fittings with single point 120 volt electrical connection with manual override switch, 16 gauge steel enclosure with integral atmospheric vacuum breaker, with mounting anchors, manufactured by PPP Inc., "Prime Time" or approved equal.
- B. Provide Proset Trap Guards in all floor drains and floor sinks where electronic trap primers are not indicated on the drawings.

2.8 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.

- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 31 Section, Earth Moving, for excavating, trenching, and backfilling.

3.2 CONNECTION

- A. Install unions downstream of all threaded valves and in all locations that supply serviceable equipment.
- B. Screwed Joints: Make joint with clean, full cut standard pipe threads. Ream after cutting and threading. Use heavy duty Teflon sealing compound or Teflon tape as threaded seal. Sealing compound shall be AGA and NSF certified, non-toxic, non-drying, anti-seize, and classified by UL.
- C. Use anti-seize compound on all bolts for flanges.
- D. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).

3.3 INSTALLATION

- A. For buried water service, clamp water pipe at fittings with 3/4 inch rods and properly anchor and support.
- B. Provide in-line strainer upstream of trap primers. Supply line to trap primers shall be taken off top of domestic cold water main, per manufacturer's recommendations.
- C. Provide a pressure gauge on each side of balancing valves on domestic hot water return loops.
- D. Provide backflow preventer certification documentation prior to final acceptance of system.
- E. No pulled tees (T-drill) are allowed.

- F. Provide a supply stop with union on the water supplies to each thermostatic mixing valve. Thermostatic mixing valve shall be located under lavatory counters hidden from view.

3.4 DRAINAGE

- A. Install water piping systems with uniform horizontal grade of 1/8 inch per 10 feet, minimum, to low points to provide complete drainage of the system. Where constant pitch cannot be maintained for long runs, establish intermediate low points and rise to new level. Grade branches to drain to mains or risers. Unless otherwise indicated, terminate low points of risers with drain valve piped to nearest hub or floor drain.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements in Section 22 05 53, Identification for Plumbing Piping and Equipment, for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

**SECTION 22 13 16
SANITARY WASTE AND STORM DRAIN PIPING**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for furnishing and installing sanitary waste, condensate and storm drain system piping within buildings and underground laterals within 5 feet of building.

1.2 RELATED WORK

- A. Section 22 05 00, Common Work Results for Plumbing.
- B. Section 22 05 53, Identification for Plumbing Piping and Equipment.
- C. Section 22 05 29, Hangers and Supports for Plumbing and Equipment.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; and "NSF-drain" for plastic drain piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Underground Piping:
 - 1. Type 1 Schedule 40 PVC pipe with DWV pattern, fittings with solvent cement joints. Conforming to ASTM D2665.

B. Above Grade Piping:

1. All aboveground sanitary sewer shall be cast iron soil pipe manufactured to ASTM A888, ASTM A74 and CISPI 301. Cast iron soil pipe shall be listed with an ANSI Accredited Testing Agency for quality assurance and manufactured by Charlotte, Tyler or New Age (Epoxy).
2. No-hub soil pipe and DWV pattern fittings conforming to ASTM A888 and CISPI301, and joined with a heavy duty couplings.
3. Heavy duty shielded stainless steel couplings and tightening devices shall conform to ASTM C1540 with neoprene gasket conforming to ASTM C564.
4. 4-band no-hub couplings for pipe sizes 4 inches and less. 6-band no-hub couplings for pipe sizes over 4 inches..
5. Couplings manufactured by Anaco "Husky" SD2000, Mission "HW" or Clamp-All 125 or New Age XHDC.

C. Piping through Wall Sleeves: Provide section of ductile iron piping, as detailed, in wall penetrations.

D. Storm drain system: Provide same as specified for sanitary waste & vent piping system.

2.2 VENT PIPE AND FITTINGS

A. Vent pipe and fittings shall be same as specified for sanitary sewer herein.

B. Provide heavy duty type 304 stainless steel minimum 4-band no-hub couplings, conforming to C.I.S.P.I. 310 as specified for drainage piping.

C. Pipe shall conform to ASTM A 74, ASTM A 53 or ASTM B 306, where applicable.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Section 22 13 16, Sanitary Waste and Vent Piping.

B. Basic piping installation requirements are specified in Section 22 05 00, Common Work Results for Plumbing.

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Section 22 05 00, Common Work Results for Plumbing.

- D. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Section 22 05 00, Common Work Results for Plumbing.
- E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- G. Vent Connections: Make vent connections to vent stacks with inverted wye fittings. Extend full-size vents through roof to at least 6 inches above roof.
- H. Flashing: Provide flashing as recommended by roofing material manufacturer and detailed by Architect/Engineer.
- I. Cleanouts:
 - 1. Install cleanouts the same size as the soil waste lines in which the cleanouts are placed. No cleanout should be larger than 4 inches in diameter.
 - 2. Where cleanouts occur in pipe chases, bring cleanouts through walls and install covers. Where cleanouts occur in floor slabs, set flush.
 - 3. Provide cleanouts where soil lines change every direction, every 50 feet on long runs, at end of each continuous waste line, and at the base of each riser.
- J. Floor Drains: Locate floor drains 1/2 inch below finish floor elevation unless shown otherwise.
- K. Slope sanitary waste piping at a uniform slope of 1/8" per foot for pipes sizes 3-inch and larger and 1/4" per foot for pipe sizes less than 4-inch. Slope vent piping at a uniform 1/8" per foot slope with the high point at the roof penetration, sloping back down toward the plumbing fixture. Refer to the plumbing code.
- L. Provide joint restraints on cast iron piping for pipe sizes over 4" and in changes in pipe diameter by two pipe sizes or more, and indicated in IPC Section 308, and conforming to CISPI 301-09. Joint restraints shall be Holdrite #117, or approved equal, or as shown on the Plumbing drawings.

3.2 UNDERGROUND PIPING INSTALLATION

- A. Pipe Grading: Lay and maintain all pipes at required lines and grades during the course of work to comply with Drawings.

B. Trench:

1. Excavate trench to depth required.
2. Properly brace and dewater trench and keep it free of water during installation, testing of pipe, and backfilling.
3. Do not discharge water onto a street or freeway without prior approval from Owner's Representative.

C. Excavation:

1. Trench shall be at least 18 inches wider than the maximum diameter of the pipe or largest bell and laid in the center of the trench.
2. Excavate trench to a minimum depth of 12" below the bottom of the final elevation of the pipe.
3. Increase trench width as required and piling left in place until sufficient compacted backfill is in place.
4. Properly sheet and brace all open trenches to render them secure and remove all such sheeting and bracing before completing the backfill.
5. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc.
6. The quantity of excavation required to install sheeting and the installation and removal of sheetings and bracings will not be regarded as Extra Work. All costs incurred for this excavation and the installation of sheeting shall be included in the Contract Price.
7. Refer to Structural and Civil drawings for trench details.

D. Grading:

1. Upon Completion of excavation and prior to the laying of the pipe, the trench bottom shall be brought up to the required elevation with a pipe cushion as per Division 31, except where the cushion has been eliminated by the Engineer.
2. Pipe cushions shall be select material deposited in the trench and shall be compacted, leveled off, and shaped to obtain a smooth compacted bed along the laying length of the pipe. Pipe cushion shall be as follows:
 - a. Stable, Firm Semidry Trench: Piping shall be laid on bedding of washed sand with minimum 3 inches thick all around pipe and covering pipe.
 - b. Undisturbed earth, in a constant uniformly sloped trench shall be under the sand bed.
 - c. Laying space for hubs or mechanical joints shall be hand cut to 6 inches either side of the joint and stabilized sand poured and wet in to even with the natural earth trench bottom.
 - d. The leakproof integrity test of the piping system shall be inspected by the Owner's Representative prior to covering the piping.
 - e. Failure to notify the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test being performed again.

- f. Where the slope of the trench is found to belly down along the line of piping, before joining, the pipe shall be removed from the trench and the belly converted to uniform slope by adding stabilized bank sand, wet down and slightly mounded to the center of the trench. The section of piping will then be "rolled" into place so with support uniform along it's entire length.
 - g. Where the slope of the trench is found to arch up along the line of piping, before joining, the pipe shall be removed from the trench and the arch converted to uniform slope by cutting the arch out. The section of piping will then be reset into place with support uniform along its entire length.
- 3. Wet Clay (Black Gumbo): Lay piping in a constant, uniformly sloped trench. After shaping, the trench shall receive 6 inch minimum clean bedding sand, which shall be uniformly distributed on the trench bottom.
 - a. Hand remove laying space for the hubs or mechanical joints and place the piping on the setting bed with the weight of the piping distributed evenly on the setting bed over its entire length.
 - b. The leakproof integrity test of the piping system shall be inspected by the Owner's Representative prior to covering the piping by the Engineer's agent. Failure to notify the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test performed again.
- 4. Rock: Where rock is encountered, the excavate trench to a minimum of 6 inches below the pipe elevation and backfill with bedding sand to provide a uniform layer for pipe support. Backfill shall be as indicated for Wet Clay- Black Gumbo.
- E. Special Considerations: Where there are expansive soil conditions on the site, special precautions shall be taken to prevent pushing and breakage of underground piping. Precautions shall be in accordance with local installation techniques and may include carton forms or special pipe bedding.
- F. Backfill: Backfill trenches only after piping has been inspected, tested, and approved by the Owner Representative.
 - 1. Place backfill material in the trench either by hand or approved mechanical methods. The compaction of backfill material shall be accompanied by tamping with hand tools or approved pneumatic tampers, by using vibratory compactors, by puddling, or by any combination of the three
 - 2. The method of compaction shall be approved and all compaction shall be done to the satisfaction of the Architect.
 - 3. Backfill completely around pipe, including 18 inches above the pipe, with suitable bank sand, tamped in 4 inch layers under, around, and over pipe. Water down backfill as required.
 - 4. The remainder of the backfill for pipes shall be select backfill material tamped at intervals of no more than 12 inch depths, to attain a 95 percent Proctor Compaction Density:

- a. All materials to be used as select material backfill shall be approved by the Architect.
 - b. If, in the opinion of the Architect, the excavated material does not meet the requirements of select material, the Contractor shall be required to screen the material prior to use as select material backfill.
 - c. Material used in the upper portion of the backfill or subgrade shall not contain stone, rock, or other material larger than 6 inches in longest dimension. No wood, vegetable matter, or other material, which in the opinion of the Architect is unsuitable, shall be included in the backfill.
 - d. The upper 24 inches of backfill may be water jetted, if desired. Bring backfill up to finish grade identified on the Architectural Drawings, including additional backfill required to offset settlement during consolidation. When removal of unsuitable, excavated material creates a shortage of backfill material, the Contractor shall, at no change in Contract amount, furnish material as specified in this Section in the amount required to complete the backfill.
- G. Existing Surfaces: Restore existing streets, driveways and sidewalks damaged during the excavation work to acceptable condition, subject to approval by the Architect.
- H. Safety: Provide street and sidewalk excavations with approved barricades, warning lights, and cover plates as required by the City. Refer Division 1 for additional requirements.
- I. Underground Piping under Slabs with Carton Forms
1. Upon completion of excavation the carton forms shall be provided in trench for pipe to rest on with a minimum clearance of 12" from bottom of pipe to bottom of trench.
 2. Clevis hangers shall be installed to support pipe w/continuous threaded rods from concrete slab as detailed on Plumbing drawings and Structural drawings.
 3. Clevis hanger support shall be installed at end pipe joint and change of direction

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Section 22 05 00, Common Work Results for Plumbing.
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- D. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

- A. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
 - 1. Use gate or full-port ball valve for piping NPS 2 and smaller.
 - 2. Use gate valve for piping NPS 2-1/2 and larger.
- B. Check Valves: Install swing check valve, downstream from shutoff valve, on each submersible pump discharge.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Section 22 05 48, Vibration Isolation for Plumbing Piping and Equipment.
- B. Pipe hangers and supports are specified in Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8 inch rod.
 - 2. NPS 3: 60 inches with 1/2 inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8 inch rod.
 - 4. NPS 6: 60 inches with 3/4 inch rod.
 - 5. Spacing for 10 foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.

- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8 inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8 inch rod.
 - 3. NPS 2: 10 feet with 3/8 inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2 inch rod.
 - 5. NPS 3: 12 feet with 1/2 inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8 inch rod.
 - 7. NPS 6: 12 feet with 3/4 inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8 inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8 inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2 inch rod.
 - 4. NPS 3 to NPS 5: 10 feet with 1/2 inch rod.
 - 5. NPS 6: 10 feet with 5/8 inch rod.
- K. Install supports for vertical copper tubing every 10 feet.
- L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Test pipe before backfilling and connecting to sewers by maintaining not less than 10 feet of hydrostatic head for 4 hours without a leak.
 - 2. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 3. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.
 - 1. After all sections of soil, waste, and vent piping are installed, but before fixtures are connected, test system by plugging all outlets and filling vertical sections with water to maintain not less than 10 feet of hydrostatic head for 4 hours without any drop in water level for all sections of piping. Provide wyes as required to facilitate plugging.
 - 2. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 3. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

**SECTION 22 13 19
PIPING SPECIALTIES**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following piping specialties:
 - 1. Drains.
 - 2. Hydrants.
 - 3. Cleanouts.

1.2 RELATED WORK

- A. Section 22 05 00 – Common Work Results For Plumbing.
- B. Section 22 13 16 – Sanitary Waste and Storm Drain Piping.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following, except special custom trench drains which shall be only the specified manufacturer:
 - 1. Wade Drains
 - 2. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 3. Watts Drainage Products Inc.
 - 4. Zurn Plumbing Products Group; Specification Drainage Operation.

2.2 DRAINS

- A. Design of drains is based on model numbers manufactured by Wade Drains, unless otherwise indicated. Subject to compliance with requirements, provide named product or comparable product by one of the listed acceptable manufacturers:
1. Floor Drains (FD-1): Wade No. 1100-G6-1 or approved equal cast iron floor drain with flashing collar, seepage flange, nickel bronze 6 inch square adjustable strainer with square holes, vandal resistant secured grate.

2.3 HYDRANTS

- A. Non-freeze Wall Hydrant (HB-1): Wade No. 8600-175, non-freeze 3/4 inch wall hydrant with vacuum breaker, nickel bronze box with bronze casing, hinged lockable cover, vandal resistant, "T" handle, "WATER" cast on cover, for 6 inch thick wall.

2.4 CLEANOUTS

- A. Location:
1. Provide drainage lines with properly specified cleanouts.
 2. Locate cleanouts in runs not more than 90 feet on centers or as required by local authority having jurisdiction.
 3. Provide cleanouts at the base of each soil or waste stack and wherever necessary to make accessible all parts of the drainage soil or waste systems, whether or not indicated on drawings.
 4. Extend cleanouts within chases to near wall and provide wall access cover compatible with wall construction.
 5. Provide cleanouts of required size, with flashing flange where installed with membrane waterproofing.
- B. Finished and Unfinished Walls. Jay R. Smith 4430, duracoated, cast iron cleanout with cast bronze plug and chrome-plated bronze square frame and secured cover with vandal-proof screws.
- C. Exposed Piping. Jay R. Smith 4505, duracoated, cast iron calk ferrule and cast bronze plug with 1/2" NPT test port with raised head plug and internal threading for test plug use.
- D. Outside Area. Jay R. Smith 4220, duracoated, cast iron cleanout with taper thread bronze plug, adjustable housing, and heavy-duty tractor-type cover with vandal-proof screws, cast flush in a 16 inch x 16 inch x 6 inch thick concrete pad in nonsurfaced areas.

2.5 INSTALLATION

- A. Refer to Section 22 05 00, Common Work Results for Plumbing, for piping joining materials, joint construction, and basic installation requirements.

- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- H. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

2.6 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

2.7 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53, Identification for Plumbing Piping and Equipment.

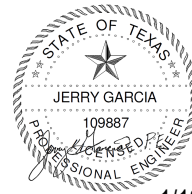
2.8 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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1/18/2018

SECTION 23 00 10

MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Except as modified in this Section, General Conditions, Special Conditions, applicable provisions of Division 01, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23.
- B. Applicable provisions of this Section apply to all Sections of Division 23 HVAC.
- C. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements, and provide coordination drawings.
- D. All work in these Sections shall be installed by craftsmen skilled in their trade.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Furnish: The term "furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. Install: The term "install" is used to describe operations at project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. Provide: The term "provide" means to furnish and install, complete and ready for the intended use.

1.3 CODE REQUIREMENTS AND PERMITS

- A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

- B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. Obtain and pay for all permits and inspections.
- D. The following building codes are applicable to this project.
 - 1. 2012 International Mechanical Code
 - 2. 2012 International Building Code
 - 3. State Energy Conservation Office (SECO) mandated state building compliance with ASHRAE 90.1-2010

1.4 REFERENCES

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, AWWA Specifications, Federal Standards or other standard specifications must comply with latest editions except where specified otherwise in individual Sections, revisions, amendments, or supplements in effect on date bids are received.
- B. Requirements in reference specifications and standards are minimums for all equipment, materials and work. In instances where capacities, size or other features of equipment, devices, or materials exceed these minimums, meet listed or shown capacities.

1.5 SUBMITTALS

- A. Equipment and Materials submittals must show sufficient data to indicate complete compliance with contract documents as follows:
 - 1. Proper sizes and capacities.
 - 2. That the item will fit in the available space in a manner that will allow proper service.
 - 3. Construction methods, materials, and finishes.
- B. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.
- C. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data for review for items of equipment and for principal materials proposed for installation. HVAC controls may be submitted separately provided the controls submittal is complete and coordinated with all other applicable trades. Include identifying symbols and equipment numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.
- D. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.

- E. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.
- F. Refer to Section 01 33 00 for additional submittal requirements

1.6 COORDINATION DRAWINGS

- A. Prior to starting work, the Contractor shall provide coordination drawings for all areas of the building.
- B. Composite. The respective Sub Contractors shall prepare one complete set of composite drawings.
 - 1. The sheet metal shop drawings shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the electrical conduit, mechanical piping, plumbing piping and fire protection piping shall be overlaid and drafted onto the composite drawing. In renovation areas, contractor shall revise existing structural and architectural backgrounds as required to resolve conflicts to match field conditions exposed during demolition operations. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of any work.
 - 2. In area of congestion (where simply overlaying and drafting will create an unreadable product) the plan view scale shall be increased and/or multiple layered views shall be developed. Elevations of the individual elements shall be established and elevations shall be drawn to illustrate that the ductwork, piping, conduit, etc. will co-exist within the available space and that the proper access to equipment, valves, filters, etc. has been established for operation, service, removal and replacement.
 - 3. The completed "Composite Drawings" shall be submitted to the architect for review prior to installation. Any work that proceeds without appropriate coordination and review will be subject to removal and relocation at no additional cost.

1.7 INTERFERENCE DRAWINGS

- A. Interference drawings are drawings that indicate conflict between the various systems and other components of the building such as beams, columns, walls, etc. They shall be drawn to scale and shall include plans, elevations, sections and other details as required to clearly define the interference and to indicate the contractor's proposed solution.
- B. They shall be submitted for approval whenever job measurements and an analysis of the drawings and specifications by the contractor indicate that the various systems cannot be installed without significant deviation from the intent of the contract. When such interference is encountered, work shall cease in the general area of the conflict until a resolution to the question has been approved.

1.8 GUARANTEE

- A. Guarantee work for one year from the date of final acceptance of the project. During that period make good any faults or imperfections that may have arisen due to defects or omissions in materials or workmanship.

1.9 SERVICE

- A. Perform service work required during the guarantee period including lubrication of bearings. Perform manufacturer's recommended monthly service and provide Owner with written report. Cleaning of air filters and pipe strainers is not included.

1.10 RESOLUTION OF CONFLICTS

- A. Where conflicts may exist between and/or within the drawings and/or specifications, the higher quality, greater quantity, more restrictive, and/or more expensive requirement shall be required and shall be the basis of Contractor pricing. The Contractor shall notify the A/E for resolution of the issue prior to executing the work in question.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacture, where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are listed in individual Sections of Division 23. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.
- B. Manufacturers' names and catalog numbers specified under Sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition.
- C. Equipment of similar design, equal to that specified, manufactured by a manufacturer named in the acceptable manufacturers' list will be acceptable on approval.
- D. Substitutions:
 - 1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/ Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.
 - 2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
 - 3. The Architect/Engineer will not give approval to material salesmen or subcontractors, and only in writing to the successful Contractor after the project has been awarded.
 - 4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
 - 5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.

6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.
7. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural or architectural, which may result from the substitution.
8. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.

2.3 NOISE AND VIBRATION

- A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate (without cost to the Owner) that equipment performs within designated vibration limits indicated in the specifications, or as specified by manufacturer.
- B. Seal all wall and partition penetrations (the penetration opening shall be one inch larger than penetrating member) by ducts and piping by stuffing the annular void with fiberglass insulation and then caulking over fully with a non hardening acoustical caulking applied to both sides of wall or partition.

2.4 AIR FILTERS AND PIPE STRAINERS

- A. Immediately prior to final acceptance of project, inspect, clean and service hydronic system strainers and replace disposable type air filters.
- B. Turn over to Owner additional sets of spare filters and other spare parts as specified.

2.5 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Cooperation with Other Trades: Cooperation with trades of adjacent, related, or affected materials or operations and of trades performing continuations of work under subsequent contract is considered a part of this work in order to effect timely and accurate placement of work and to bring together in proper and correct sequence the work of such trades.
- B. Workmanship: Work must be performed by workmen skilled in their trade.

- C. Installation of all equipment and materials must be complete. Installation shall meet requirements of specifications and manufacturer's recommendations.
- D. Electrical Wiring of Motors and Equipment. The Contractor shall note that the electrical design was based upon the mechanical equipment indicated on the mechanical construction documents and specifications. If Contractor proposes any mechanical equipment that requires changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.2 SPACE REQUIREMENTS

- A. Consider space limitations imposed by contiguous work, including clearances required for service, in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
- B. The following space allocation and coordination shall be followed, unless otherwise indicated on the construction drawings:
 - 1. Gravity-fed plumbing and roof drain line shall take priority over all other systems.
 - 2. Light fixtures and cable tray arrangements shall take priority in spatial layout. In areas with ceilings, other systems shall be routed above the light fixtures, and offset from above cable tray allowing for access and maintenance clearance.
 - 3. Install HVAC ductwork as close to the bottom of structural framing as possible while allowing clearance for installation of insulation wrap. Install ductwork to be accessible from the ceiling plane.
 - 4. Install HVAC chilled/hot water piping in the plane directly below HVAC ductwork unless indicated otherwise on drawings.
 - 5. Install fire sprinkler piping in the plane directly beneath the HVAC chilled/hot water piping. Do not install sprinkler piping directly below equipment requiring maintenance.
 - 6. Install domestic hot and cold water in the plane directly above the light fixtures.
 - 7. Refer to Division 26 for electrical and control wiring requirements.
 - 8. Install piping to permit removal of coils at air handling units and to permit access to all terminal unit components.

3.3 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.
- C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- D. Assume total responsibility for and repair any damage to existing utilities or construction.

3.4 OPENINGS

- A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.5 DELIVERY, STORAGE AND HANDLING

- A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.
- B. Cover all equipment stored exposed to elements with waterproof tarps, provide adequate ventilation.
- C. At work completion, all work must be clean and in like new condition.
- D. Storage of all mechanical equipment, piping materials and ductwork shall be in strict accordance with manufacturers written installation instructions.
- E. Rotate air handler fans and pump shafts on routine basis.
- F. Provide factory installed pipe caps for all pipes to be installed on the project.
- G. Provide covers over all openings in ductwork stored or installed on the project.
- H. Energize motor heaters with temporary power as soon as the motor is received on site.
- I. Air Handling Units shall not be used as storage containers

3.6 LUBRICATION AND OIL

- A. Provide a complete charge of correct lubricant and/or oil for each item of equipment requiring lubrication.

3.7 CUTTING AND PATCHING

- A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.
- B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer.
 - 1. Do not use impact-type equipment except where specifically acceptable to the Architect/Engineer.
 - 2. Core drill openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., to exact size.
- C. Restoration: Restore all openings to "as-new" condition under the appropriate Specification Section for the materials involved
- D. Match remaining surrounding materials and finishes.
- E. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.

- F. Provide adequate support during cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.
- G. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.8 OPERATING TESTS

- A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner's Representative.
- B. Prove operations of control systems and all safeties, freezestats and alarms.
- C. Make adjustments as required to ensure proper functioning of all systems.
- D. Special tests on individual systems are specified under individual Sections.

3.9 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings in accordance with Specification 01 78 23. Detailed requirements for these items are as follows:
 - 1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
 - a. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
 - b. Special tools and equipment required for testing and maintenance.
 - c. Parts lists reflecting the true manufacturer's name, part number and nomenclature.
 - d. Recommended spares by part number and nomenclature and spare stocking levels.
 - e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
 - f. Troubleshooting, checkout, repair and replacement procurement procedures.
 - g. Operating instructions including start up and shutdown procedures.
 - h. Safety considerations including load limits, speed, temperature and pressure.
 - 2. Provide O&M manuals for all HVAC equipment.

3.10 PROJECT RECORD DOCUMENTS

- A. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.
- B. Mark the drawings with a colored pencil.

- C. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed.
- D. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.
- E. At conclusion of project, obtain without cost to Owner, reproducibles of original mechanical drawings and transfer as-built changes to these.
- F. Delivery of as-built prints and reproducibles is a condition of final acceptance.

END OF SECTION

SECTION 23 05 19

GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes the following for hydronic piping:
 - 1. Thermometers.
 - 2. Gauges.
 - 3. Pressure and Temperature Taps.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated, submit detailed shop drawings and manufacturer's data, including:
 - 1. Measurement tolerances.
 - 2. Range.
 - 3. Accuracy.
 - 4. Device dimensions and connection sizes (include schedule indicating stem length versus pipe diameter).
 - 5. Scales.
 - 6. Materials of construction.
 - 7. Valves that will be used for isolating gauges.
- B. Submit a schedule for each device to be installed, including:
 - 1. Location.
 - 2. Pressure or temperature range of device and fluid measured.
 - 3. Temperature or pressure of fluid.
 - 4. Pipe size and bulb length of thermometers.
 - 5. Type of valve used with the Pressure Gauge.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Thermometers: Calibrate against standards traceable to the NIST and guaranteed accurate to plus or minus one scale division.
- B. Pressure Gauges: ASME B40.1 Grade 2A accuracy 0.5 percent of scale range.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products meeting all requirements of this specification Section of the following manufacturers are acceptable:
 - 1. Thermometers: Ashcroft, Dwyer, Marsh Instrument, Trerice, Weiss, Weksler
 - 2. Pressure Gauges: Ashcroft, Dwyer, Trerice, Weiss, Weksler
 - 3. Pressure/Temperature Taps: Peterson Engineering Company, Sisco or Trerice

2.2 BIMETAL THERMOMETERS

- A. Construction: All stainless steel bi-metal type construction with 5 inch dial.

- B. Window: Glass.
- C. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- D. Dial: Black figures on white background with black pointer.
- E. Stem: Stainless steel thermowell installation, ¼-inch diameter, minimum 2-1/2 inch straight or angle form of length to suit installation.
- F. Coil: Bimetallic, hermetically sealed with silicone dampened
- G. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.
- H. Furnish thermometers for services in the following ranges and divisions:
 - 1. Chilled Water: 0 to 100 degrees F or 25 to 125 degrees F, 1 degree divisions
 - 2. Heating Hot Water: 20 to 240 degrees F, 2 degree divisions
 - 3. Condenser Water: 25 to 125 degrees F, 1 degree divisions
 - 4. Process Chilled Water: 0 to 100 degrees F or 25 to 125 degrees F, 1 degree divisions

2.3 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Brass or stainless steel with pressure and temperature ratings suitable for their application. Wells for insulated piping shall have a 2-1/2 inch lagging protrusion. Locate thermometer wells so the sensing bulb will give a true and correct reading. Install thermometer so as not to cause undue restriction in small piping. Where wells are located in pipelines 1-1/2 inch and smaller, provide a section of pipe of such diameter that the net area of the pipeline will not be reduced by the thermometer well.

2.4 PRESSURE GAUGES

- A. Direct-Mounting, Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.
 - 1. Case: Liquid-filled type, polypropylene case, 4-1/2 inch diameter, solid front with blow-out back.
 - 2. Bourdon Tube: Bronze or 316 stainless steel with brass or stainless steel socket.
 - 3. Movement: 300 series stainless steel rotary type with stainless steel bushings
 - 4. Dial: White face with black figure.
 - 5. Pointer: Red or black, micro adjustable.
 - 6. Window: Molded Acrylic.
 - 7. Ring: Metal.
 - 8. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
 - 9. Gauge Ranges
 - a. Provide 0 - 160 psi gauges for 150 psi chilled/hot water service.
 - 10. Provide liquid filled gauges for all pressure gauges.
- B. Pressure-Gauge Fittings:
 - 1. Valves: NPS 1/4 brass or stainless-steel needle type.
 - 2. Siphons: NPS 1/4 coil of brass or stainless steel tubing with threaded ends.
 - 3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 PRESSURE AND TEMPERATURE TAPS:

- A. Taps. Provide 1/2" solid brass fittings which will receive either a pressure or temperature probe, with valve core of Nordel and fitted with a color coded cap and gasket. P/T Taps shall be rated for 275 degrees F. and 1000 psig. Provide long stem type for insulated pipe.
- B. Instruments. Provide two each, No. 500 "Pete's Plug" pressure gauge adapters with four gauges and probes and four each 5" stem pocket thermometers: Two each, thermometers for chilled water, heating and domestic hot water systems, when applicable. Applicable meaning the system is being installed as part of the project. "Pete's Plugs" to match insulation thickness.

PART 3 - EXECUTION

3.1 THERMOMETER INSTALLATIONS

- A. Provide thermometers and thermometer wells in the following locations:
 - 1. Inlet and outlet of each air handling unit coil connection.
 - 2. Inlet and outlet of for supply and return connections of each heat exchanger.
 - 3. As shown on Drawings and control schematics.
- B. Install direct-mounting thermometers and adjust vertical and tilted positions.
- C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

3.2 GAUGE INSTALLATIONS

- A. Provide pressure gauges in the following locations:
 - 1. Suction and discharge side of each pump.
 - 2. Each hydropneumatic tank.
 - 3. Inlet and outlet of each air handling unit coil.
 - 4. Supply and return piping connections of coils (where shown on details).
 - 5. Inlet and outlet of each heat exchanger vessel.
 - 6. As shown on Drawings and control schematics.
- B. Install direct-mounting pressure gauges in piping tees with pressure gauge located on pipe at most readable position.
- C. Install needle-valve in piping for each pressure gauge for fluids.
- D. Install snubber for gauges associated with pumps.
- E. Provide fittings as necessary to install pressure gauge in the vertical position.

3.3 PRESSURE AND TEMPERATURE TAP INSTALLATIONS

- A. Provide pressure and temperature taps at the following locations:
 - 1. Inlet and outlet of each coil connection.
 - 2. Inlet and outlet of each hydronic control valve
 - 3. Inlet and outlet of for supply and return connections of each heat exchanger.
 - 4. Where shown in details on mechanical drawings.
- B. Provide liquid filled gauges upstream and downstream of all pumps.

3.4 CONNECTIONS

- A. Install thermometers and gauges adjacent to machines and equipment to allow service and maintenance for thermometers, gauges, machines, and equipment. Thermometer

3.5 ADJUSTING

- A. Adjust faces of meters and gauges to proper angle for best visibility.

END OF SECTION

SECTION 23 05 23

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for furnishing and installing chilled water piping, valves and appurtenances, including fittings and strainers.
- B. Related Sections:
 - 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
 - 2. Section 23 05 53, Identification for HVAC Piping and Equipment, for valve tags and schedules.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data showing compliance with requirements of Part 2. Clearly indicate piping, equipment, materials of construction, pressure rating and which options are to be provided.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect all piping, valves, fittings, etc. before installation in accordance with manufacturer's written instructions.
- B. Piping shall be sent from the factory with capped ends and shall be stored on supports off of the ground with ends covered to prevent nesting of insects, birds and other animals, or the accumulation of dirt and debris in and around the piping components.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.

4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 1. Ball Valves: Provide an insulated stem extension.
 2. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Solder Joint: With sockets according to ASME B16.18.
 3. Threaded: With threads according to ASME B1.20.1.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Check Valves: Apco, Crane, Kitz, Mission, Milwaukee, Mueller, Nibco, Powell, Stockham and Weco.
 2. Butterfly Valves: Bray, Clow, Demco, DeZurik, Crane, Kitz, Milwaukee, Nibco, Pratt, or Stockham.
 3. Ball Valve: Apollo, Crane, DeZurik, Kitz, Milwaukee, Nibco, or Watts.
 4. Strainers: Armstrong, Keckley, Mueller Spirax or Watts.

2.3 CHECK VALVES

- A. For pipe 2 inches in diameter and smaller, furnish 150-pound (class 150) screwed, horizontal, swing check valve, all bronze construction, with screwed cap.
- B. For pipe 2-1/2 to 10 inches in diameter, provide 125-pound (class 125), lugged style, drill and tapped, double door valve, with cast iron body and aluminum bronze doors, Buna-N seat, and Type 316 stainless steel spring.
- C. For pipe 10 inches in diameter and larger, provide 125-pound (class 125), raised-face, lugged style silent check valve, with cast iron body and aluminum bronze twin disc, Buna-N seat, steel lifting eye bolt, and Type 316 stainless steel hinge pin, stop pin, thrust bearing and spring.

2.4 BUTTERFLY VALVES

- A. For pipe 2-1/2 through 12 inches in diameter, furnish 200-pound flanged or tapped lug type butterfly valve with ductile iron body, stainless steel stem, aluminum-bronze disc with EPDM liner. Provide lever-operated valves 6 inches and smaller. Furnish valves 8 inches and larger with totally enclosed worm gear operators. Provide valves with enclosed worm gear operators with chain wheel and chain on valves installed higher than 84 inches above floor. Use valves designed for drip-tight shutoff in dead end service against 200 psi.
- B. For 14 inch diameter pipe and larger, employ 150-pound, full-flanged or tapped lug butterfly valve with ductile iron body, stainless steel stem, and aluminum bronze disc with EPDM liner. Provide totally enclosed worm gear operators for all valves. Provide valves with enclosed worm gear operators with chain wheel and chain on valves 84 inches above floor or as indicated on drawings. Provide valves designed for drip tight shutoff in dead end service against 150 psi.

- C. Where balancing valve is shown, provide butterfly valve with position lock operator (memory stop) for valves 6 inches and smaller and worm gear operator with memory stop for valves 8 inches and larger.

2.5 BALL VALVES

- A. For pipe 2 inches in diameter and smaller, provide 600 psi WOG screwed, two piece bronze or forged brass body, Teflon seat, full port, stainless steel stem and ball. Provide extension stem and insulated handle for valves installed in insulated piping. Where ball valves are used as balancing valves, provide valve with memory stop.

2.6 STRAINERS

- A. For pipe 2 inches in diameter and smaller, use 125-pound (class 125) cast bronze screwed Y-type strainer with 12-mesh stainless steel screen. Provide full size blowoff ball valve where shown on drawings.
- B. For pipe 2-1/2 inches and larger, provide 150-pound (class 150) cast steel or iron flanged Y-type strainer with 0.045 inch stainless steel screen through 4, and 1/8 inch stainless steel screen for 6 inches and larger. Provide full size blowoff ball valve where shown on drawings.

PART 3 - EXECUTION

3.1 STORAGE:

- A. Protect all piping, valves, fittings, etc. before installation in accordance with manufacturer's written instructions. All piping shall be sent from the factory with capped ends and shall be stored on supports off of the ground with ends covered to prevent nesting of insects, birds and other animals, or the accumulation of dirt and debris in and around the piping components.

3.2 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.3 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.

- C. Provide clearance for access to valves, fittings and equipment for operation and maintenance.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement and with operators and stems upright or horizontal.
- F. Install chainwheels on operators for butterfly gate and globe valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor.
- G. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.
- H. All piping shall be clean when it is installed.
- I. Check Valves. Install lugged check valves between flat flange and full-face gasket. Install check valves a minimum three to four pipe diameters downstream of pump discharge or elbows to avoid flow turbulence.

3.4 ISOLATION VALVES

- A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor and at branch takeoffs serving equipment, and at other locations as indicated and required for isolation of piping or equipment.
- B. At air handling units, where multicoil (stacked) arrangement is used, provide each supply and return line to and from each stacked coil section with a union, pressure gauge and thermometer well and a balancing valve (with memory stop) for balancing, and valves for isolation of each coil.

3.5 DRAIN VALVES AND VENTS

- A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained.
- B. Install 2 inch drain for 2 inch pipes and larger.
- C. Install a line size drain valve for pipes smaller than 2 inches.
- D. Provide hose adapter and cap on all drain lines.
- E. Provide automatic vents with isolation valves or manual vents at locations as indicated on Drawings and all high points in piping systems.

3.6 TESTING

- A. Apply a hydraulic pressure 1-1/2 times the operating pressure, 150-psig minimum, and carefully check for leaks.
- B. Remove or isolate valves, expansion joints, strainers and equipment that are rated at pressures less than test pressure.
- C. Repair all leaks and retest the system until proven leak tight.

3.7 ADJUSTING

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

END OF SECTION

SECTION 23 05 48

VIBRATION ISOLATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for furnishing, installing, and adjusting vibration isolation, for mechanical equipment and piping, including bases of structural steel and concrete, with steel pouring forms and concrete reinforcing bars.
- B. Related Sections Include:
 - 1. Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.
 - 2. Section 23 21 13, Hydronic Piping and Fittings.
 - 3. Section 23 34 13, Fans.

1.2 SUBMITTALS

- A. Product Data: Submit product data showing type, size, load, deflection, and other required information. Include clearly outlined procedures for installing and adjusting isolators. Submit Drawings for each item of equipment with complete isolation installation information.
- B. Submit detailing of inertia bases and locations of vibration, including weight of inertia base.

1.3 QUALITY ASSURANCE

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

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 10.
- B. Include copies of approved submittals and any submittal comments.
- C. Provide tab for each major type of equipment (fan coil units, pumps, piping, fans, etc.). Provide schedule of vibration isolator type with location and load on each. Include data on each isolator type that corresponds to:
 - 1. Spring diameter.
 - 2. Deflection.
 - 3. Compressed spring height.
 - 4. Point location of each isolator.
 - 5. Calculated load at each point.
 - 6. Field static deflection.
- D. Include copy of written certification from factory representative as required in Part 3 of this specification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
 2. Kinetics Noise Control
 3. Korfund Dynamics
 4. Mason Industries.
 5. Metraflex
 6. Vibration Eliminator Co., Inc.

2.2 ISOLATOR DESIGN

- A. Materials:
1. Design and treat vibration isolators for resistance to corrosion.
 2. Steel components shall be PVC coated or phosphatized and painted with industrial-grade, corrosion-resistant enamel.
 3. Furnish zinc-electroplated or cadmium plated nuts, bolts and washers.
 4. All isolators exposed to the weather shall have the steel parts hot dip galvanized and a PVC coating.
 5. Clean steel bases thoroughly of welding slag and prime with zinc-chromate or metal etching primer.
- B. Design:
1. Unless otherwise instructed, use spring-type vibration isolators for all equipment driven by motors of 3 horsepower and larger.
 2. The isolator manufacturer must calculate the amount of spring deflection required for each isolator to achieve optimum performance and to prevent the transmission of objectionable vibration and noise.
 3. Isolators must be sized for starting torque of equipment motors.
 4. The following minimum spring deflections apply unless noted otherwise in the specifications:

BELT DRIVEN EQUIPMENT

Motor Size Horsepower	Installation Above Grade	Installation at Grade or Below
5 – 10	1"	1"
15 – 30	1-1/2"	1"
40 – 75	2"	1-1/2"

DIRECT DRIVEN EQUIPMENT

Motor Size Horsepower	Installation Above Grade	Installation at Grade or Below
5 – 20	1"	1"
25 – 75	1"	1"

5. All spring isolators must be completely stable in operation and must be designed for not less than 30 percent reserve deflection beyond actual operation conditions.
6. Height saving brackets used with isolators having 2-1/2 inch deflection or greater shall be of the precompression type to limit exposed bolt length.

2.3 ISOLATOR TYPES

- A. Design of isolator types listed is based on model numbers manufactured by Kinetics Noise Control, unless otherwise indicated. Subject to compliance with requirements provide named product.
- B. Type SH: Spring hanger consisting of a rectangular steel box, coil spring, spring retainers, neoprene-impregnated fabric washer, and steel washer.
- C. Type NGS: Pad-type mounting consisting of two layers of 3/8 inch thick ribbed or waffled neoprene pads bonded to a 16-gage galvanized steel separator plate. Size pads for approximately 20 to 40 psi load and a deflection of 0.1 inch to 0.16 inch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
- D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- E. Install motor driven equipment with vibration isolators as indicated in schedule below.
- F. Isolate pumped water-piping systems with spring-type vibration isolators as indicated in schedule.
- G. All open-type spring isolators shall be restrained as recommended by the manufacturer.

3.2 APPLICATION

- A. The following is a schedule of equipment and piping on a typical project that requires vibration isolation and base isolators of the types specified. Refer to Drawings for equipment scheduled for the Project. Any equipment, system or condition that may be altered, added, or changed; or that is not specifically described in the Contract Documents shall be isolated in a manner specified for similar equipment, system or condition in order to comply with these Specifications.
- B. Provide isolation for the following equipment:

Equipment	Isolator Type	Minimum Deflection (inches)
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Equipment	Isolator Type	Minimum Deflection (inches)
Fan Coil Units: Floor Mounted	NGS	0.1 – 0.16

C. Provide isolation for the following piping systems:

Piping Systems	Isolator Type	Minimum Deflection (inches)
<u>Piping in Pump Rooms:</u> Chilled Water Piping – First two hangers adjacent to pumps	SH	Equal to Equipment Isolation
Chilled Water Piping – All piping 1-1/2 inches and larger, except first two hangers adjacent to pumps	SH	1
<u>Fan Coil Units:</u> First two hangers adjacent to equipment	SH	1

3.3 STOCK REQUIREMENTS

A. The isolation manufacturer's representative must maintain an adequate stock of springs and isolators of type used so that changes required during construction and installation can be made.

3.4 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.5 FACTORY REPRESENTATION:

A. After installation, furnish factory-trained representative of the isolation manufacturer to check various isolators and report measured versus anticipated deflection on all isolators. Have the representative submit written certification that the isolators have been installed in accordance with the specifications, manufacturer's recommendations and approved submittals

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.
 - 7. Duct labels.

1.2 SUBMITTAL

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.4 RELATED WORK

- A. Painting. Division 09.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 10.
- B. Valve Tags
 - 1. Provide valve charts listing functions of each valve in a metal frame and behind glass placed as directed by Owner
 - 2. For each valve tag, indicate service, function, valve position (NC or NO), floor, room location and nearest column numbers.
- C. Equipment Labels

1. Provide three ring binder including equipment label information (8-1/2 x 11 inch paper).
2. Each type of equipment (pumps, AHUs, etc) shall be individually tabbed in the binder.
3. For each item of equipment to be labeled, provide equipment identification number, floor, room location, and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufactures: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Marking Services, Inc.
 3. Seton Identification Products.

2.2 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: Black.
 3. Background Color: Background to contrast with letter color.
 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch x 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.3 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Background to contrast with letter color.
- D. Maximum Temperature: Able to withstand temperatures up to 160°F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch x 3/4 inch.

- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering 2/3 to 3/4 the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.5 DUCT LABELS

- A. Identify ductwork with stencil.
- B. Letter Color: Black.
- C. Lettering Size: At least 1-1/2 inches high.
- D. Paint: Shall meet VOC requirements per Division 09 painting specification.
- E. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

2.6 VALVE TAGS

- A. Provide valves with 1 1/2 inch diameter stainless steel or brass valve tag with stamped and black-filled numbers. Service designations shall be 1/4 inch letters, and valve numbers shall be 1/2 inch letters. Service designations shall be approved by Architect/Engineer. Secure tags to valves by use of brass "S" hooks and brass chain. Secure chain to valve by use of copper or monel meter seals.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment. Use fasteners for all equipment labels where possible. Where it is not possible to use fasteners, use adhesive.
- B. Locate equipment labels where accessible and visible.

3.3 VALVE TAG

- A. Install valve tags for all major valves. This shall include branch isolation and balancing valves, isolation valves for equipment such as air handling units, pumps, chillers, etc.
- B. Do not provide valve tags for isolation valves directly adjacent to fan coil units and terminal boxes.

3.4 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. Do not label drain piping where the floor drain is located adjacent to the equipment.
- B. Provide pipe labels for the following piping systems:
 - 1. Chilled Water Systems
 - 2. Drain lines
 - 3. Refrigerant Piping

3.5 DUCT LABEL INSTALLATION

- A. Identify ductwork with stencil.
- B. Identify exhaust fan number, air handling unit number, service and area served.
- C. Locate identification at air handling unit or fan, at each side of penetration of structure or enclosure at each obstruction, every 20 feet on long horizontal runs. Provide identification for the following ductwork:
 - 1. All supply air ductwork served by Air Handling Units
 - 2. All outside air ductwork, including pretreated outside air ducts.
 - 3. All return air ductwork, not including return air boots and transfer ducts.

END OF SECTION

SECTION 23 07 00
INSULATION - GENERAL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section specifies the general requirements for furnishing and installing insulation. These requirements apply to all other Mechanical Division sections specifying insulation.
- B. All the ductwork and piping in pump rooms, mechanical rooms and equipment rooms including areas without ceilings is to be considered as exposed piping or ductwork

1.2 RELATED WORK

- A. Internal insulation for air units is specified in the sections on air handling units. The units do not require external insulation.
- B. Insulation. Refer to specific sections on individual insulation types.
- C. Section 09900 or 09901, Painting.

1.3 FIRE HAZARD RATING

- A. All equipment, duct and piping insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements.

1.4 QUALITY ASSURANCE:

- A. Applicator shall be a company specializing in insulation application with minimum 5 years' experience.

1.5 SUBMITTALS

- A. Product Data. Submit product data on each insulation type, adhesive and finish to be used in the work. Include manufacturer's installation instructions, list of materials and thickness for equipment scheduled.
- B. Samples. Make an application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with the work.
- C. Shop Drawings: Show details for the following:
 - 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Attachment and covering of heat tracing inside insulation.
 - 3. Insulation application at pipe expansion joints for each type of insulation.
 - 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Removable insulation at piping specialties, equipment connections, and access panels.

6. Application of field-applied jackets.
7. Application at linkages of control devices.
8. Field application for each equipment type.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are listed under individual specification sections.

2.2 INSULATION

- A. Insulate in accordance with appropriate specification section.

PART 3 - EXECUTION

3.1 COMMON INSULATION REQUIREMENTS

- A. All materials shall be delivered to the site shall be dry, undamaged and maintained in good condition throughout the progress of the project.
- B. Insulation shall not be installed until all testing and inspection of pipe, duct, vessel, etc. has been completed and approved by Engineer/Owner's representative.
- C. Insulate valves, fittings, flanges and special items in accordance with appropriate specification section.
- D. Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also replace any damage caused by the condensation.
- E. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- F. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- G. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- H. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- I. Install multiple layers of insulation with longitudinal and end seams staggered.
- J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- K. Keep insulation materials dry during application and finishing.
- L. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- M. Install insulation with least number of joints practical.

- N. Where vapor barrier is indicated, seal joints, duct wrap seams, vapor retarder (ASJ) film seams and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier coating/mastic.
1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier coating/mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

3.2 ACCESSORIES

- A. Installation of accessories such as jacketing, bands, adhesives, insulation shields, coatings, finishes, etc. is specified under individual specification sections.

END OF SECTION

SECTION 23 07 13

EXTERNAL DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section provides for furnishing and the installation of external insulation on concealed and exposed ductwork, including single wall supply ductwork, outside air ductwork, and relief and return air duct work in non air conditioned spaces and other miscellaneous ductwork. It also includes insulating the tops of all supply diffusers.
- B. All the ductwork exposed to view in public spaces, in mechanical and pump rooms, crawl space and equipment rooms including all areas without ceilings is to be considered as exposed ductwork.
- C. Consider space above ceilings air conditioned if floor above is air-conditioned or if the space is a return air plenum.

1.2 RELATED WORK

- A. Section 23 07 00, Insulation - General.
- B. Section 23 31 13, Ductwork.

1.3 REFERENCES STANDARDS

- A. ASTM C 411 - Temperature Range.
- B. ASTM C 553 - Mineral Fiber Blanket and Felt Insulation.
- C. ASTM C 612 - Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM C 1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
- E. ASTM E 96 Procedure A - Jacket Vapor Transmission.
- F. ASTM E 119 – Standard Method of Fire Test of Building Construction and Materials.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Fiberglass:
 - 1. CertainTeed.
 - 2. JohnsManville.
 - 3. Owens-Corning.
 - 4. Knauf Insulation.

2.2 INSULATION

- A. Type D2, Semi-Rigid Glass Fiber Insulation: Provide semi-rigid glass fiber insulation adhered to UL labeled, reinforced foil scrim kraft (FSK) facing vapor barrier on the outside surface, 2.5 pound per cubic foot density. A K factor of 0.24 at 75°F mean is required.
- B. Type D3, Rigid Glass Fiber Insulation: Provide rigid board glass fiber duct insulation with integral, UL labeled, reinforced foil scrim kraft (FSK) facing vapor barrier on the outside surface, minimum density of 3 pounds per cubic foot. A “K” factor of 0.23 at 75°F mean is required.

2.3 COATINGS AND ADHESIVES

- A. Glass Fiber Insulation
 - 1. Coating. Foster 30-80 or Childers CP-38 vapor barrier coating. Permeance shall be 0.013 perms or less as tested by ASTM E96/ASTM F1249. Coating must comply with MIL-C-19565C, Type II and be QPL listed.
 - 2. Adhesive. Fosters 85-60 or Childers CP-127 adhesive. Product must comply with ASTM C916 and ASTM E84 25/50 requirements.
- B. Reinforcing Mesh. Fiberglass or polyester, 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10.

PART 3 - EXECUTION

3.1 GENERAL

- A. Do not apply insulation until ductwork has been tested.
- B. Verify surfaces are clean, foreign material removed, and dry.
- C. Where trapeze hangers are used, provide strip of non-compressible insulation between ductwork and hanger.

3.2 FIRE SAFETY REQUIREMENTS

- A. Do not extend duct coverings through walls or floors required to be fire stopped or required to have fire resistance rating. Interrupt duct coverings in the immediate vicinity of heat sources such as electric resistance or fuel-burning heaters.

3.3 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air ductwork.
 - 2. Indoor, exposed supply and outdoor air ductwork.
 - 3. Indoor, concealed & exposed return air ductwork, from connection of outside air ductwork to air handling unit.
- B. Air Devices:
 - 1. Supply Diffuser.
 - 2. Uninsulated Plenums on Slot Diffusers and Linear Bar Grilles.
- C. Items Not Insulated:
 - 1. Indoor, concealed return air ductwork (in chases, above ceilings, except as noted above).

2. Indoor, exposed return air ductwork (in chases, mechanical rooms except as noted above).
3. Flexible connectors.
4. Double wall ductwork.

D. Definitions

1. Oval ductwork shall be insulated the same as round ductwork.
2. Outside air duct shall be considered ductwork (or plenum) from louver or intake hood to air handling unit.
3. Pretreated outside air shall be insulated the same as supply ductwork.

3.4 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE

- A. Provide insulation with minimum thickness and installed “R” valves in accordance with ASHRAE Standard 90.1-2010 Tables 6.8 2A & B, but not less than thickness specified in this specification and as required to prevent condensation:

Ductwork System	Application	Insulation Type	Insulation Thickness
Supply & Outside Air – Rectangular (Hot, Cold, Combination)	Exposed Ductwork	D3	2”
Supply & Outside Air – Round (Hot, Cold, Combination)	Exposed Ductwork	D2	2”
Return Air, Relief Air, and Exhaust Air – Rectangular	Exposed, Where Scheduled	D3	1”
Return Air, Relief Air, and Exhaust Air - Round	Exposed, Where Scheduled	D2	1”

3.5 TYPE D2, SEMI-RIGID GLASS FIBER INSULATION

- A. All exposed ductwork in public areas and mechanical rooms shall be wrapped in accordance with manufacturer's recommendations. Firmly butt all joints together and seal longitudinal laps of factory-applied vapor barrier jacket with adhesive. Cover butt joints with a 4 inch wide strip of factory-supplied vapor barrier jacket facing adhered with adhesive. Cover all seams, joints, pin penetrations and other breaks with two coats of vapor barrier coating and reinforcing mesh.

3.6 TYPE D3, RIGID GLASS FIBER INSULATION

- A. Exposed ductwork shall be covered with rigid board insulation in accordance with manufacturer's recommendations.
- B. Fill and point up all joints, perforations and exposed edges with two coats of vapor barrier coating reinforced with reinforcing mesh. Coating shall completely cover and conceal mesh.
- C. Securely fasten insulation to metal surface with adhesive and mechanical fasteners on 12 inch centers.

- D. Sheet metal screws and discs or other approved fasteners may be used. In addition, secure insulation to the bottom of rectangular horizontal ductwork and on vertical ductwork over 24 inches wide by the use of mechanical fasteners at no more than 18 inches on center. Weld stick clips to duct work to secure insulation. Adhesive applied stick pins are not acceptable.

3.7 STANDING SEAMS

- A. Insulate standing seams and stiffeners which protrude through insulation with 3-pound density, 1-1/2 inch thick, faced duct insulation, flexible blanket or rigid insulation to match duct insulation. As a vapor seal on exposed edges, use glass cloth with vapor barrier coating. Insulation should not prevent adjustment of damper operators.

END OF SECTION

SECTION 23 07 19
PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Piping insulation for Chilled Water Piping within building envelope.
 - 2. Primary and Secondary chilled water piping shall be considered chilled water piping in these specifications.
 - 3. Furnishing and installation of insulation.
 - 4. Jackets and accessories.
 - 5. Refrigerant piping insulation.

1.2 REFERENCES

- A. ANSI/ASTM C 195 - Mineral Fiber Thermal Insulation Cement.
- B. ANSI/ASTM- C 547 - Mineral Fiber Preformed Pipe Insulation.
- C. ANSI/ASTM C 552 - Cellular Glass Block and Pipe Thermal Insulation.
- D. ASTM B 209 - Aluminum and Aluminum-alloy Sheet and Plate.
- E. ASTM C 449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.

1.3 QUALITY ASSURANCE

- A. Applicator. Company specializing in piping insulation application with five years minimum experience.
- B. Materials. UL/ULC Classified per UL 723 or Flame spread/fuel contributed smoke developed rating of 25/50 in accordance with ASTM E84.

1.4 SUBMITTALS

- A. Refer to Specification 23 07 00.
- B. Submit product data on insulating materials, including manufacturer's safety and installation instructions.
- C. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexible Elastomeric
 - a. Armacell; AP Armaflex.
 - b. RBX Corporation.
 - 2. Phenolic Foam
 - a. Dyplast

- b. Resolco Insulphen
- c. ITW

2.2 INSULATION

- A. Type P2. Furnish closed-cell expanded rubber materials complying with ASTM C534, Type 1 for tubular materials. Insulation shall have a maximum “K” factor of 0.27 Btu-in./h-ft²- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
- B. Type P5. Furnish minimum 2.5-pound density rigid closed-cell phenolic foam insulation with factory applied all service reinforced vapor barrier (ASJ) jacket having integral laminated aluminum vapor barrier. Insulation shall be in accordance with ASTM C-1126 with a maximum “K” factor of 0.15 BTU-in/hr-ft²-°F at 75°F.

2.3 INSULATION SHIELDS AND SADDLES

- A. Field Fabricated:
 - 1. Use high compression strength Phenolic Foamglas blocks (HLB 1600) that will support the bearing area at hangers and supports.
 - 2. Further support insulation at hangers and supports with a shield of galvanized metal extending not less than 2 inches on either side of the support bearing area, covering at least half of the pipe circumference, and conforming to the schedule below.
 - 3. When pipe is guided at top and bottom, metal shields should cover the whole pipe circumference.
 - 4. Adhere metal shield to insulation so that metal will not slide with respect to insulation. Furnish vapor barrier and sealant where used on low temperature service (below 100°F).

Pipe Diameter	Insulated Section Length in Inches	Minimum U.S. Standard Gauge of Metal Shield
2 1/2" and smaller	14	16
3" to 4"	14	16
6" to 12"	24	14
14" and larger	24	12

- 5. At Contractor's option, factory-made insulation shields may be provided as made by Anvil Fig 168, equivalent by Pipe Shields, Inc., or equal. Insulation should extend at least 1 inch beyond metal. Select proper shield for service and pipe span.
- 6. For Type P2 insulation, factory-made insulation shields such as Armafix IPH may be used at Contractor's option.
- 7. For Type P5 insulation, use minimum 5 pound density insulation or denser as required by manufacturer at all pipe supports.
- B. Saddles: Fit piping 2 inches through 10 inches operating at high temperatures with Anvil Figure 161 through 164 protection saddles, or similar saddles of proper design for specified insulation thickness. Fit pipe sizes over 10 inches with Anvil Figure 163A through 165A or similar saddle as required by insulation thickness specified.
- C. All shields are to be secured by 2 stainless steel bands, 1/2 inch wide by 0.015 inch thick with matching seals

2.4 JACKETS

- A. Canvas or Glass Jackets and Lagging Adhesive/Coating: UL listed treated cotton fabric, 6 ounce/square yard or low odor glass cloth, Childers CP-50AMV1, Fosters 30-36 lagging adhesive or approved equal.

2.5 SEALANT, ADHESIVE AND FINISH

- A. Flexible Elastomeric
 - 1. Adhesive: Furnish Armaflex 520 BLV Low VOC Adhesive, Foster 85-75, or Childers CP-82 to seal longitudinal laps and to adhere butt joint covers.
 - 2. Finish: Furnish Armaflex WB or Foster 30-64 water based latex enamel finish.
- B. Phenolic Foam - Low Temperature (Below 70°F):
 - 1. Flashing Sealant: Furnish Childers CP 76 or Foster 95-44 elastomeric sealant at valve covers, anchors and hangers.
 - 2. Lap Adhesive: Furnish Childers CP-82 or Foster 85-20 to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers.
 - 3. [Vapor Barrier Coating: Furnish Childers CP-38 or Foster 30-80 with reinforcing mesh on all insulated fittings, flanges, and valves. Coating permeance shall be no greater than 0.013 perms at 43 mils dry as tested by ASTM E96. Coating must comply with MIL-C-19565C, Type II and be QPL listed. All ASJ seams shall be coated with vapor barrier coating to prevent moisture ingress. Outdoors: Foster 30-90; Childers CP-35 only. White]
 - 4. Reinforcing Mesh: Fiberglass or polyester. 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10

2.6 FITTINGS

- A. Provide pre-molded fittings and elbows molded in two matching half sections of same insulation thickness as adjoining piping. As an alternative, provide mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs. No insert or blanket insulation allowed.

2.7 PRIMER

- A. Polyguard RG-CHW for surface temperatures less than 130F, RG-2400 LT for piping with surface temperatures between 130F and 250F. Application thickness shall be 25 mils.
- B. Global Encasement Rust Inhibition Primer. Application thickness shall be minimum 3 mils (dry)
- C. Sherwin Williams Pro-Cryl Universal Acrylic Primer. Application thickness shall be minimum 3 mils (dry).

2.8 ALUMINUM JACKET

- A. Piping. Furnish for finishing interior insulated pipe, a prefabricated jacket of ASTM B209 aluminum, 0.020 inch thick, with factory-applied 2-mil moisture barrier.
- B. Valves, Fittings and Flanges. Provide complete coverage of all valves, fittings and flanges, provide aluminum covers, 0.020 inch thick, ASTM B209 aluminum.
- C. Straps and Seals. Furnish 1 inch x 0.010 inch, ASTM B209 aluminum strapping and seals for applying aluminum jacket and covers to provide completely weather tight covering of all insulation including caps, flanges and end of lines.

- D. Metal Jacketing Sealant: Furnish 1/8" bead of Foster 95-44 or Childers CP-76 underneath all metal jacketing laps to prevent water entry on outdoor applications.

PART 3 - EXECUTION

3.1 PIPE

- A. Pressure testing of piping systems shall be complete prior to application of insulation.
- B. Prior to insulating piping,
1. Remove all oil, grease, cutting oils, dirt and other contaminants. Use suitable solvents, steam cleaning with detergent, or fresh water wash with detergent. Follow with thorough fresh water rinse.
 2. Provide primer coat on all chilled and steel piping in accordance with manufacturer's recommendations, to include field welds and over factory applied paint/coating, in total compliance with mechanical identification section and compatible with and approved by the insulation manufacturer. Painting must be completed and approved prior to installation of insulation.
- C. Butt insulation joints firmly together. Seal longitudinal laps and butt strips with sealant.
- D. Type P5 Phenolic Foam - Low Temperature:
1. Where piping is interrupted by fittings, flanges, valves or hangers and at intervals not to exceed 25 feet on straight runs, an isolating vapor seal shall be formed between the vapor barrier jacket and the bare pipe by liberal application of the vapor barrier sealant to the exposed joint faces carried continuously down to and along 4 inches of pipe and up to an along 2 inches of the jacket.
- E. Type P2.
1. Provide finish as specified on all insulation.

3.2 VALVES, FLANGES AND FITTINGS

- A. Low Temperature:
1. Insulate all valves, flanges and fittings with molded fitting covers secured with wire. Thickness of insulation shall be equal to that adjoining piping.
 2. Finish with two coats vapor barrier coating reinforced with reinforcing mesh. The application shall provide a minimum dry film thickness of 37 mils.
- B. High Temperature:
1. Omit insulation at screwed unions and at valves smaller than 1-1/2 inches.
 2. On concealed (other than mechanical and pump rooms) piping, insulate fittings and valves 2-1/2 inches IPS and larger, with pre-molded fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with mastic reinforced with reinforcing mesh.
 3. On concealed piping, insulate fittings and valves 2 inches IPS and smaller with pre-molded fitting covers with a thickness equal to or greater than adjoining straight pipe. Finish with mastic reinforced with reinforcing mesh.
 4. In exposed (mechanical, pump and equipment rooms) area, insulate all fittings, flanges and valves with pre-molded fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with mastic reinforced with reinforcing mesh.
 5. Omit insulation on heating hot water flexible pump connectors or expansion joints.

3.3 CONTROL VALVE COVERS - LOW TEMPERATURE SERVICE ONLY

- A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.
- B. Seal covers to valve insulation proper with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve. Finish valve cover with two coats of vapor barrier coating and reinforcing mesh.

3.4 SHIELDS AND HANGERS

- A. When the insulation is jacketed in aluminum, install a length of 40-pound roofing felt 1/2 inch longer than the insulation shield between shield and jacket.
- B. Where piping hangers or anchors must be in direct contact with pipe, seal off the pipe insulation on both sides of the hanger by carrying the vapor seal down to the bare pipe. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe. Draw wire loops tight over the vapor barrier jacket, with ends of wire bent down. Take care to avoid puncturing the vapor seal. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.5 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Continue insulation with vapor barrier through penetrations.
- C. In exposed piping areas, locate insulation and cover seams in least visible locations. For outdoor installations seal jacket lap with 1/8" bead of metal jacketing sealant underneath each lap to prevent infiltration of water beneath jacket. On horizontal piping place over lap at side of pipe arranged so that water will run off of jacket and not into seam lap.
- D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. Neatly finish insulation at supports, protrusions, and interruptions. Use 1-1/2 inch Type P2 insulation to insulate drains gauges, thermometers, and strainers.

3.6 PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE

- A. Provide insulation with minimum thickness and conductivity values in compliance with ASHRAE standard 90.1-2010, Table 6.8.3A&B, but not less than thicknesses specified in this specification and as required to prevent condensation. Where multiple materials are listed for a single service and location, it is the Contractor's option to choose from the allowable insulations.

Service	Location	Insulation Type	Pipe Sizes	Insulation Thickness-Inches
Chilled Water	Interior	P5	2" to 6"	1-1/2
AHU/FCU Condensate Drains	Interior	P2	All sizes	1

Service	Location	Insulation Type	Pipe Sizes	Insulation Thickness-Inches
Refrigerant Suction Piping	Interior/ Exterior	P2	All Sizes	1

3.7 ALUMINUM JACKET

- A. Apply aluminum jacket and covers according to manufacturer's recommendations, using aluminum strapping and metal jacketing sealant to provide completely weathertight covering. Completely encapsulate insulation on all piping, valves, flanges, reducers, etc.
- B. Provide aluminum jacket for all piping within 84 inches of finished floor in air handler mechanical rooms, pump rooms and penthouses. Do not install jacketing on AHU Condensate drains unless noted otherwise. Do not install jacketing on flexible pump connectors or expansion joints.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Chilled-water piping.
 - 2. Condensate-drain piping.
 - 3. Blowdown-drain piping.
 - 4. Air-vent piping.
- B. Related Specifications
 - 1. Section 23 05 19, Meters and Gauges, for HVAC Piping for thermometers and gauges.
 - 2. Section 23 05 23, General Duty Valves for HVAC Piping, for valves
 - 3. Section 23 21 23, Hydronic Pumps, for pumps, motors, and accessories for hydronic piping.
 - 4. Section 23 05 29, Hangers and Supports, for hangers and supports.
 - 5. Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.
 - 6. Section 23 21 16, Hydronic Specialties, for hydronic specialties.
 - 7. Section 23 21 13.13, Pre-Insulated Underground Hydronic Water Piping

1.2 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pipe
 - 2. Fittings and accessories
- B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Cleaning/Flushing Plan: This must be submitted and approved prior to any piping being installed. Plan, including all steps to be taken to ensure the piping installation will be cleaned properly prior to: service, circulation through equipment, or connection to another system. This shall include, but not be limited to:
 - 1. A step by step explication of the process.
 - 2. Drawing(s) indicating flow (gpm) values required to meet the minimum velocity in each pipe.
 - 3. Drawing(s) indicating the phase(s) in which the system will be cleaned as required to ensure the minimum velocity will be maintained in each section of piping.
 - 4. Drawing(s) indicating locations of the required temporary connections, valves, strainers, and bypasses.
 - 5. Cutsheet of the temporary pump to be used during flushing.
 - 6. Water treatment and pipe cleaning chemicals.
- D. Field quality-control test reports.
- E. Submit certification of welder's qualifications to perform the required welding operations.

- F. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- B. Provide domestic manufactured piping and fittings.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect piping, valves, fittings, etc. before installation in accordance with manufacturer's written instructions.
- B. Piping shall be shipped from the factory with capped ends and stored on supports off the ground with ends covered at all times to prevent nesting of insects, birds, and other animals. Any pipe found to be without end-caps or not raised off of the ground should be cleaned by the contractor prior to installation.
- C. Protect piping from accumulation of dirt and debris in and around piping/components.

1.5 OPERATION AND MAINTENANCE DATA

- A. Operation and maintenance manuals shall include the following information:
 - 1. The approved submittal with all approved items present (not a partial resubmittal)
 - 2. Chemicals used in cleaning, flushing, inhibiting, and final water treatment.
 - 3. Water quality test reports from the cleaning process.

PART 2 - PRODUCTS

2.1 STEEL PIPING AND FITTINGS

- A. 2 inches and less in diameter. ASTM A 53, Grade B, standard-weight seamless black steel pipe with standard-weight seamless steel welded fittings, satisfying ASTM A 234, Grade WPA or WPB, ANSI B16.9.
- B. 2-1/2 inches to 10 inches in diameter. ASTM A 53, Grade B, standard-weight seamless black steel pipe with standard-weight seamless steel welded fittings, satisfying ASTM A 234, Grade WPA or WPB, ANSI B16.9.

2.2 COPPER PIPING AND FITTINGS

- A. ASTM B88, hard drawn Type L seamless copper tube with wrought copper fittings, ASTM B16.22.

2.3 JOINTS

- A. Screwed (Steel Piping, 2" and smaller):
 - 1. Make screwed joints using machine-cut ANSI taper pipe threads.
 - 2. Apply suitable joint compound, such as Teflon tape to the male threads only.
 - 3. Ream pipe to full inside diameter after cutting. All-thread nipples are not permitted.

- B. Dissimilar Metals: Make joints between copper and steel pipe and equipment along with steel pipe and ductile iron pipe using insulating unions.
 - 1. Provide insulating unions as manufactured by Crane, EPCO Sales, Inc. or approved equivalent.
- C. Solder Joints (Copper Piping):
 - 1. Prior to making joints, cut pipe square and ream to full diameter. Clean exterior of pipe and socket. Apply thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.
 - 2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.
 - 3. Utilize lead free solder. Use silver brazing alloy or Sil-Fos on refrigerant piping and on underground piping.
- D. Welded (Steel Piping, 2-1/2" and larger):
 - 1. Make welded joints as recommended by the standards of the American Welding Society.
 - 2. Ensure complete penetration of deposited metal with base metal.
 - 3. Provide filler metal suitable for use with base metal.
 - 4. Keep inside of fittings free from globules of weld metal.
 - 5. Do not use mitered joints.
 - 6. Use standard weld elbow fittings for changes of direction or cut a standard elbow for odd angles.
- E. Flanged:
 - 1. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64 inch per foot inclination of the flange face from true alignment.
 - 2. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Red rubber gaskets are not acceptable. Garlock gaskets or EPDM shall be used. Apply non-stick clean surface lubricant coating to both sides of gaskets.
 - 3. Use ANSI nuts and bolts, galvanized or black to match flange material. Use galvanized steel nuts and bolts underground, coated with tow coats of coal tar enamel. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets. Use anti-seize compound on all bolts above and below grade. Bolt threads not to protrude more than 2 threads past nut.
 - 4. Use carbon steel flanges conforming to ANSI B16.5 with materials conforming to ASTM A 105, Grade II or ASTM A 108, Grade II. Use welding neck type flanges at all fittings and on all pipe.
 - 5. Flanges for ductile iron pipe are specified in sections using that pipe.
 - 6. Keep flange covers on equipment and shop-fabricated piping until ready to install in system.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8 inch maximum thickness unless 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.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Gasket Material: Thickness, material, and type suitable for fluid to be handled, and working temperatures and pressures.

2.5 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Unions(for connecting to equipment where OEM connection provided is plastic):
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBi.
 - d. NIBCO INC.
 - 2. MSS SP-107, CPVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

2.6 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
 - 2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180°F.
- D. Dielectric Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
 - 2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.

2.7 UNIONS

- A. Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping larger than 2-1/2 inches.

2.8 BRANCH CONNECTIONS

- A. For Pipe 2 inches and smaller, use threaded fittings for steel pipe. For threaded piping, use straight size of reducing tee.
- B. For 2-1/2 Inches through 20 inches. For welded piping, when branch size is the same as and one size smaller than header size, use welding tee. Use Weldolet when branch is two or more sizes smaller than header. For threaded branch connections, use thread-olet welded to header.

2.9 GASKETS

- A. Provide gaskets between flanges of all flanged joints. Inside diameter of gaskets shall conform to nominal pipe size. Gaskets shall be ring type between raised face flanges and full face between flat face flanges with punched bolt holes and pipe opening.
- B. Gaskets shall be cut from 1/8 inch thick non-metallic, non-asbestos gasket material suitable for operating temperatures from -150°F to +750°F. Garlock or equal. For pipe smaller than 6 inches, use 1/16 inch thick gasket.

2.10 FLOOR AND CEILING PLATES

- A. Provide chrome-plated floor and ceiling plates around pipes exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Size plates to fit pipe or insulation and securely lock in place.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.

- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- N. Install valves according to the appropriate section.
- O. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- P. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- Q. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- R. Identify piping as specified in the above referenced specification section.
- S. Support piping adequately to maintain line and grade, with due provision for expansion and contraction.
- T. Use only long radius elbows on steel and copper piping unless a short radius elbow is specifically shown on the drawings.
- U. Slope condensate drain piping at a minimum 1/8 inch per foot in the direction of flow.

3.2 WELDING

- A. Weld and fabricate piping in accordance with ANSI Standard B31.9, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
- B. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
- C. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.
- D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.
- E. Remove dirt, scale and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

3.3 OFFSETS AND FITTINGS

- A. Because of the small scale of drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.
- B. Install all piping close to walls, ceilings and columns so piping will occupy the minimum space. Provide proper space for covering and removal of pipe, special clearances, and for offsets and fittings.
- C. Install piping as to not obstruct any equipment or architectural access doors.

3.4 ISOLATION VALVES

- A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor and at branch takeoffs serving equipment, and at other locations as indicated and required for isolation of piping or equipment.
- B. At air handling units, where multicoil (stacked) arrangement is used, provide each supply and return line to and from each stacked coil section with a union, pressure gauge and thermometer well and a balancing valve (with memory stop) for balancing, and valves for isolation of each coil. Refer to mechanical details for additional requirements.

3.5 DRAIN VALVES AND VENTS

- A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained.
- B. Install 2 inch drain for 2 -inch pipes and larger.
- C. Install a line size drain valve for pipes smaller than 2 inches.
- D. Provide hose adapter and cap on all drain lines.
- E. Provide automatic vents with isolation valves or manual vents at locations as indicated on Drawings and all high points in piping systems.

3.6 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.7 CLEANING OF PIPING SYSTEMS

- A. Cleaning of piping system must be performed by the mechanical contractor. Cleaning chemicals, procedure, water testing, reporting, and consultation must be provided by a qualified water treatment company specializing in this type of work. Qualified water treatment vendor will have the following features.
Operating in the business of industrial water treatment for minimum 5 years.
1. Certified to the ISO 9000 quality standard.
 2. Manufacture and deliver their own products.
 3. Provide technical specialist(s) for onsite water testing, reporting, and consultation.
 4. Have the ability to perform offsite analytical laboratory work and reporting if necessary.
- B. Acceptable vendors should include, but not be limited to the following companies:
1. ChemCal, Inc.
 2. GE Water & Process Technologies
 3. Nalco Company
- C. Minimum velocity of 10 feet per second for steel piping must be maintained in the pipes during flushing period.
1. Do not use building pumps for circulating water.
 2. Provide temporary pumps as required to achieve minimum velocities.
 3. Remove flow meters from building piping during flushing operation.
 4. Provide means (instrumentation) during flushing period to prove to the Owner that the minimum velocities are maintained in the pipes.
 5. For copper piping, maintain the flushing velocity between 3 (min) and 5 (max) feet per second. Limit temperature of water inside piping to a maximum 140°F.
- D. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the systems in service. Provide temporary connections and valves as required for cleaning, purging and circulating. Provide temporary relief valves to protect the piping system if recommended by the pipe cleaning subcontractor.
- E. Install temporary strainers in front of pumps, tanks, water still, solenoid valves, control valves, and other equipment where permanent strainers are not indicated. Keep these strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blowoff valve.
- F. Provide bypasses at the following equipment as close as feasibly possible to the equipment (no more than 10 feet total of piping at each piece of equipment) and isolate equipment as required (temporary blind flanges or similar):
1. Hydronic coils
- G. Chemicals shall remove mill scale, oil, and greases as well as passivate surfaces with a protective oxide film. NOTE: All residuals of the cleaning and passivating chemicals must be totally blown-down prior to system startup.

1. Alkaline cleaner/penetrant/dispersant chemical. This product must be in liquid form and capable of removing mill scale, oils, greases, debris, and byproducts of construction. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.
 2. Passivating chemical. This product must be in liquid poly-phosphate form and capable of laying down a protective oxide film on metal surfaces after treatment with the cleaning chemical. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.
 3. Antifoam chemical. This product must be in liquid form and capable of controlling or eliminating foam in water systems.
- H. Chemical for inhibiting and controlling corrosion and deposits must be added immediately after the chemical cleaning and passivating procedure.
1. Closed loop corrosion inhibitor chemical. This product must be in liquid form and impart the following active ingredients at the following dosages when fed in the Chilled Water Loop water: 1) nitrite (as NO₂) = 400-800 ppm, 2) borate = 200-400 ppm, 3) azole = 20-60 ppm. This product must impart the following active ingredients at the following dosages when fed in Heating Hot Water Loop water: 1) nitrite (as NO₂) = 800-1200 ppm, 2) borate = 400-600 ppm, 3) azole = 40-80 ppm.
- I. Circulate chemical cleaner and passivator in closed loop water piping systems to remove mill scale, grease, oil, and silt.
1. Flush and drain loops to remove debris prior to using chemicals.
 2. Fill loops and add chemical cleaner and passivator at the dosage rates recommended by the water treatment vendor based on system volume.
 3. Add antifoam at the dosage rates recommended by the water treatment vendor.
 4. Circulate water for 24-72 hours.
 5. Drain and flush system.
 6. Dispose of circulated water with chemical residuals as per local code requirements.
 7. Refill and immediately charge with the proper corrosion inhibitor – based on the type of piping system – to the recommended level.
 8. Match chemicals presently used in other systems used by Owner if possible.
 9. Submit all chemicals to Owner and Engineer prior to cleaning for approval.
 10. Match chemicals presently used in other systems used by Owner.
 11. Provide report comparing make-up water quality to the water circulated in the pipe after cleaning chemicals are removed. Report shall include the following at a minimum:
 - a. Conductivity
 - b. Ph
 - c. phosphate
 - d. Iron
- J. Special requirements, if any, are specified in the appropriate Sections for each type of piping.
- K. After systems have been flushed and cleaned; as required by specifications, provide written certification from the cleaning contractor that the systems are clean and ready for use. This shall include the water quality report comparing the make-up water to the water circulated in the piping after removal of chemicals to verify pipe condition.

3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure, minimum 150 psig. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

3.9 PIPING APPLICATION SCHEDULE

- A. Provide piping and fittings meeting the requirements of Part 2 as identified in the table below:

Service	Pipe Sizes	Pipe Material
Chilled Water Piping	2" and smaller	Copper Steel

Service	Pipe Sizes	Pipe Material
Chilled Water Piping	2-1/2" and larger	Steel
Condensate Piping	All	Copper, Galvanized Steel
Blowdown-Drain Piping	All	Steel
Air-vent Piping	All	Copper, Steel

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping and accessories used for air-conditioning applications.

1.2 REFERENCES

- A. ANSI B16.22 - Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
- B. ASTM B88 - Seamless Copper Water Tube
- C. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
- D. ASHRAE 15 - Safety Code for Mechanical Refrigeration
- E. AHRI 710 – Performance Rating of Liquid Line Dryers.
- F. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
- G. ANSI/AWS C3.4 - Specification for Torch Brazing
- H. AHRI 495 - Performance Rating Of Refrigerant Liquid Receivers
- I. ASME B31.5 – Code for Pressure Piping, Section on Refrigeration Piping and Heat Transfer
- J. AWS A5.8/A5.8M – Specification for Filler Metals for Brazing and Braze Welding.

1.3 QUALITY ASSURANCE

- A. Qualify soldering processes, procedures, and solderers for copper and copper alloy pipe and tube in accordance with ASTM B 828.
- B. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4. Qualify brazing procedures and brazer performance in accordance with either Section IX of the ASME Boiler and Pressure Vessel Code, or AWS B2.2.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.
 - 2. For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.

- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Pipe and tube required by the applicable standard to be cleaned and capped shall be delivered to the job site with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipe and tube from moisture and dirt. Elevate above grade. When stored inside, do not exceed the structural capacity of the floor.
- C. Protect fittings, flanges, and piping specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements provide products by one of the following manufacturers:
 - 1. Danfoss.
 - 2. Mueller Brass Company.
 - 3. Sherwood

2.2 REFRIGERANT PIPING AND FITTINGS

- A. ASTM B88 type L hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked "ACR", with ANSI B16.22 wrought copper or forged brass solder-type fittings
- B. Piping shall be shipped pressurized with dry nitrogen gas and sealed under pressure with a positive plug.
- C. Solder Filler Metals: ASTM B 32. Use Alloy Sb5 95-5 Tin Antimony or Alloy HB solder to join copper socket fittings on copper pipe.
- D. Brazing Filler Metals: AWS A5.8.

2.3 VALVES AND SPECIALTIES

- A. General
 - 1. All refrigerant piping specialties shall be suitable for the working refrigerant.
- B. Ball Valves
 - 1. Features: Forged brass with full port construction to match line size ID, chrome plated ball, internally equalized ball design, rupture-proof encapsulated stem, access port, brass cap, extended copper flare connection and UL Listed.
 - 2. Working Pressure Rating: 700 psig
 - 3. Working Temperature Range: -40°F to 250°F

- C. Check Valves
1. Features: Screw bonnet, forged brass body, Teflon gasket, internal components shall be removable, UL Listed.
 2. Working Pressure Rating: 700 psig
 3. Working Temperature Range: -40°F to 300°F
- D. Y-Type Strainers:
1. Features: Forged brass body with brass clean-out plug, 100-mech monel or stainless steel screen, UL Listed.
 2. Working Pressure Rating: 500 psig.
 3. Maximum Operating Temperature: 275°F.
- E. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in ppm.
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture as required for type of refrigerant and temperature. Submit information on color for dry, intermediate and wet indications.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 160°F.
- F. Filter Dryers
1. Comply with AHRI 710.
 2. Body and Cover: Provide painted-steel shell with zinc-chromated steel top cover with external access connection.
 3. Filter Media (Replaceable):
 - a. For systems under 15 tons, provide 25 micron filter media.
 - b. For systems 15 tons and above, provide 15 micron filter media.
 4. Desiccant Media: 100% molecular sieve solid core suitable for HFC refrigerants or 80% molecular sieve and 20% activated alumina solid core suitable for HCFC refrigerants.
 5. Designed for reverse flow (for heat-pump applications).
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Working Pressure Rating: 500 psig.
 8. Maximum Operating Temperature: 160°F.
- G. Liquid Accumulators: Comply with AHRI 495.
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or threaded.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275°F.
- H. Charging Valves
1. Provide 1/4" SAE brass male flare access ports with finger tight, quick seal caps. Provide 2-inch long copper extension sections.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section, Access Doors and Frames, if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed belowground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

- Q. Seal penetrations through fire and smoke barriers according to Division 07 Section, Penetration Firestopping.
- R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- T. Seal pipe penetrations through exterior walls according to Division 07 Section, Joint Sealants, for materials and methods.
- U. Identify and label refrigerant piping and valves according to Section 23 05 53, Identification for HVAC Piping and Equipment.

3.2 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated below:
 - a. Test Pressures
 - 1) Suction Lines for Air-Conditioning Applications: 185 psig.
 - 2) Suction Lines for Heat-Pump Applications: 325 psig.
 - 3) Hot-Gas and Liquid Lines: 325 psig
 - b. Fill system with nitrogen to the required test pressure.
 - c. System shall maintain test pressure at the manifold gage throughout duration of test.
 - d. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - e. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.4 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers (for ones with replaceable core) after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.5 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13

DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Perform Work required to provide and install ductwork, flexible duct, hangers, supports, sleeves, flashings, vent flues, and all necessary accessories as indicated in the Contract Documents. Provide any supplementary items necessary for proper installation
- B. Section Includes:
 - 1. Rectangular ducts and fittings.
 - 2. Sheet metal materials.
 - 3. Sealants and gaskets.
 - 4. Hangers and supports.
- C. Related Sections:
 - 1. Division 09 Section, Painting, for interior painting of metal ductwork exposed to view through grilles, registers, and other openings.
 - 2. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, for testing, adjusting, and balancing requirements for metal ducts.
 - 3. Section 23 07 13, External Ductwork Insulation.
 - 4. Section 23 33 00, Ductwork Accessories, for dampers, spin-in fittings, flexible duct connections.
 - 5. Section 23 34 13, Fans.
 - 6. Section 23 36 00 Air Terminal Units
 - 7. Section 23 37 13, Air Devices.

1.2 DEFINITIONS

- A. Low Pressure: Up to 2 inches w.g. positive or negative static pressure and velocity equal to 1500 fpm. Constructed and tested for +2 inches W.G.
- B. Medium Pressure: Over 2 inches w.g. through 6 inches w.g. positive or negative static pressure and velocity greater than 1500 fpm. All medium pressure ductwork shall be constructed and tested for +6 inches w.g.
- C. High Pressure: Over than 6 inches w.g. positive static pressure and velocity greater than 2500 fpm.
- D. Duct Size. The supply, return and exhaust duct sizes shown on drawings are [clear inside] sheet metal dimensions.

1.3 GUARANTEE

- A. Guarantee all ductwork for 1 year from the date of final acceptance. The guarantee will cover workmanship, noise, chatter, whistling or vibration. Ductwork shall be free from pulsation under all conditions of operation.

1.4 CONTRACTOR COORDINATION

- A. Erect all ducts in the general locations shown on the drawing(s), but conform to all structural and finish conditions of the building. Before fabricating any ductwork, Contractor to check the physical conditions at the job site and make all necessary changes in cross sections, offsets and similar items, whether they are specifically indicated on drawing(s) or not. Do not obstruct the induced air plenum opening at VAV boxes and service access spaces for VAV boxes and other equipment.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

1.5 STANDARDS AND CODES

- A. Except as otherwise indicated, sheet metal ductwork material, fabrication and installation shall comply with second edition of SMACNA HVAC Construction Standards Metal and Flexible, except where indicated otherwise. All air distribution devices (such as dampers) included in this Section shall comply with the second edition of SMACNA HVAC Construction Standards Metal and Flexible.
- B. In addition, construct ductwork and all air distribution devices to the following:
 - 1. IMC International Mechanical Code
 - 2. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
 - 3. NFPA 90B Installation of Warm Air Heating and Air Conditioning Systems

1.6 SUBMITTALS

- A. Product Data
 - 1. Submit product data for each product. Refer to Section 23 00 10.
 - 2. Provide acoustical data on insulated flexible ductwork as indicated in Part 2.
- B. Delegated-Design Submittal. Include the following for each system furnished on the project.
 - 1. System name and type
 - 2. Duct system design pressure.
 - 3. Sheet metal thicknesses and materials.
 - 4. Reinforcement details and spacing.
 - 5. Seam and joint construction and sealing.
 - 6. Fittings, construction and details.
 - 7. Hangers and supports, including materials, fabrication, methods for duct and building attachment.
- C. Ductwork shop drawings. Provide CAD-generated shop drawings of mechanical rooms and building ductwork drawn at a minimum scale of ¼ inch per foot. Include the following as a minimum:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory and shop fabricated duct and fittings.
 - 3. Duct layout indicating sizes, configuration and pressure classes.
 - 4. Elevations of top and bottom of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Reinforcement and spacing.

- 7. Penetrations through fire-rated and other partitions.
- 8. Equipment installation based on equipment being used on Project.
- 9. Duct accessories, including access doors and panels, fire dampers and smoke dampers.

D. Welding certificates. For duct welders including procedures and standards of acceptance

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sheet Metal Products. McCorvey Sheet Metal Works, Gowco, United McGill, Flexmaster

2.2 APPLICATION

A. Ductwork shall be constructed in accordance with the following as a minimum. Refer to drawings for any deviations from this table.

SYSTEM	MATERIAL	MINIMUM PRESSURE CLASSIFICATION ⁽¹⁾
Supply Systems:		
All fan coil unit supply ductwork	Galvanized Steel	Low Pressure

- B. Notes to Table:
- 1. Positive pressure unless noted otherwise in Table.

2.3 DUCT MATERIAL AND CONSTRUCTION

- A. General. Noncombustible or conforming to requirements for Class I air duct materials or UL 181. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise on Drawings. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein
- B. Galvanized Steel Ducts. Constructed of G-60 coated galvanized steel meeting requirements of ASTM A 653 or ASTM A 527. Stencil coils of sheet steel throughout on 10 foot centers with gage and manufacturer's name. All materials associated with the duct system shall be galvanized steel including stiffeners, fasteners, etc.
- C. Fasteners. Rivets, bolts or sheet metal screws.
- D. Sealant.
 - 1. Sealant shall be water based, latex UL 181B-M sealant with flame spread of 0 and smoke developed of 0. Sealants shall be similar to Foster 32-19, Childers CP-146, Hard Cast Iron Grip 601, Ductmate Pro Seal or Design Polymerics DP 1010.
 - 2. Scrim tape shall be fiberglass open weave tape, 3 inches wide, with maximum 20/10 thread count.
- E. Hangers and Supports.
 - 1. Support ductwork with continuously threaded hanger rods of galvanized steel or 20 gauge straps as indicated in these specifications.

2.4 RECTANGULAR DUCTS AND FITTINGS GENERAL REQUIREMENTS

- A. General Fabrication Requirements: Comply with SMACNA based on indicated static-pressure class unless otherwise indicated. In no case shall the ductwork be less than 26 gage for low pressure ductwork, 24 gage for medium pressure ductwork.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Snaplock longitudinal seams (L2) are not acceptable.
- D. Fittings:
 - 1. Select types and fabricate according to SMACNA Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.
 - 2. Construct bends and elbows per SMACNA Figure 2-2, "Rectangular Elbows", Type RE1 with radius of not less than 1-1/2 times width of duct on centerline. Where not possible or where indicated on construction documents, construct Type RE2 rectangular elbows with welded-in-place double wall airfoil turning vanes (whether specifically shown on drawings or not), or short radius type RE1 radius elbows.
 - 3. Construct tees per SMACNA Figure 2-5, "Divided Flow Branches", Type 2, Type 3, Type 4A or 4.
 - 4. Construct branch connections per SMACNA Figure 2-6, "Branch Connection". Use 45 degree entry, 45 degree lead in, conical or bellmouth connections only.
 - 5. Unless indicated on construction document details, transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence. Divergence upstream of equipment shall not exceed 30 degrees. Convergence downstream of equipment shall not exceed 45 degrees.
 - 6. Bullhead tees are not permitted.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Construction Standards. Use construction methods which follow the requirements outlined SMACNA publications, as well as SMACNA Balancing and Adjusting publications, unless indicated otherwise in these specifications or accompanying drawings.
- B. Reinforcement. Reinforce ducts having one side equal to 25 inches or more in accordance with recommended construction practice of SMACNA.
- C. Plenum Construction. Construct plenum chambers of not less than No. 20 U.S. gage metal reinforced with galvanized structural angles.
- D. Cross Breaking or Beading. Cross break or bead sheet metal for rigidity, except ducts which are 12 inches or less in the longest dimension.
- E. Wall and Floor Penetrations.

1. Install fire, smoke and combination fire smoke dampers in floor penetrations and in one and two-hour rated walls where indicated in drawings and in accordance with Specification 23 31 33.
 2. Where ducts pass through walls in exposed areas, install suitable escutcheons made of galvanized sheet metal angles as closers.
 3. At all locations where ductwork passes through floors, provide watertight sleeves projecting 3 inches above finished floor and flush with bottom of floor slab. Fabricate sleeves of 1/8 inch thick steel, galvanized after fabrication. Anchor into adjacent floor slab as required.
 4. Sleeves are required inside as well as outside chases.
- F. Interior Painting. Interior painting of metal ductwork exposed to view through grilles, registers, and other openings is specified in the Section on painting. Do not install grilles, registers, or similar items until painting is complete.
- G. Ductwork Openings. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- H. Ductwork Location. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities, including access to electrical and control panels.
- I. Instrument Test Hole Fitting. Provide Duro Dyne Model TH-1 instrument test ports with heavy-duty zinc-plated heavy-gage cap, instant-release wing nut, neoprene expansion plug, flat neoprene mounting bracket and mounting holes. Provide fittings to air balance contractor.
- J. Provide transitions at equipment and air device connections as per SMACNA standards. Where equipment requires an oval inlet and a round flex duct is routed to the equipment, provide insulated round to oval transition.
- K. Refer to mechanical details for information on terminal box connections, diffuser connections, fume hood connections, lab-trac equipment, etc.

3.2 SEAM AND JOINT SEALING

- A. All duct systems (except welded exhaust ductwork and double wall flue) shall be sealed. Duct shall be thoroughly cleaned prior to application of sealant. All transverse joints, longitudinal seams and duct wall penetrations shall be sealed. All ductwork shall be sealed as per seal Class A of SMACNA Standards irrespective of the duct pressure classifications

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports." Unless indicated otherwise in specifications.
- B. Hanger Spacing. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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. Do not use wire to support ductwork.

- C. Horizontal Ducts Up to 40 Inches. Support horizontal ducts up to and including 40 inches in their greater dimension by means of No. 20 U.S. gage band iron hangers attached to the ducts by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beam clamps or other approved means. Use clamps to fasten hangers to reinforcing on sealed ducts.
- D. Horizontal Ducts Larger Than 40 Inches. Support horizontal ducts larger than 40 inches in their greatest dimension by means of hanger rods bolted to angle iron (or equivalent unistrut) trapeze hangers. Place supports on at least 8'-0" centers according to the following:

Angle Length	Angle	Rod Diameter
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8'-0"	2" x 2" x 1/8"	5/16"
10'-0"	3" x 3" x 1/8"	3/8"

The trapeze is to be placed on the exterior of non-compressible insulation between hanger and ductwork.

- E. Vertical Ducts. Support ducts to ensure rigid installation. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Fig. 4-7, Fig 4-8, Fig 4-9 "Riser Supports – From Floor". Support vertical ducts where they pass through the floor lines with 1-1/2 inches x 1-1/2 inches x 1/4 inch angles for ducts up to 60 inches. Above 60 inches, the angles must be increased in strength and sized on an individual basis considering space requirements. Support vertical duct drops more than 6 feet in length with angle iron frames attached to ducts.
- F. Refer to drawings for additional hanger details and requirements. Note that not all hangers are shown on the drawings are in the BIM model. The Contractor shall coordinate all hangers with the structure and other trades.

3.4 CLEANING

- A. Protect all ductwork and equipment from dirt during storage, installation and prior to grille, diffuser installation with protective covering at each end. Ductwork exposed to dirt and dust due to inadequate protection will have to be removed, cleaned and reinstalled.
- B. Do not operate any air handling units or fan coil units during construction without filters.
- C. Provide temporary filters on return air ductwork during construction to protect ductwork from dust.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Combination fire and smoke dampers.

1.2 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specification 23 31 13, Ductwork

1.3 SUBMITTALS

- A. Product Data: Submit product data for each product. Refer to Section 23 00 10.
- B. Fire and Combination Fire/Smoke Damper. Include manufacturer's literature to include performance data and installation requirements. Include any wiring diagrams.
- C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
 - e. Wiring Diagrams: For power, signal, and control wiring.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 10.
- B. Fire dampers, smoke dampers and combination fire/smoke dampers.
 - 1. Include operation and maintenance information, including recommended testing requirements.
 - 2. Assign identification numbers (FD – Fire Damper, FSD – Fire/smoke Damper, SD – Smoke Damper) for each damper. Include table in O&M manual that indicates identification number, room location, duct system and size.

1.5 QUALITY ASSURANCE

- A. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

2. AMCA 500-D, "Laboratory Method of Testing Dampers for Rating"
3. NFPA 101 - Life Safety Code.
4. SMACNA - HVAC Duct Construction Standards Metal and Flexible – Second Edition
5. UL 555 – Standard for Fire Dampers.
6. UL 555C – Standard for Ceiling Radiation Dampers.
7. UL 555S – Standard for Smoke Dampers

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Fire, Smoke and Fire/Smoke Dampers. Greenheck, Pottorff, Ruskin, Nailor.

2.2 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316L, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

2.3 COMBINATION FIRE AND SMOKE DAMPERS (FSD)

- A. Quality Standards. Furnish and construct combination fire/smoke dampers according to NFPA 90A and UL 555 (Dynamic). Dampers must bear UL label and suitable for dynamic application and a Leakage Class 1 Smoke Rating in accordance with UL 555S. Dampers shall possess a 1-1/2 hour protection rating 165 degrees F. Dampers shall have a minimum 5 year warranty.
1. Dampers shall be suitable for dynamic closure to 3000 fpm and 6 inches w.g. static pressure at 120"x96" for vertical installation and 144"x96" for horizontal installation.
 2. Damper shall have 5" frame constructed from minimum 16 gage galvanized steel channel and reinforced at the corners.
 3. Blades shall be 6" wide airfoil type and constructed from minimum 14 gage (equivalent) galvanized steel.
 4. Bearings shall be self-lubricating stainless steel sleeve, turning in extruded hole in frame.
 5. Blade seals shall be inflatable silicone fiberglass material, rated for maintaining smoke leakage at a minimum of 450°F and galvanized steel for flame seal to 1,900 degrees F. Seals shall be mechanically attached to blade edge. Provide stainless steel flexible metal compression jamb.
 6. Linkage shall be concealed in frame.

7. Provide ½-inch diameter plated steel hex shaped axle attached to blade.
8. Temperature Release Device. Close in a controlled manner and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades. Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation. Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.
9. Actuator. Provide electric 120V, 60 Hz, two-position, fail close actuator. Operators shall be UL listed and labeled.
10. Pressure drop shall be a maximum of 0.07 inches w.g. at 2,000 feet per minute through 24 x 24 inch damper.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.

3.2 FIRE, SMOKE AND COMBINATION FIRE/SMOKE DAMPERS

- A. Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.
- B. Install dampers square and free from racking with blades running horizontally.
- C. Do not compress or stretch damper frame into duct or opening.
- D. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.
- E. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

- F. Provide access doors for all fire, smoke and combination fire/smoke dampers. Refer to details for additional requirements.

END OF SECTION

SECTION 23 34 13

FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for furnishing and installing fans and supplemental equipment including the following:
 - 1. Centrifugal fans.

1.2 PERFORMANCE

- A. Provide fan type, arrangement, rotation, capacity, size, motor horsepower, and motor voltage as shown. Fan capacities and characteristics are scheduled on the drawings.
- B. Rate fans according to appropriate Air Moving and Conditioning Association, Inc. (AMCA), approved test codes and procedures. Supply fans with sound ratings below the maximums permitted by AMCA standards. All fans provided must be licensed to bear the Certified Ratings Seal.
- C. Statically and dynamically balance all fans.

1.3 SUBMITTALS

- A. General:
 - 1. Submit shop drawings and product data.
 - 2. Shop drawings shall indicate assembly, unit dimensions, weight, required clearances, construction details and field connection details.
 - 3. Product data shall indicate capacities, ratings, fan performance, motor electrical characteristics, and gages and finishes of materials.
 - 4. Provide fan curves with specified operating point clearly plotted.
 - 5. Include backdraft damper information for each fan, including the size of the backdraft damper.
 - 6. Submit sound power levels.
 - 7. Submittals shall show compliance with Section 23 05 13, Common Motor Requirements for HVAC Equipment.

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.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 00 10.

- B. Include installation instructions, assembly views, lubrication instructions and replacement parts list.
- C. Include copy of approved submittals (with all comments corrected).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Fans:
 - a. Greenheck.
 - b. Loren Cook Company.
 - c. Twin City Fan & Blower

2.2 PROTECTIVE COATINGS

- A. Manufacturer's Standard: Apply manufacturer's standard prime coat and finish to fans, motors and accessories, except on aluminum surfaces or where special coatings are required.
- B. Galvanizing:
 - 1. After fabrication of the parts, hot-dip coat all surfaces which require galvanizing.
 - 2. Where galvanizing is specified, a zinc coating may be used.
 - 3. After fabrication, apply the zinc coating and air-dry the coating to 95 percent pure zinc.
 - 4. Acceptable zinc coatings include Zincilate, Sealube, Amercoat, Diametcoat, or an approved equal.

2.3 SUPPLEMENTAL EQUIPMENT

- A. Motor Covers: Provide weatherproof motor covers for installations out of doors. Apply the same finish as used on the fan.
- B. Belt Drives:
 - 1. Unless otherwise specified for belt-driven fans, equip the fan motors with variable pitch sheaves. Select the sheave size for the approximate midpoint of adjustment and to provide not less than 20 percent speed variation from full open to full closed. Size drives for 150 percent of rated horsepower. Key the fan sheave to the fan shaft.
 - 2. Nonadjustable motor sheaves may be used for motor sizes over 15 horsepower, at the Contractor's option. However, if changing a nonadjustable sheave becomes necessary to produce the specified capacity, the change must be made at no additional cost.
 - 3. Provide belt guards and apply the same finish as used for the fan.
- C. Safety Disconnect Switch: Provide a factory-wired, safety disconnect switch on each unit equipped with a 115/1/60 motor. Division 26 will provide safety disconnect switches for all motors that are not 115/1/60, such as three phase motors, unless noted otherwise in specifications or fan schedule.
- D. Motors. All 115/1/60 motors shall be provided with thermal overload protection.

- E. Nameplates. Provide an aluminum or stainless steel nameplate secured with screws to the equipment in a location that is readable when the equipment is installed and in operation. The following information shall be included on the nameplate: manufacturer, model number, serial number, date of manufacture, Motor HP, Motor enclosure, motor volts/ph/hz and rpm, design CFM, design SP, Fan Class, Fan RPM, Max RPM.

2.4 INLINE EXHAUST

- A. General: Fan shall be a duct mounted centrifugal square inline fan.
- B. Construction: The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Pivoting motor plate shall utilize threaded L-bolt design for positive belt tensioning. Housing shall be pre-drilled to accommodate universal mounting feet for vertical or horizontal installation.
- C. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05.
- D. Fan Motor, Bearing and Drives. Motor shall be Nema design B with class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure. Bearings shall be ball type selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans level and plumb.
- B. Support floor-mounting units using spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section, Cast-in-Place Concrete.
- D. Support suspended units from structure using threaded steel rods and spring hangers. Vibration-control devices are specified in Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.
- E. Install units with clearances for service and maintenance.
- F. Label fans according to requirements specified in Section 23 05 53, Identification for HVAC Piping and Equipment.

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00, Air Duct Accessories.
- B. Ground equipment according to Division 26 requirements.
- C. Connect wiring according to Section 26 05 19, Insulated Conductors.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

SECTION 23 41 00

PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.2 REFERENCES

- A. AMCA 99 – Standards Handbook.
- B. ARI 850 – Commercial and Industrial Air Filter Equipment.
- C. ASHRAE 52.1 – Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter.
- D. ASHRAE 52.2 – Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size.
- E. ASHRAE 62 – Ventilation for Acceptable Indoor Air Quality.
- F. IEST RP-CC—1 – HEPA Filters.
- G. NFPA 70 – National Electrical Code.
- H. SMACNA – HVAC Duct Construction Standards – Metal and Flexible.
- I. UL 586 – High Efficiency, Particulate Air Filter Units.
- J. UL 900 – Test Performance of Air Filter Units.

1.3 DEFINITIONS

- A. IEST – Institute of Environmental Sciences and Technology.
- B. HEPA – High Efficiency Particulate Air.
- C. MERV – Minimum Efficiency Reporting Value.

1.4 SUBMITTALS

- A. Product Data: Include dimensions; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; MERV rating, efficiency and test method; fire classification; furnished specialties; and accessories for each unit indicated.
- B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
 - 1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
 - 2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
 - 3. Include wiring diagrams.

- C. Operation and Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the specified products with minimum three years documented experience, who issues complete catalog data on total product.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ARI 850.
- D. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.
- E. Comply with NFPA 90A and NFPA 90B.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site in accordance with Section 23 00 10, Mechanical General Provisions.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean, dry space and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- D. Ship equipment to jobsite with not less than a prime coat of paint or as specified.

1.7 PROJECT CONDITIONS

- A. Environmental Requirements: Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fans have been test run under observation.

1.8 SCHEDULING

- A. Capacities and characteristics are generally shown on schedules on Drawings. Reference shall be made to schedules for such information.
- B. Capacities shown are minimum capacities. Variations in capacities of scheduled equipment supplied under contract will be permitted only with written direction from Owner.

1.9 MAINTENANCE

- A. Extra Materials: Provide two complete sets of filters for each unit. Tag to identify associated unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AAF International.
 2. Cambridge.
 3. Camfil
 4. Flanders
 5. Koch
 6. Dwyer Instruments, Inc.

2.2 FILTERS

- A. Filters shall be listed as Class 2 in accordance with UL 900 and shall be tested and reported in accordance with ASHRAE Test Standards 52.1 and 52.2. Dust spot efficiencies listed are results when tested by ASHRAE Standard 52.1. MERV and MERV-A values listed are results when tested by ASHRAE Standard 52.2. and ASHRAE Standard 52.2 Appendix J.
- B. Medium Efficiency Panel Filter (Disposable, Dry Type)
1. MERV 8 Filters:
 - a. Media: 0.18-inch nonwoven cotton and synthetic blend media, formed into a uniform radial pleat. Provide industry standard sizes as required for installation. The minimum media area shall be 17.3 square feet for a 24X24 filter.
 - b. Frame: Provide filter media in permanent removable frames with corrosion resistant welded wire grid bonded to the downstream side of the media. Media shall be fully bonded to frame to prevent air leakage.
 - c. Rating: Initial resistance no greater than 0.31-inches w.g. at 500 FPM face velocity. Minimum Efficiency Reporting Value shall be MERV 8, dust spot efficiency of 25-30 percent.
 - d. Thickness: 2-inches. Filters shall be 2-inches unless otherwise noted on the Drawings or Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Coordinate filter installations with duct and fan coil unit installations.
- D. Electrical wiring and connections are specified in Division 26 Electrical Sections.

END OF SECTION

SECTION 23 62 00

AIR-COOLED DX CONDENSING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Unitary small air cooled condensing units (5 tons and smaller).

1.2 PERFORMANCE REQUIREMENTS

- A. Provide performance as scheduled on Drawings.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, sound data and accessories.
- 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.
- C. Operation and maintenance data.
- D. Warranty Information.
- E. Compliance with the minimum energy efficiency listed in ASHRAE/IESNA 90.1-2013, Section 6.

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. ASHRAE/IESNA 90.1-2013 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2013, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- C. Energy efficiency and performance shall be certified as follows:
 - 1. Unitary Small AC to ANSI/AHRI Standard 210/240.
- D. Sound data shall be certified to ANSI/AHRI Standard 270.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.6 WARRANTY

- A. Unitary small AC units.
 - 1. Provide 5-year compressor warranty.

2. Provide 5-year parts warranty.

PART 2 - PRODUCTS

2.1 UNITARY SMALL AC UNITS (5 TONS AND LESS)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. York
 2. Trane
 3. Carrier
- B. REFRIGERANT
 1. Without exception, the refrigerant for the units shall be R-410A.
- C. MANUFACTURED UNITS
 1. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.
 2. Condenser Coil: Seamless copper or aluminum tube, aluminum finned coil; factory leak tested to 150 psig and pressure tested to 425 psig. Circuit to match compressors.
 3. Condenser Fans and Drives: Propeller fans for vertical air discharge; directly driven with permanently lubricated ball-bearing motors with integral current- and thermal-overload protection; and anti-short cycle timer control circuit to prevent the compressor from restarting for five (5) minutes after stopping.
 4. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; 115-V control transformer, if required; magnetic contactors for condenser fan motors; and high and low pressure switches.
 5. Unit Casings: Galvanized or zinc-coated steel treated and finished with manufacturer's standard paint coating, designed for outdoor installation with weather protection for components and controls, and with removable panels for access to controls, condenser fans, motors, and drives; fan guards, lifting eyes, and removable legs.
 6. Accessories: Provide the following accessories with each unit:
 - a. Low-Ambient Kit for temperatures down to 0°F.
 - b. Crankcase Heater.
 - c. Thermal Expansion Valve (TXV).
 - d. Hard Start Kit.
 - e. Filter drier.
 - f. Field installed disconnect switch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances for service and maintenance.
- B. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Section 23 23 00, Refrigerant Piping.
- C. Furnish charge of refrigerant and oil.
- D. Furnish and install all low voltage control wires as required.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Contractor shall perform the following field tests and inspections and prepare test reports:
 - 1. Perform electrical test and visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Non-precharged refrigerant piping:
 - a. After all refrigeration equipment and piping is installed, charge the system with the proper refrigerant and dry nitrogen to 300 psig. Test all joints for leaks with electronic leak detector. Repair any leaks and recharge and retest. .
 - b. After refrigerant system has been pressure tested, connect a suitable vacuum pump and evacuate the piping system and equipment. Operate the vacuum pump as long as required to evaporate all moisture in the system. Check the humidity within the system with a wet bulb indicator until the wet bulb temperature is reduced to minus 40°F. After the system has been evacuated, break the vacuum by charging the proper refrigerant into the system.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 6. Verify proper airflow over coils.
- C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- D. Remove and replace malfunctioning air-cooled condensers and retest as specified above.

3.3 ADJUSTING

- A. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.
- B. Shut down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.
- C. Provide cooling season start-up and winter season shutdown for first year of operation.

END OF SECTION

SECTION 23 82 19

FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies horizontal fan coil units for concealed overhead or exposed installation.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- 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.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Units shall be ARI 440 certified and labeled.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2010, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IESNA 90.1-2013 Compliance: Applicable requirements in ASHRAE/ IESNA 90.1-2013, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

- A. Provide one (1) year manufacturer's warranty. Include coverage of fan-coil unit and motors.

1.5 DEFINITION

- A. Exposed cabinet is defined as a unit that does not have supply or return duct connections, but has integral supply and return registers.

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. Fan-Coil-Unit Filters: Install new filters at substantial completion per Part 3 of this specification. Furnish one additional spare filters for each filter installed to be used by Owner after substantial completion.
2. Fan Belts: Furnish one spare fan belt for each unit installed with a belt.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide scheduled products by one of the following:
 1. Daikin
 2. Enviro-Tec, Inc.
 3. Greenheck
 4. International Environmental Corporation.
 5. Johnson Controls
 6. Temtrol

2.2 DIRECT DRIVE FAN-COIL UNITS

- A. Cabinet. Construct of heavy gauge galvanized steel panels. Exposed units shall be shall be finished with a heat cured anodic acrylic powder paint of the standard factory color. All units shall be insulated with 1/2-inch, 1-1/2 pound foil faced fiberglass insulation meeting NFPA 90A requirements. Insulate coil and fan sections. Seal insulation edges.
- B. Access. Exposed units shall have fan and filter bottom access panel attached with quarter turn quick open fasteners for access to service.
- C. Fan. Unit fan shall be a dynamically balanced, forwardly curved, DWDI centrifugal type constructed of 18 gauge zinc coated galvanized steel for corrosion resistance. The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit. Plenum unit fan assemblies shall be easily serviced through an access panel provided.
- D. Motor. Motors shall be high efficiency, permanently lubricated sleeve bearing, permanent split-capacitor type with UL and CSA listed automatic reset thermal overload protection and three separate horsepower taps. Single speed motors are not acceptable.
- E. Hydronic Coil. 1/2 inch copper tube, 0.016-inch tube wall thickness, with mechanically bonded aluminum fins spaced no closer than 12 fins/inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220°F. Include manual air vent and drain valve.
- F. Drain Pan. Primary condensate drain pans shall be single wall, heavy gauge stainless steel for corrosion resistance, and extend under the entire cooling coil. Drain pans shall be of one-piece construction and be positively sloped for condensate removal. Drain pans on concealed models shall be field reversible for right or left hand connections. The drain pan shall be externally insulated with a fire retardant, closed cell foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21
- G. Filters. All plenum and exposed units shall be furnished with a minimum 1" pleated MERV 8 filter. Filters shall be tight fitting to prevent air bypass. Plenum unit filters shall be easily removable from the side of the unit without the need for tools.

- H. Electrical. Units shall be furnished with single point power connection. Provide an electrical junction box with terminal strip for motor and other electrical terminations. The factory mounted terminal wiring strip consists of a multiple position screw terminal block to facilitate wiring terminations for the electric control valves and thermostats. Provide unit mounted three speed fan and disconnect switch.
- I. Controls: All controls, including terminal equipment controller for fan coil unit shall be supplied by Temperature Controls Contractor to fan coil unit manufacturer for factory installation.
- J. Options: Refer to FCU Schedule
 - 1. Provide double deflection discharge grille where indicated on fan coil unit schedule.
 - 2. Provide insulated mixing box with return connection.
- K. DX Coil. Furnish a DX coil, tested to 450 PSIG pressure and factory sealed and charged with a minimum of 5 PSIG nitrogen or refrigerated dry air. DX coils shall be provided with a fixed orifice refrigerant distributor.

2.3 BELT DRIVE FAN COIL UNITS

- A. General. Provide horizontal or vertical fan coil units as indicated on schedule. All units shall be of "draw-thru" design with coils, fans, motor/ drive and drain pan completely contained within the unit cabinet.
- B. Cabinet. Construct of 18-gage galvanized steel panels. Exposed units shall be finished with a heat cured anodic acrylic powder paint of the standard factory color. Units shall be insulated with 1-inch, 1-1/2 pound foil faced fiberglass insulation meeting NFPA 90A requirements. Insulate coil and fan sections. Seal insulation edges.
- C. Access. All access panels shall be fully insulated and attached with standard fasteners on at least two opposite sides. No coil or drain piping or electrical connections shall pass through any access panel.
- D. Fan. Unit fan shall be a dynamically balanced, forwardly curved, DWDI centrifugal type constructed of 18 gauge zinc coated galvanized steel for corrosion resistance. The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit. Fan shall have permanently lubricated ball bearings with a minimum design average life (L50) of 100,000 hours.
- E. Motor. Motors shall be high efficiency, standard NEMA design motors of the horsepower listed in the equipment schedule. All motors shall be 1750 RPM, 60 hertz single speed motors rated for continuous duty. All motors shall be reversible rotation type. Three phase motors shall be "across-the-line" start type. All motors shall be mounted on an adjustable base. All motor wiring is to be terminated in a junction box, external to the unit casing. All fan drive assemblies shall include an adjustable pitch motor pulley, a fixed pitch blower pulley and a standard cross section "V-belt". All fan drives shall be selected at a minimum service factor of 1.2.
- F. Hydronic Coil. 1/2 inch copper tube, 0.016-inch tube wall thickness, with mechanically bonded aluminum fins spaced no closer than 12 fins/inch, rated for a maximum working pressure of 300 psig and a maximum entering-water temperature of 200°F. Include manual air vent and drain valve. Provide stainless steel coil casing.

- G. Drain Pan. Primary condensate drain pans shall be single wall, heavy gauge IAQ stainless steel for corrosion resistance, and extend under the entire cooling coil. Drain pans shall be of one-piece construction and be positively sloped for condensate removal.. The drain pan shall be externally insulated with a fire retardant, closed cell foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21
- H. Filters. All plenum and exposed units shall be furnished with a minimum 1" pleated MERV 8 filter. Filters shall be tight fitting to prevent air bypass. Plenum unit filters shall be easily removable from the side of the unit without the need for tools.
- I. Electrical. Units shall be furnished with single point power connection. Provide an electrical junction box with terminal strip for motor and other electrical terminations. The factory mounted terminal wiring strip consists of a multiple position screw terminal block to facilitate wiring terminations for the electric control valves and thermostats
- J. Controls: All controls, including terminal equipment controller for fan coil unit shall be supplied by Temperature Controls Contractor to fan coil unit manufacturer for factory installation.
- K. Options::
 - 1. Provide mixing box where shown on schedule or drawings. Mixing box shall be fully insulated and constructed the same as cabinet.
 - 2. A main incoming power non-fused disconnect switch shall be factory furnished and wired by the unit manufacturer for single point power connection where indicated on schedule.
 - 3. Unit shall have a 12 gauge galvanized steel base rail for ceiling or floor mounting.
- L. DX Coil. Furnish a DX coil, tested to 450 PSIG pressure and factory sealed and charged with a minimum of 5 PSIG nitrogen or refrigerated dry air. DX coils shall be provided with a fixed orifice refrigerant distributor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fan-coil units to comply with NFPA 90A.
- B. Suspend fan-coil units from structure with vibration isolators as specified in Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.
- C. Verify locations of thermostats and other exposed control sensors with Drawings and room details before installation.
- D. Install new filters in each fan-coil unit at Substantial Completion.
- E. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

- F. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Section 23 33 00, Air Duct Accessories. Comply with safety requirements in UL 1995 for duct connections.

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

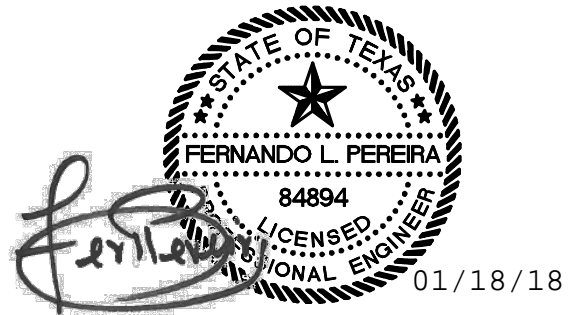
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END OF SECTION



SECTION 26 00 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 WORK INCLUDED

- A. General Requirements specifically applicable to Division 26.
- B. The Contractor shall be responsible for:
 - 1. The work included consists of furnishing all materials, supplies, equipment and tools, and performing all labor and services necessary for installation of a completely functional power, lighting, fire alarm and signaling systems. Complete systems in accordance with the intent of Contract Documents.
 - 2. Coordinating the details of facility equipment and construction for all Specification Divisions, which affect the work covered under this Division.
 - 3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
 - 4. Temporary power service and lighting for construction. Coordinating all shutdown dates and schedules with Owner's Representative and obtain all work-permits required by Owner.
- C. Intent of Drawings:
 - 1. The Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every device or raceway in its exact location, unless specifically dimensioned. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceway, subject to prior review by the Owner and Engineer. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
 - 2. The intent of the Drawings is to establish the type of systems and functions, but not to set forth each item essential to the functioning of the system. The drawings and specifications are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Review pertinent drawings and adjust the work to conditions shown. In case of doubt as to work intended, or where discrepancies occur between drawings, specifications, and actual conditions, immediately notify the Architect/Engineer and the Owner's representative, and propose a resolution.

1.3 RELATED WORK

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project electrical systems and equipment.

1. Division 01 Sections included in the project specifications.
2. The contract.

1.4 SUBMITTALS

- A. Submit the material and equipment list as directed in Division 01 and include, but not limit the submittals to, the following (as applicable):
1. Switchboards
 2. Safety Switches
 3. Fuses
 4. Magnetic Motor Starters
 5. Manual Motor Starters
 6. Conduit
 7. Wire
 8. Wiring Devices
 9. Outlet Boxes
 10. Lighting Fixtures
 11. Grounding System

1.5 SHOP DRAWINGS

- A. Submit the following in addition to and in accordance with the requirements of Division 01 for submittal requirement.
1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
 2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of it are clearly indicated and non-applicable portions clearly deleted or crossed out.
 3. All schematic, connection and/or interconnection diagrams in accordance with the latest edition of NEMA.
 4. Provide submittals as required by individual specification Section.
- B. Provide the following with each submittal:
1. Catalog cuts with manufacturer's name clearly indicated. Applicable portions shall be circled and non-applicable portions shall be crossed out.
 2. Line-by-line specification review by equipment manufacturer and contractor with any exceptions explicitly defined.
- C. Equipment Layout Drawing: 1/8-inch scale minimum drawings indicating electrical equipment locations. Dimensions for housekeeping pads should be indicated on these drawings. Indicate routing of conduit 2 inches and over on these drawings.
- D. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.
1. Itemize equipment and material by specification Section number; include manufacturer and identifying model or catalog numbers.
 2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.
 3. If a satisfactory replacement is not submitted within a two-week period, owner will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to owner.

- E. As-Built Record Drawings: The Contractor shall maintain a master set of As-Built Record Drawings that show changes and any other deviations from the drawings. The markups must be made as the changes are done. At the conclusion of the job, these As-Built Record Drawings shall be transferred to AutoCAD electronic files, in a format acceptable to the Owner, and shall be complete and delivered to the Owner's Representative prior to final acceptance. Refer to 01210 Project Administration for other requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Refer to Division 01 for Record Documents, Operating and Maintenance Manuals, and other similar submittals.

1.7 STANDARDS AND CODES

- A. Standards of the following organizations as well as those listed in Division 01, may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.
1. Association of Edison Illuminating Companies (AEIC)
 2. American National Standards Institute (ANSI)
 3. Institute of Electrical and Electronics Engineers (IEEE)
 4. Insulated Cable Engineers Association (ICEA)
 5. National Electrical Code (NEC)
 6. National Electrical Manufacturers Association (NEMA)
 7. Electrical Safety in the Workplace
 8. National Fire Protection Association (NFPA)
 9. Underwriter's Laboratories (UL)
 10. ASHRAE/IES 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- B. Work, materials and equipment must comply with the latest National and State Ordinances, Codes rules and regulations including but not limited to the following:
1. National Electrical Code (NEC)
 2. Electrical Safety in the Workplace
 3. Occupational Safety and Health Act (OSHA)
 4. American with Disability Act (ADA)
 5. American Society for Testing and Materials (ASTM)
 6. University of Texas (UT) System
 7. Applicable state and federal codes, ordinances and regulations
 8. National Fire Protection Association (NFPA)
- C. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's representative in writing and ask for an interpretation. In cases where Contract Document requirements exceed Code or Ordinance requirements the contract requirements govern. When requested, provide satisfactory evidence of compliance with applicable regulations. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified shown.
- D. Contractor shall obtain permits and arrange inspections required by codes applicable to this Section and shall submit written evidence to the Owner and Engineer that the required permits, inspections and code requirements have been secured.

1.8 SPECIAL CONDITIONS

- A. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.
- B. Be responsible for fitting material and apparatus into the building and carefully lay out work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation.
- C. The Electrical and associated Drawings are necessarily diagrammatic in character and cannot show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. Carefully investigate structural and finish conditions and coordinate the separate trades in order to avoid interference between the various phases of work. Layout work so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Install work to avoid crippling of structural members; install inserts to accommodate hangers before concrete is poured, and provide proper openings through floor, walls, beams, etc., as hereinafter specified or as otherwise indicated or required. Install all work parallel or perpendicular to the lines of the building unless otherwise noted.
- D. When the Electrical Drawings do not give exact details as to the elevation of conduit and ducts, physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Conduit and duct systems are generally intended to be installed true and square to the building construction, located as high as possible against the structure in a neat and workmanlike manner and located above finished ceilings. Drawings do not show all required offsets and other location details. Conceal work in all finished areas.

1.9 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and sub-surface obstructions which has been taken from UTMB's and utility company drawings. This information is not guaranteed as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided, verify locations given.
- C. Should obstruction be encountered, whether shown or not, re-route existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown on the drawings.
- D. Where obstructions encountered are beyond the scope of work shown or specified in this project, refer the matter to the Owner's representative and a cost differential proposal will be agreed upon before the added work is undertaken as stipulated in the uniform general conditions.

1.10 CONNECTION TO EXISTING SERVICES

- A. Do not make connection to existing services or utilities without the Owner's Representative's knowledge and permission. All such connections must be planned and scheduled to minimize the length of service interruption required. Make request for shutdown to Owner's Representative as far as possible in advance, and provide a detailed written schedule of activities during shutdown and a list of materials required for connection and renewal of service. All such service interruptions must be made at UTMB's convenience, not the Contractor's; and no increase in contract amount will be allowed for reasons of premium time or inefficiency of operations which may result.
- B. Outages of services as required by the new installation will be permitted but only at a time approved by the owner's representative. Allow the Owner's Representative as much time as possible in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner's Representative. Include all costs of outages, including overtime charges in the contract amount. Do not turn off or on any equipment for a building or shut any valves without permission from Owner's Representative.

1.11 RELATION WITH OTHER TRADES

- A. Concrete: Furnish and locate all sleeves for this work. Furnish sizes of required equipment pads and furnish and locate all bolts and fittings required to be cast in them. Perform all required core drilling and subsequent fire stopping.
- B. Mechanical Work: Division 23 specifies the furnishing of mechanical equipment controls. Division 26 specifies the connection of all such work to the electrical system.
- C. Motors: Install all motors specified under other Divisions that are not factory mounted on the equipment. Align motors and drive equipment according to manufacturer's specifications. Repair or replace motors or equipment that are damaged or a malfunction due to improper handling or installation.

1.12 SHORING AND EQUIPMENT SUPPORTS

- A. The Contractor shall provide all permanent and temporary shoring, anchoring, and bracing required to make all parts absolutely stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.
- B. The Contractor shall adequately support all freestanding panels, motor control centers, enclosures, and other equipment. This shall include bolting to the floor or solid structural steel to prevent tipping. Install free-standing electrical equipment on 4" thick concrete housekeeping pads that are provided by others. Under no condition shall equipment be fastened to non-rigid building steel (i.e., removable platform steel gratings, handrails, etc.).
- C. The Contractor shall provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. At no time shall the Contractor mount or suspend equipment from other disciplines' supports.

1.13 TEMPORARY POWER REQUIREMENTS

- A. Provide power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, lighting, and start-up/testing of permanent electric-powered equipment prior to its permanent connection to electrical

system. Provide proper overload protection. Ground fault circuit interrupters (GFCI) are to be used on all 120-volt, single-phase, 15 and 20 amp receptacle outlets where portable tools and equipment are used. Ground fault circuit interrupters shall be tested weekly by the Contractor.

- B. Temporary power feeders shall originate from a distribution panel. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord.
- C. Branch circuits shall originate in an approved receptacle or panelboard. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord. Each branch circuit shall have a separate equipment grounding conductor.
- D. All receptacles shall be of the grounding type and electrically connected to the grounding conductor.
- E. Provide temporary lighting by factory-assembled lighting strings or by manually-assembled units. All lamps for general lighting shall be protected from accidental contact or breakage. Protection shall be provided by installing the lights a minimum of 7 feet from the work surface or by lamp holders with guards. Branch circuits supplying temporary lighting shall not supply any other load. Provide sufficient temporary lighting to ensure proper workmanship by combined use of day lighting, general lighting, and portable plug-in task lighting. Comply with OSHA required foot-candle levels and submit plan for approval by the owner.
- F. For temporary wiring over 600 volts, suitable fencing, barriers, or other effective means shall be provided to prevent access of anyone other than authorized and qualified personnel.
- G. Temporary power cords shall be kept off the ground or floor. The Contractor shall provide temporary supports as required to keep temporary cords off the ground or floor.

1.14 SUBSTITUTION OF MATERIALS AND EQUIPMENT

- A. Refer to Uniform General Conditions and Supplementary General Conditions for substitution of materials and equipment.
- B. The intent of the Drawings and/or Specifications is neither to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).
- C. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the designer is final.
- D. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

- E. **Timeliness:** The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.
- F. All equipment installed on this project shall have local representation; local factory authorized service, and a local stock of repair parts.
- G. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.
- H. **Certification:** The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.
- I. **Physical Size of Equipment:** Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.
 - 1. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

- A. **Manufacturers' Instructions:** Follow the manufacturers' published instructions for preparing, assembling, installing, erecting, and cleaning manufactured materials and equipment, unless otherwise indicated. Promptly notify the Owner's Representative in writing of any conflict between the requirements of the Contract Documents and the manufacturers' directions and obtain the Owner's Representative instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Owner's Representative, bear all costs arising in connection with the deficiencies.
- B. Minimum capacities are specified or noted.
- C. **Nameplates:** Each major component of equipment must have the manufacturer's name, address and catalog number on a plate securely attached to the item of equipment. All data on nameplates is to be legible at the time of Final Inspection.

- D. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts located so that any person can come in close proximity thereto, are to be fully enclosed or properly guarded.
- E. Materials and Equipment: Labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Materials shall be of a standard industrial quality if no specifications or specific model numbers are given.
- F. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.
- G. All materials shall be new and unused.
 - 1. Provide materials suitable for corrosive environments, such as non-metallic, aluminum or galvanized steel, where located outdoors or in corrosive areas or as otherwise specified.

2.2 EQUIPMENT IDENTIFICATION AND LABELING

- A. Nameplates: Laminated plastic, 3 layers, with engraved white 1/2" high letters. Secure nameplates to equipment or panel boards with self-threading machine screws.
 - 1. Emergency Power: Red-white-red.
 - 2. Normal Power: Black-white-black.
- B. Wire tags: Self-sticking vinyl cloth or Mylar Cloth.
- C. Panels and Disconnect Switches: Identify name nameplate voltage, phase, service, and load equipment.

EXAMPLE:

<u>PANEL PB</u>	<u>PANEL 3C</u>
277/480 3 PH 4W	120/108V 3 PH 4W
Fed from Pnl P	Fed from Pnl PC
1st Fl. Rm. 1.100	3rd Fl. Mach. Rm.

- D. Transformers: Identify name, primary voltage and connection type, secondary voltage and connection type, service, and load equipment.
- E. Distribution Panels: Identify the panel as specified above. Identify the load equipment for each circuit breaker and location (room number).
- F. Branch Circuit Panelboards: Identify the panel as specified above. Identify individual circuit breakers on typed circuit directories, placed under clear plastic in metal frames located inside the panel door. Furnish copies of all panel directories in the project manuals. Identify the loads by Owner designated room number for each breaker position. Identify all spares and spaces with erasable lead pencil.
- G. Motor Control Centers and Motor Starters: Identify name, voltage, phase, motor number, motor HP, motor FLA, and load.
- H. Wires: Identify circuit number and voltage.
- I. Receptacle Labels: Adhesive 1/2" white label with 1/4" letters, equal to Brother "P-Touch"

- J. Identify circuit which serves the receptacle, e.g. "2LA-7".
- K. Normal Circuits: Black letters.
- L. Emergency Circuits: Red letters.

2.3 FIRE SAFING OF PENETRATIONS

- A. Refer to Division 07 – Through Penetration Firestop Systems.

2.4 ACCESS DOORS

- A. General: Provide wall or ceiling access doors as specified in Division 08 for unrestricted access to all concealed items of mechanical equipment.
- B. Doors: Provide access doors for access to all electrical devices installed within, or concealed behind, finish materials.

PART 3 - EXECUTION

3.1 VERIFICATION OF DIMENSIONS

- A. Be responsible for the coordination and proper relation of all work with the building structure and to the work of all trades. Visit the premises and become thoroughly familiar with all details of the work and working conditions, verify all dimensions in the field and advise the Owner's Representative of any discrepancy before performing any work. Make adjustments to the work required in order to facilitate a coordinated installation at no additional cost to UTMB.

3.2 PRECEDENCE OF MATERIALS

- A. These Specifications and the accompanying Drawings are intended to cover systems which will not interfere with the structural design of the building, will fit within available spaces, and which will ensure complete and satisfactory operating systems. Be responsible for the proper fitting of materials and equipment into the building.
- B. Harmonize and coordinate work of all other trades so that it may be installed in the most direct and workmanlike manner. Address interferences by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order or precedence will, in general, be observed.
 - 1. Building Lines
 - 2. Structural Members
 - 3. Soil and Drain Piping
 - 4. Fuel Oil Gravity Return Piping
 - 5. Supply and Return Duct
 - 6. Exhaust Duct
 - 7. Vent Piping
 - 8. Refrigerant Piping
 - 9. Steam Piping
 - 10. Condensate Piping
 - 11. Electrical Bus Duct
 - 12. Circulating Chilled Water Piping
 - 13. Fuel Oil Supply Piping
 - 14. Domestic Hot and Cold Water Piping
 - 15. Medical Gas Piping
 - 16. Natural Gas Piping

- 17. Fire Sprinkler Piping
- 18. Electrical Conduit

3.3 PROTECTION

- A. At all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. Include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage if recommended by the manufacturer. Failure to comply with the above will be sufficient cause for the rejection of the items in question.
- B. Take particular care not to damage the building structure in performing work. Cover all finished floors, step treads and finished surfaces to prevent any damage by workmen or their tools and equipment during the construction of the building.
- C. Protect equipment and materials from rust both before and after installation. Any equipment found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these Specifications.
- D. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surface of ferrous metal is to be given a rust-inhibiting coating. The treatment must withstand 200 hours in salt-spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen is to show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust-inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, for items fabricated of steel sheet of 12 gauge and lighter, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to ASTM A 780. All steel heavier than 12 gauge specified to be galvanized must be hot dip galvanized after fabrication.

3.4 INSTALLATION ARRANGEMENT AND COORDINATION

- A. Location of Outlets in Rooms: Reference all plumbing, acoustical tile, modular lighting outlets, diffusers, grilles, registers and other devices to coordinated, established data points and locate to present symmetrical arrangements with these points and to facilitate the proper arrangements of acoustical tile panels and other similar panels with respect to the mechanical and electrical outlets and devices. Reference those mechanical and electrical outlets to such features as wall and ceiling furring, balanced border widths, masonry joints, etc. Outlets in acoustical tile must occur symmetrically in tile joints or in the centers of whole tiles. The exact location of each outlet and arrangements to be followed must be acceptable to the Owner's Representative.
- B. The Drawings show diagrammatically the location of the various outlets and apparatus. Exact locations of these outlets and apparatus is to be determined by reference to the general Drawings and to all detail drawings, equipment Drawings, rough-in Drawings, etc., by measurements at the building, and in cooperation with the other trades. The Owner's Representative reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.

3.5 SERVICE ACCESS

- A. Install all equipment in a manner to permit access to all surfaces as required by the National Electrical Code. Install all electrical devices, and other accessory items in a position to allow removal for service without disassembly of another part.

3.6 LARGE APPARATUS

- A. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts is to be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, protect such apparatus from damage as hereinafter specified.
- B. Storage at Site: Do not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

3.7 DEMOLITION AND RELOCATION

- A. Modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. Conduct all removals and/or dismantling in a manner as to produce maximum salvage. Salvage materials will remain the property of UTMB. Deliver salvaged materials and equipment to such destination as directed by the Owner's Representative unless they are not wanted, then remove such items from the UTMB campus and properly dispose of them. Repair and restore to good operative condition materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations. The Contractor may, at his discretion, and upon the approval of the Owner's Representative, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.
- B. Remove all items which are to be relocated in reverse order to original assembly or placement and protect until relocated. Clean, repair and provide all new materials, fittings and appurtenances required to complete the relocations and to restore them to good operative order. Perform all relocations by workmen skilled in the work and in accordance with standard practice of the trades involved.
- C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, call the attention of the Owner's Representative to such items and receive further instructions before removal. Be responsible for items damaged in repositioning operations and repair or replace as approved by the Owner's Representative, at no additional cost to UTMB.
- D. Remove service lines and wiring to items to be removed, salvaged, or relocated to points indicated on the Drawings, specified, or acceptable to the Owner's Representative. Remove service lines and wiring not scheduled for reuse to the points at which reuse is to be continued or service is to remain. Seal, cap, or otherwise tie-off or disconnect such services in a safe manner acceptable to the Owner's Representative. All disconnections or connections into the existing facilities must be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Do not interrupt services to existing areas or facilities which must remain in operation during the construction period without prior specific approval of the Owner's Representative.
- E. Remodeling and demolition work in the middle of an existing facility involves identification and location of many pieces of existing piping and equipment. Locations of much of this

is shown on project plans from information available. Cognizance of these variables must be considered in the bid to accomplish the intent of the plans and specifications.

- F. Plans are intended only as a guide to aid the Contractor in determining the scope of his work in the removal of existing work.
- G. Plans do not necessarily show all demolition nor all demolition that may be required by other trades in related areas.
- H. Where the project involves connection to existing power or other wiring, repair the insulation at the point of connection. Provide identification markers on the existing conduits within four feet of the connection, as well as on the run of new conduit.

3.8 INSTALLATION METHODS

- A. **Where to Conceal:** Conceal all pipes, conduits, etc., in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.
- B. **Where to Expose:** In mechanical rooms, janitor's closets tight against pan soffits in exposed precast concrete "Tee" Structures, or storage spaces, but only where necessary, piping may be run exposed. Route all piping in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines whether concealed or exposed.
- C. **Support:** All piping shall be adequately and properly supported from the building structure as specified in this Division and in accordance with the National Electrical Code.
- D. **Maintaining Clearance:** For new construction, where limited space is available above the ceilings, below concrete beams or other deep projections, sleeve pipe and conduit through the projection where it crosses, rather than hang below them, in a manner to provide maximum above-floor clearance. Approval shall be obtained from the Structural Engineer for each penetration.
- E. **Cut all pipe and conduits accurately and work into place without springing or forcing.** Include necessary offsets at j-boxes and other termination points. Install all ducts, pipes and conduits run exposed in machinery and equipment rooms parallel to the building lines, except that piping must be sloped to obtain the proper pitch. Install piping and ducts run in furred ceilings, etc., similarly, except as otherwise shown. Conduits in furred ceilings and other concealed spaces may be run at angles to the construction but must be neatly grouped and racked indicating good workmanship. All conduit and pipe openings must be kept closed until the systems are closed with final connections.
- F. **Study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of the extremely limited spaces.** Where conflicts occur, meet with all involved trades and resolve the conflict prior to erection of any work in the area involved.

3.9 CONSTRUCTION REVIEW

- A. **Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, notify the Owner's Representative and the Architect so that arrangements can be made for a construction review of the above-ceiling area about to be "sealed" off.** Give as much advance notice as possible, up to 10 working days, but no less than 5 working days.

- B. All above-ceiling areas will be subject to a formal construction review before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets and lighting fixtures, is to be complete and installed in accordance with contract requirements, including power to lighting fixtures, fans, and other powered items. Provide adequate lighting to permit thorough construction review of all above-ceiling items. The construction review will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling and the Owner's Representative. Coordinate areas to be included and time of construction review with all parties.
- C. The purpose of this construction review is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, the fire protection system and any other special above ceiling systems such as pneumatic tube, vacuum cleaning, and cable tray systems. The ceiling supports (tee bar or lath) must be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
- D. No ceiling materials may be installed until the resulting punch list from this construction review is worked off and the Owner's Representative has given approval.
- E. Review, observation, assistance, and actions by the Engineer or Owner's representative shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The review and observation activities shall not relieve the Contractor from the responsibilities of these Contract Documents.
- F. The fact that the Engineer or Owner's Representative do not make early discovery of faulty or omitted work shall not bar the Engineer or Owner's Representative from subsequently rejecting this work and insisting that the Contractor make the necessary corrections.
 - 1. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the Engineer or Owner's Representative for an increase in the Contract price, or for any payment on account of increased cost, damage, or loss.

3.10 EXCAVATION, TRENCHING AND BACKFILLING

- A. Refer to Division 02 sections for requirements.
- B. Install all exterior lines with a minimum cover of 24", unless otherwise indicated. Generally, provide more cover if grade will permit.

3.11 FOUNDATIONS

- A. Provide concrete foundations for the support of equipment such as floor-mounted panels, water heaters, pumps, fans, fire pumps, switchboards, transformers, capacitor banks., not less than 6" high and extended 4" on all sides beyond the limits of the mounted equipment unless otherwise noted. Pour in forms built of new-dressed lumber. Chamfer all corners of the foundations neatly by means of sheet metal or triangular wood strips nailed to the form. Place foundation bolts in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt is to be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, remove the forms and hand rub the surface of the foundations with carborundum. Provide foundations for equipment located on the

exterior of the building as indicated. Construct foundations in accordance with Division 03 sections.

3.12 CONNECTION OF EQUIPMENT SUPPLIED BY OTHERS

- A. Rough-in for and make all connections to all fixtures, equipment, machinery, etc., provided by others in accordance with detailed rough-in Drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

3.13 WORKMANSHIP

- A. Install work in compliance with NEC latest edition.
- B. Install material and equipment in accordance with manufacturers' instructions. Provide calibrated torque wrenches and screwdrivers and tighten all terminals, lugs, and bus joints using it.
- C. Comply with startup procedures as defined by Construction Manager and Owner.
- D. Arrange electrical work in a neat, well-organized manner. Do not block future connection points of electrical service. Install all electrical work parallel or perpendicular to building lines unless noted otherwise, properly supported with purpose-designed apparatus, in a neat manner.
- E. Apply, install, connect, erect, use, clean, adjust, and condition materials and equipment as recommended by the manufacturers in their published literature.
- F. Make opening through masonry and concrete by core drilling in acceptable locations. Restore openings to original condition to match remaining surrounding materials.

3.14 SERVICE CONTINUITY

- A. Maintain continuity of electric service to all functioning portions of process or buildings during the hours of normal use. Phase construction work to accommodate Owner's occupancy requirements.
- B. Arrange temporary outages for cutover work with the Owner. Keep the outages to a minimum number and minimum length of time.
- C. All service outages shall be requested in writing a minimum of two weeks prior to the date. Owner reserves the right to postpone shutdowns up to 24 hours prior to the shutdown at no additional cost. Outage requests shall include a schedule of the work to be performed and the time requirements.
- D. The Contractor shall obtain all appropriate Owner permits for working in equipment.

3.15 HAZARDOUS LOCATIONS

- A. Equipment, wiring, devices, and other components located within hazardous areas to be of appropriate type per NFPA requirements.
- B. Ground exposed non-current carrying parts of entire electrical system in hazardous areas, in accordance with NEC and as instructed by Owner.

3.16 SLEEVES AND SEALS

- A. Provide sealing and/or fire stopping where electrical equipment passes through walls, ceilings, and floors. Seals shall be watertight and/or fire rated as applicable.

END OF SECTION

SECTION 26 00 00.01
ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electrical demolition for remodeling.
- B. Electrical/control portion of HVAC work covered by Division 23 pertaining electrical demolition shall follow the requirement set forth by this specification.

1.2 RELATED WORK

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for minor electrical demolition for remodeling.
 - 1. Section 26 00 00 - Basic Electrical Requirements.
- B. In the event of conflict regarding minor electrical demolition requirements between this Section and any other Section, the provisions of this Section shall govern.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: as specified in individual Sections.
- B. Provide all materials necessary for work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. All demolitions or modifications to existing systems shall be coordinated through Owner's Representative. Demolition drawings are based on casual field observation and existing record documentations. Therefore the accuracy or exactness of the drawings is not guaranteed. The Contractor shall verify that field measurements and circuiting arrangements are as shown on Drawings and abandoned wiring and equipment serve only abandoned facilities. The Contractor shall be responsible for reporting discrepancies to Engineer before disturbing existing installation.
- B. Beginning of demolition means Contractor accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal. Provide temporary wiring and connections to maintain remaining systems in service during demolition and/or modification. Owner reserve the right up to 24 hours prior to any scheduled event to delay or suspend shutdowns or outages to more convenient times at no additional cost.
- B. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. No work shall begin without proper permits and

authorizations. Disable system only to make switchovers and connections. Obtain permission from Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

- C. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Provisions for manual fire watch shall be provided in areas where services are interrupted. Make temporary connections to maintain service in areas adjacent to work area.
- D. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Notify Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new plan drawings.
- B. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes full length from source to device. Cut embedded or concealed conduit flush with walls and floors, and patch surfaces.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- D. Disconnect and remove abandoned panelboards and distribution equipment.
- E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- G. Repair adjacent construction and finishes damaged during demolition and extension work.
- H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- I. Extend existing installations using materials and methods compatible with existing electrical installation or as specified.
- J. The level of completion shall be demonstrated to Owner's Representative.
- K. Where equipment is indicated to be demolished and returned to Owner, the Contractor shall include the delivery of this equipment to the Owner's site storage area. Remove with care all equipment to be relocated. Repair or replace of newly damaged equipment is the responsibility of the Contractor.

3.4 CLEANING AND REPAIR

- A. The Contractor shall follow Owner's clean work policy and shall include the removal of trash and demolished material from the building or work area at the end of the each day and removal from the site once a week.
- B. The Contractor shall be responsible for repairing adjacent construction and finishes damaged during demolition and/or modification. The Contractor shall be responsible for the removal of ceiling tiles required in the demolition work. The Contractor shall be responsible for the replacement of damaged tiles and reinstallation of the ceiling prior to final acceptance.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts.

3.5 DISPOSITION OF MATERIAL AND EQUIPMENT

- A. Review with the Owner materials that have been removed and are no longer required, to determine any which the Owner may desire to keep. Deliver those materials that the Owner desires to the Owner's specified location.
- B. For those materials not required by the Owner, dispose of them in accordance with applicable regulations.

END OF SECTION

SECTION 26 05 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Hinged cover enclosures and cabinets
- B. Contactors
- C. Control relays
- D. Push buttons, and selector switches
- E. Terminal blocks and accessories
- F. Penetration sealing systems (fire stops)
- G. Electrical/control portion of HVAC work covered by Division 23 pertaining basic electrical materials and methods shall follow the requirement set forth by this specification.

1.2 APPLICABLE CODES AND STANDARDS

- A. NFPA 70, National Electrical Code (latest edition)
- B. American National Standard, National Electrical Safety Code, (latest edition)
- C. Applicable publications of NEMA, ANSI, IEEE, and ICEA
- D. Underwriters Laboratories, Inc. Standards (UL)
- E. Federal, city, state, and local codes and regulations having jurisdiction
- F. OSHA requirements
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- H. NEMA WD 1 – General-Purpose Wiring Devices
- I. UL 98 - Enclosed Switches

1.3 INTENT

- A. This Section is not, and shall not be interpreted to be, a complete listing of all materials or equipment that is Contractor furnished and erected. It is intended to clarify and further define the Contractor scope of work, procurement, and responsibilities for those incidental materials that are not specified by other specifications, but important to a complete and operational system.
- B. The Contractor shall furnish all equipment and materials, whether or not specified in other Sections of specification and on drawings, for installation and connection required to place equipment into satisfactory operating service. The Contractor shall review the Drawings and specifications for clarification of his responsibility in the handling and installation of equipment and material. Where applicable, and not in contradiction with

the Drawings and specifications, the Contractor shall install and connect the equipment in accordance with the manufacturer's recommendations and instructions.

- C. All materials and equipment shall be of types and manufacturer specified wherever practical. Should materials or equipment so specified be unattainable, the Contractor shall submit the description and manufacturer's literature, reason for substitution request and shall secure the approval of the Engineer before substitution of other material or equipment is purchased. This Section establishes performance requirements and the quality of equipment acceptable for use and shall in no way be construed to limit procurement from other manufacturer.

1.4 SUBMITTALS

- A. Provide submittals in addition and in accordance with Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.
- B. Submit manufacturer's literature and specification data sheets for each type of basic material, which is applicable to the project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-wrapped waterproof flexible barrier material for covering materials, where applicable, to protect against physical damage in transit. Damaged materials shall be removed from project site.
- B. In their factory-furnished coverings, store materials in a clean, dry indoor space, which provides protection against the weather.

PART 2 - PRODUCTS

2.1 ENCLOSURES AND CABINETS

- A. Enclosures and cabinets for all Contractor furnished electrical equipment and devices shall be suitable for the location and environmental conditions and shall be of the NEMA type as shown in Table 26 05 00-1. Exceptions shall be specifically designated on the Drawings.

Table 26 05 00-1 Enclosures		
Location	Environment	Enclosure Type
Indoor Utility	Dry, subject to dust, falling dirt and dripping non-corrosive liquids	NEMA 12
Indoor	Clean, Dry	NEMA 1
Indoor	Wet, subject to hose-directed water	NEMA 4
Indoor corrosive or Outdoor	Subject to corrosion, windblown dust and rain, splashing water and hose-directed water	NEMA 4X

- B. Enclosures shall have the following properties:
 - 1. Hinged Cover Enclosures: NEMA 250.
 - a. Type 1: Steel.
 - b. Type 4: Steel with gasket door, rain tight.
 - c. Type 4X: Stainless steel, (polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas).
 - d. Type 12: Steel with gasketed door, dust-tight.

- C. Finish: Exterior, manufacturer's standard gray enamel finish; interior, white enamel finish.
- D. Covers: Continuous hinge, held closed by flush latch operable by hasp and staple for padlock. Where required for NEMA ratings, gaskets shall be neoprene rubber.
- E. Interior Panel for Mounting Terminal Blocks or Electrical Components: 14-gauge steel, white enamel finish.
- F. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.
- G. Forced Ventilation: Where indicated, provide 115V single-phase fan motor, filtered with air plenum, finger guard, and stainless steel grille. Washable aluminum filter, accessible for cleaning from outside the enclosure; 20,000-hour continuous operation without lubrication or service. Provide matching exhaust grille assembly. Mount fan in lower side corner, exhaust grille in opposite upper side corner.

2.2 CONTACTORS

- A. Acceptable Manufacturers:
 - 1. General Electric Company
 - 2. Square D Company
 - 3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.
- B. Contactors: NEMA ICS 2; electrically held or mechanically held as indicated on Drawings. Two-wire control for electrically held contactors and three-wire control for mechanically held contactors.
- C. Enclosure: NEMA 1 unless indicated otherwise on Drawings.
- D. Control Transformer: Provide when indicated on Drawings. Minimum capacity shall be 100 VA. Provide primary and secondary fuse protection.
- E. Coil operating voltage; 110 volts, 60 Hz or as per drawings.
- F. Size: NEMA ICS 2; size as indicated on Drawings.
- G. Contacts: As indicated on Drawings; 600 Volts, 60 Hz.
- H. Provide solderless pressure wire terminals on bus terminals suitable for mounting in panelboard as indicated on Drawings.

2.3 CONTROL RELAYS

- A. Acceptable Manufacturers
 - 1. General Electric Type CR120A
 - 2. Cutler-Hammer Type M-300
 - 3. Square D Company
 - 4. Allen-Bradley
 - 5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

- B. Provide magnetic control relays, NEMA Class A: A300 (300 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control type with field-convertible contacts, and meeting the requirements of NEMA ICS 2.
- C. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a solid-state timer attachment adjustable from 0.2 to 60 seconds (minimum) or with range as indicated. Provide with field convertible from ON delay to OFF delay and vice versa.
- D. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts.

2.4 PUSH BUTTONS, AND SELECTOR SWITCHES

- A. Acceptable Manufacturers
 - 1. Allen-Bradley
 - 2. Square D
 - 3. Cutler Hammer
 - 4. Seimens
 - 5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.
- B. For non-hazardous, indoor, dry locations, including control panels, and individual stations, provide heavy duty, NEMA 13, oil tight type pushbuttons, indicating lights, selector switches, and stations for these devices.
- C. For non hazardous, or normally wet locations, or where otherwise indicated, provide heavy duty corrosion resistant, NEMA 4, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4 watertight enclosures. Provide special gasketing required to make complete station watertight.
- D. For hazardous locations, provide control station listed by UL for Class I, Divisions 01 and 02, Groups C and D; Class II, Division 01 and 02, Groups E, F, and G. Specific type shall be in accordance with area classification as indicated on the Drawings.
- E. For outdoor and corrosive locations, provide nonmetallic components and enclosures meeting NEMA Type 4X.
- F. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide push-button stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated. Nameplates shall be as specified in Section 16195.
- G. Utilize selector switches having standard operating levers. All indicating lights shall be LED type, push-to-test type. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

2.5 TERMINAL BLOCKS AND ACCESSORIES

- A. Signal And Control Terminals:
1. Acceptable Manufacturers
 - a. Phoenix Contact
 - b. Buchanan
 - c. Weidmüller
 - d. Entrelec
 - e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 23 00 00 and Division 01 for substitution requirement.
 2. Signal and Control Terminals: Modular construction type, DIN 46 277/3 channel mounted; screw clamp compression connectors, rated 300 volts. Minimum terminal width of 0.24-inch, capable of holding two No. 12 or two No. 14 AWG conductors in each connector. Terminal identification numbers shall be thermoset characters (black) on a white background. Provide 25 percent spare terminals.
- B. Power Terminals
1. Acceptable Manufacturers
 - a. Buchanan
 - b. IlSCO
 - c. Square D Company
 - d. Burndy
 - e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.
 2. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts, size as required. Provide 25 percent spare terminals.

2.6 PENETRATION SEALING SYSTEMS (FIRE STOPS)

- A. Provide sleeves for all conduit penetrations. Provide penetration sealing where conduit, cable tray, etc. pass through rated walls, ceilings, and floors. See Section 07840, Fire Stopping, and Section 07900, Joint Sealants, for sealing requirements and systems. No split sleeves are allowed.

2.7 UL LISTING

- A. All equipment and materials shall be new and conform to the requirements of this Section. All equipment and materials shall be UL listed, and shall bear their label whenever standards have been established and level service is regularly furnished. All equipment and materials shall be of the best grade of their respective kind for the purpose.

PART 3 - EXECUTION

3.1 FABRICATION - CONTROL ENCLOSURES AND CABINETS

- A. Shop assembles enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.

3.2 INSTALLATION - ENCLOSURES AND CABINETS

- A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to dry wall is not permitted.
- B. Provide accessory feet for freestanding equipment enclosures.
- C. Install trim plumb.

3.3 ERECTION OF EQUIPMENT

- A. Manufacturer's Installation Instructions: Where furnished or called for by the manufacturer equipment manufacturer's installation instructions shall be considered a part of this specification and fully complied with. Where the Contractor damages the finishing coat of paint in existing or completed areas, he shall refinish with matching paint.
- B. Mounting Heights: Individual safety switches and buttons and devices shall normally be installed at the following mounting heights, when not specified on the Drawings.
 - 1. Safety Switches: 6 feet 0 inches (to top).
 - 2. Pushbuttons: 4 feet 0 inches (to center).
 - 3. Control Panels: 6 feet 0 inches (to top).
- C. Mounting: Equipment and control devices shall be supported independent of conduit connections. Panels or cabinets shall be mounted on metal frame supports independently of equipment. Control devices and metal enclosures shall be bolted or welded to steel channel or steel plate. All electrical equipment and devices not covered by the above, such as miscellaneous switches, thermostats, duct switches, temperature switches, floats, photoelectrical devices, and similar electrical devices shall be located and set as suitable for the application. Where control panels are provided as part of the equipment racks mounted on the floor, they shall be provided to support conduits and flexible connections to control panels.

3.4 COORDINATION

- A. Exact location of all electrical equipment, devices and fixtures shall be determined in field by contractor and verified by Engineer's field representative prior to installation.

END OF SECTION

SECTION 26 05 19

CABLE, WIRE AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.
 - 1. Where the term "Owner's Designated Representative" is used, it shall mean a member of the project's capital team as defined by UTMB, Facilities Development, 301 University Boulevard, Galveston, Texas 77555-1116. Phone (409) 772-3500, Fax (409) 772-5199.

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. ASTM B3 – Standard specification for soft or annealed copper wire for electrical purposes.
- C. NEMA WC 3: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- D. NEMA WC 5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.3 RELATED SECTIONS

- A. 26 00 00 – Basic Electrical Requirements.

1.4 SUBMITTALS

- A. Refer to Division 01. Submit manufacturer's data for 600 volt cable, wire and connectors.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Generally, cable, wire and connectors shall be of manufacturer's standard materials, as indicated by published product information.
- B. Provide factory-fabricated wire of the size, rating, material and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be #12 copper with insulation as noted below. Minimum size for control shall be #14 copper.
- C. The conductors of wires and cables shall be of copper (tinned where specified), and have conductivity in accordance with the standardization rules of the IEEE. The conductor and each strand shall be round and free of kinks and defects.

- D. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by the NEC. Conductors intended as a neutral shall be colored solid white, or identified as required by the NEC. All motor or equipment power wiring shall be colored according to Section 26 05 53, Electrical Identification.
- E. All cable specified for use in tray shall be multiconductor and shall have an outer jacket of flame-retardant, moisture and sunlight resistant polyvinyl chloride (PVC) and shall be UL and NEC approved type for tray installation.
- F. All low voltage power and control cable installed in open cable tray above ceilings used for return air shall be plenum rated. Where tray cable is not available in size and type required, conductors shall be installed in conduit.
- G. Use compression lugs for all wiring termination's, except on breakers or terminal strips in panel boards.

2.2 BUILDING WIRE

- A. Manufacturers:
 - 1. Cablec.
 - 2. General.
 - 3. Essex.
 - 4. Okonite.
 - 5. American.
 - 6. Diamond Wire.
 - 7. Capital.
 - 8. Rome.
 - 9. Southwire.
 - 10. Triangle PWC.
- B. Description: New single conductor insulated wire, uniform in cross-section, free from flaws, scales and imperfections. Use Standard American wire gauge sizes.
- C. Conductor: Soft drawn annealed copper conforming to the requirements of ASTM B3; conductivity not less than 98% of that of pure copper.
- D. Insulation Voltage Rating: 600 volts.
- E. Insulation: ANSI/NFPA 70, Type THHN/THWN.
- F. Feeders and Branch Circuits-All sizes: 98% conductivity copper, soft-drawn, stranded conductor, 600 volt insulation, THHN/THWN-2 Use XHHW-2 conductors where installed in conduit underground.

2.3 FIXTURE WHIPS

- A. Manufacturers:
 - 1. AFC.
 - 2. Allflex.
 - 3. Cablec.
 - 4. Kaf-Tech.
- B. Description: ANSI/NFPA 70, Type AC.

- C. Wire: Solid copper conductor with 600 volt, 90°C thermoplastic insulation, minimum No. 14 AWG.
- D. Armor: Galvanized steel interlocking tape.
- E. Ground: Provide a full size ground wire, green insulation.
- F. Regulatory Requirements:
 - 1. Conform to the requirements of the current edition of the NEC.
 - 2. Satisfy the specifications of ASTM B3.
- G. Identification: Permanent identification at regular intervals of:
 - 1. Size.
 - 2. Insulation.
 - 3. Manufacturer.
 - 4. Voltage.

2.4 APPLICATION

- A. Minimum size:
 - 1. Power and Lighting Circuits: No. 12 AWG.
 - 2. Control Circuits: As recommended by equipment manufacturer.
- B. Conductor:
 - 1. No. 12 AWG and Smaller: Solid.
 - 2. No. 10 and Larger: Stranded.
 - a. No. 2 and Smaller: ICEA Class BV.
 - b. No. 1 AWG and Larger: ICEA Class C.
- C. Color coding.
 - 1. Provide integrally pigmented insulation as follows:

	120/208 V Systems	277/480 V Systems
Phase A	Black	Brown
Phase B	Red	Purple
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
 - 2. No. 8 AWG conductors and larger may be identified by 3M Scotch Brand 35 or Electrotape #60 fade resistant colored electrical tape or other approved means.

2.5 CONNECTORS

- A. Manufacturers:
 - 1. Scotch.
 - 2. Ideal.
 - 3. Burndy.
 - 4. Buchanan.
 - 5. 3M.
 - 6. Thomas and Betts.
 - 7. Mac.
 - 8. Anderson/Square D.
 - 9. NSI.

- B. Application:
- C. Solid Conductors: Insulated spring wire connectors.
- D. Stranded Conductors No. 8 AWG and Larger: Inline, long barrel compression connectors.

2.6 LOW-VOLTAGE CABLE

- A. Manufacturers
 - 1. Belden.
 - 2. Berk-Tek.
 - 3. Mohawk.
- B. Regulations: Comply with all requirements of the following:
 - 1. NEC Article 725 - Class 1, Class 2, and Class 3 remote control, signaling and Power-Limited Circuits.
 - 2. NEC Article 760 - Fire Protective Signaling Systems.
 - 3. NEC Article 770 - Optical Fiber Cables (1984 Edition).
 - 4. NEC Article 800 - Communication Circuits.
 - 5. UL Subject 910.
 - 6. EIA/TIA 568.
 - 7. EIA/TIA 569.
 - 8. Section 16741 – Telecommunications Interior Distribution.
- C. Marking: Indicate UL Classification and compliance with the appropriate National Electrical Code Article.

2.7 PULLING LUBRICANT

- A. Manufacturers:
 - 1. Ideal # Yellow – 77.
 - 2. T&B.
 - 3. Polywater.
 - 4. 3M.

2.8 M/C CABLE

- A. M/C cable is not permitted.

2.9 2-HOUR UL-LISTED FIRE-RATED SYSTEM

- A. Listing:
 - 1. UL 2196. Systems constructed with fire-resistive cable. Exposure up to 1850°F with immediate application of water hose stream and maintenance of full utilization voltage and electrical load throughout the duration of the test.
 - 2. UL 1724. Systems incorporating cable protected with electrical circuit protective materials.
 - 3. UL 44 for Thermoset-Insulated Wires and Cables (Type RHH or RHW).
 - 4. UL 83 for Thermoplastic-Insulated Wires and Cables.
 - 5. UL Fire Resistance Directory:
 - a. Electrical Circuit Protective system (FHIT) No. 27.
 - b. Electrical Circuit Protective system (FHIT) No. 25.
 - c. Accepted substitution.

- B. UL-listed two-hour fire rated circuit protective systems shall be used where approved by the NEC and where proposed substitutions are accepted in writing by the Architect/Engineer and the Owner. Refer to Division One requirements for submittals and substitutions.
 - 1. Mineral-insulated (MI) cable per NEC-332.
 - 2. UL-listed fire-wrapping for conductors rated 600 volt and below.

PART 3 - EXECUTION

3.1 DELIVERY AND STORAGE

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.
- C. Delivery in complete coils or reels. Identify each reel with size and insulation type.
- D. Protect from weather and damage during delivery and storage.

3.2 WIRE AND CABLE INSTALLATION

- A. Install all wire and cable in raceway in exposed locations. Plenum rated cable is allowed in concealed locations.
- B. Install wire continuous without splice. Pull all conductors into raceway simultaneously.
- C. Completely and thoroughly swab raceway before installing wire.
- D. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 100 feet. Maximum Voltage Drop: 5 volts.
- E. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet. Maximum Voltage Drop: 10 volts.
- F. Install no more than three circuits in a single conduit. Provide dedicated neutrals for each branch circuit located in a common conduit.
- G. Use wire pulling lubricant for building wire 6 AWG and larger.
- H. Use split bolt connectors for copper wire splices and taps, 6 AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- I. Protect exposed cable from damage.
- J. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- K. Clean conductor surfaces before installing lugs and connectors.
- L. Splices and Tape:
 - 1. Make splices and taps to carry full ampacity of conductors with no perceptible temperature rise.
 - 2. Make splices in conductors larger than 10 AWG only where approved. Use in-line compression type connectors with manufacturer's recommended crimping tool.
 - 3. Provide splice box or wireway for all splices and taps.

- M. Support conductors in vertical raceways at intervals which satisfy the requirements of the National Electrical Code. Provide additional supports indicated on the Drawings.
- N. Identify each conductor with its circuit number in accordance with Section 26 00 00.

3.3 CONNECTIONS TO EQUIPMENT BY OTHER DIVISIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions and approved shop drawings.
- B. Make conduit connections to equipment using galvanized steel flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations. Minimum length: 48 inches.
- C. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- D. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- E. Provide wiring for and make connections to motor heaters specified by Division 23.

3.4 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Division 01.
- B. Inspect wire and cable for physical damage and proper connection.
- C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- D. Test all power, lighting, and control wiring for continuity, polarity, short circuits and improper grounding.
- E. Test each grounding circuit for continuity.
- F. Perform a dielectric absorption ratio insulation resistance test for each feeder circuit and each motor branch circuit for 50 HP motors and larger. Test circuit at 1000 V DC and measure values at 30 sec and 60 sec. Measured values must conform to acceptable limits established by the NEC, NFPA 99, and cable manufacturer.
- G. Replace defective wiring identified by above tests.
- H. Leave the entire electrical system installed under this Contract in proper working order. Upon completion of the installation, verify proper operation under the direction of the Owner and Engineer of all switches, circuit breakers, transformers, lighting, relays, and other electrical equipment and controls.
- I. Document all tests on Owner approved forms.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 REFERENCES

- A. NFPA 70 – National Electrical Code.
- B. NECA 1-2000 – Standard Practices for Good Workmanship in Electrical Contracting.
- C. NFPA 99 – Standard for Health Care Facilities.
- D. Texas Department of Health Services (TDHS) – Hospital Licensing Rules.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Ground Electrode Conductors: Stranded, tinned, annealed copper cable.
- B. Equipment Grounding Conductors: As specified by Section 16120, green insulation, sized in accordance with NFPA 70Code, Table 250.122.
- C. Grounding Clips: Steel City Type G, or equal.
- D. Ground Rods: Copper-encased steel, 3/4" diameter, minimum length 10 feet.
- E. Provide bare conductors for bonding jumpers.
- F. Ground Bus. Where a field-provided ground bus is required, use round-edge copper bar with 98 percent International Annealed Copper Standard (IACS) conductivity. Size the bus for not less than 25 percent of the cross-sectional area of the related feeder. A minimum size of 1/4 inch {6 mm} by 2 inches {51 mm} is required.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install ground system as indicated, in accordance with the applicable requirements of the NFPA 70 and NECA 1-2000.
- B. Install #6 AWG grounding electrode conductors or larger in conduit, bonded at each end.
- C. Install grounding conductors continuous, without splice.
- D. Provide a separate, insulated equipment grounding conductor in all feeder and branch circuit conduits. Terminate each end on a grounding lug, bus, or bushing.

- E. Bond grounding electrode conductors to metal water pipe using suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
- F. Install Exothermic Welded ground connectors where they are concealed or inaccessible.
- G. Install internal ground wire on liquid tight flexible metal conduit.
- H. Electrical Service: Bond main switchboard ground bus to grounding electrode system.
- I. Bond all equipment cabinets, junction boxes, outlet boxes, motors, controllers, raceways, conduit, fittings, switchgear and other metallic equipment and enclosures with an equipment grounding conductor. Unless some separate grounding provision is specified or indicated, equipment and enclosures will be considered to be grounded by the continuous grounded metallic conduit or raceway system; however, provide bonding jumpers and grounding conductor shall be provided wherever necessary to insure the electrical continuity.
- J. Motors: Ground each motor by means of a separate grounding conductor securely and permanently attached to the motor housing.
- K. Dry Type Transformers:
 - 1. Transformers with Secondary Neutrals: Ground each transformer by means of a separate grounding conductor in the primary feeder conduit. Terminate the feeder conduit with a grounding bushing. Bond the grounding conductor to the secondary neutral, the transformer housing and feeder conduit grounding bushing.
- L. Conduit Grounding Bushings: Install grounding bushings on all Conduits terminating in equipment that has a ground bus. Ground each conduit by means of a grounding conductor securely and permanently attached to the grounding bushing and to the ground bus in the equipment.

3.2 GROUND RESISTANCE MEASUREMENTS

- A. Method: The Fall Of Potential method accurate within plus or minus two (2) per cent.
- B. Instrument: Biddle Digital Resistance Tester Catalog Number 250200.
- C. Maximum Acceptable Resistance: Two (2) OHMS.
- D. Documentation:
 - 1. Method and equipment used for measurement.
 - 2. Calibration date of equipment used.
 - 3. Plot plan outlining measurement points.
 - 4. Name of person(s) performing measurement.
 - 5. Date of test.

END OF SECTION

SECTION 26 05 29

SECURING AND SUPPORTING METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Raceway, cable tray, and equipment supports
- B. Fastening hardware
- C. Coordinate location of concrete equipment pads

1.2 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry. Support systems shall be sized adequately to support an additional 25% for future loads

1.3 COORDINATION

- A. Coordinate with other trades where conduit and cable tray supports are in the same location as piping, ductwork, and work of other trades and where supports are furnished and installed under other Divisions. Supporting from the work or supports of other Contractors shall not be allowed except by express, written permission of the Owner.

1.4 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 00 00.UT, Basic Electrical Requirements, and Division 01 for submittal requirement.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Support Channel:
 - 1. All non-corrosive locations: Hot-dip galvanized steel.
 - 2. Corrosive locations: Nonmetallic fiberglass.
- B. Hardware:
 - 1. All non-corrosive locations: Hot-dip galvanized steel.
 - 2. Corrosive locations: Stainless steel threaded rod, attachments and fasteners shall be used with fiberglass supports.
- C. Threaded Rod: used for rack support from structure above; 3/8-inch minimum diameter.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, or beam clamps. Do not use spring steel clips and clamps. Provide necessary calculations to select proper support materials for electrical equipment, raceway, and cable tray supports. Provide cable tray supports for cable tray filled to 125 percent capacity per NEC.

- B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NEC for installation of supporting devices. Install supports with spacing in compliance with NEC requirements.
- C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors in solid masonry walls; or concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- D. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.
- E. Do not use powder actuated anchors without written permission from the Engineer.
- F. Do not drill structural steel members without written permission from the Structural Engineer.
- G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- H. Bridge studs top and bottom with channels to support recessed mounted cabinets and panelboards in stud walls.
- I. Install surface mounted cabinets and panelboards with a minimum of four anchors. Provide strut channel supports to stand cabinet 1-5/8 inches off wall. Utilize "Post Bases" where support channel is attached to structural floor.
- J. Provide extra care in supporting PVC conduit to protect it from potential damage.
- K. Use fiberglass for nonmetallic raceway systems supports in areas subject to corrosives.
- L. All supports in contact with floor using stanchion type support shall be solidly bolted to the permanent structural floor.
- M. Conduit supports shall have at a minimum, the bottom support member constructed of double strut. This horizontal member shall be double-nutted, and the supporting all-thread rod shall be trimmed to one inch below lowest nut.
- N. Conduit entering/exiting cable tray shall be attached to the tray rail by means of unistrut bolted to the rail and standard manufacturer's accessories. Conduit shall only enter/exit tray horizontally supported within three feet of the tray, and extended into the tray two inches. Conduit shall be terminated with a grounding bushing, and bonded to the tray ground wire. (The attachment to the tray shall not be considered a support.)
- O. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- P. Install freestanding electrical equipment on 4-inch concrete pads. Pad shall be a minimum four inches larger than equipment. No crevices shall be left around the pads. Equipment includes but not limited to the following:
 - 1. Motor Control Centers
 - 2. Static Transfer Switches
 - 3. Floor mounted VFDs
 - 4. Floor mounted transformers
 - 5. Switchboards, 1200A and larger

- Q. Do not anchor supports to columns. Where panelboards, cables, or conduits are routed on the face of a column provide "column hugging" channel supports.

3.2 TOUCH-UP

- A. Touch-up all scratches on securing and supporting system, and paint the ends of channel after cutting with an approved zinc chromate or 90 percent zinc paint.

END OF SECTION

SECTION 26 05 33

RACEWAYS, CONDUIT, AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 REFERENCES

- A. ANSI C80.1 – Rigid Steel Conduit, Zinc-Coated.
- B. ANSI C80.3 – Electrical Metallic Tubing, Zinc Coated.
- C. ANSI/NEMA FB 1 – Fittings and Supports for Conduit and Cable Assemblies.
- D. ANSI/NEMA OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
- E. ANSI/UL 1 – Flexible Metal Conduit.
- F. ANSI/UL 5 – Surface Metal Raceways and Fittings.
- G. ANSI/UL 360 – Liquid-tight Flexible Steel Conduit.
- H. ANSI/UL 467 – Electrical Grounding and Bonding Equipment.
- I. ANSI/UL 797 – Electrical Metallic Tubing.
- J. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
- K. Underwriter's Laboratories Standard UL-5A.
- L. ANSI/UL 651 – Schedule 40 and 80 Rigid PVC Conduit.
- M. EIA/TIA Standard 568A.
- N. ANSI/UL 651 – Electrical Metal Tubing
- O. ANSI/UL 870 – Wireways Auxiliary Gutters and Fittings
- P. UL 6 – Rigid Metal Conduit

1.3 SECTION INCLUDES

- A. Conduit.
- B. Conduit fittings.
- C. Conduit accessories.
- D. Surface metal raceways.

- E. Wireway.
- F. Boxes.
- G. Manholes and in-ground pullboxes.

1.4 RELATED SECTIONS

- A. Division 02 - Excavation, Backfilling, and Trenching.
- B. Division 02 - Site Grounding.
- C. Division 07 - Fire Stopping.
- D. Division 07 - Roofing Penetrations.
- E. Section 26 00 00 – Basic Electrical Requirements.
- F. Section 26 05 19 – Cable, Wire and Connectors.
- G. Section 26 05 26 – Grounding.
- H. Refer to Division 01. Submit manufacturer's product data for conduit, boxes, wireways, raceways, in-ground pull boxes and manholes.

1.5 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 00 00.UT, Basic Electrical Requirements, and Section 01330, Submittal Procedures.
- B. Shop drawings consisting of a complete list of equipment and materials, which will be used for the project, including manufacturer's descriptive and technical literature, catalog cuts and installation instructions.
- C. Submit detailed shop drawings for Bio-Safety Level 3 (BSL3) area sealed conduit systems, raceway seals and sealing fittings. Refer to Division 7 requirements for sealing and firestopping materials.

1.6 STORAGE AND HANDLING

- A. Handle materials carefully to avoid damage, breaking, denting and scoring. Damaged equipment or materials shall not be installed.
- B. Store materials in a clean dry space and protected from the weather.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. General: Install all wiring in conduit in accordance with latest edition of National Electrical Code and these Division 26 Specifications.
- B. Application Requirements:
 - 1. Minimum Size: 3/4 inch unless otherwise specified. Flexible conduit connections to lighting fixtures may be 3/8 inch not to exceed 72 inches in length.
 - 2. General: Use rigid steel conduit for all applications except as noted below.
- C. Underground Installations:

1. Use thick wall schedule 40 nonmetallic conduit or rigid steel conduit.
 2. Minimum Size: 1 inch.
 3. Before turning to above grade, transition to rigid steel conduit. All elbows and 90° fittings shall be rigid steel conduit. Where conduits exit concrete slabs, use rigid steel conduit through slab a minimum of three inches above finished slab. Wrap rigid steel conduits with two layers of vinyl electrical tape, extending a minimum of two inches above and below slab.
- D. Electrical Service Conduits: Provide concrete ductbank.
- E. Telephone Service Conduits: Provide concrete ductbank, minimum 4-4" conduits.
- F. Wet and Damp Locations: Use rigid steel conduit or rigid aluminum conduit.
- G. Dry Locations:
1. Concealed: Use electrical metallic tubing (EMT) for 4" and smaller.
 2. Exposed in Electrical and Telephone Rooms: Use electrical metallic tubing (EMT) for 4" and smaller.
 3. Exposed in Other Areas Above 8': Use electrical metallic tubing (EMT) for 4" and smaller.
 4. AC and MC cable is not allowed.
- H. Pump Motor Connections: Use liquid-tight flexible metal conduit.
- I. Motors and Dry Type Transformer Connections: Use liquid-tight flexible metal conduit not exceeding 72" in length.
- J. Telecommunications Conduit System: Provide conduits, outlet boxes, and pull boxes as indicated and specified. Use same grade as specified above, minimum one (1) inch unless indicated otherwise. Terminate conduit in the Telephone Room within eight (8) feet of the floor grade.
- K. Rigid Steel Conduit: Hot dip galvanized, including threads, as manufactured by Pittsburgh Standard, Triangle or Allied.
- L. Rigid Aluminum Conduit: Pittsburg Standard, Triangle or Allied.
- M. Nonmetallic Conduits: Schedule 40 PVC as manufactured by Carlon, Krayloy or Pittsburgh Standard.
- N. EMT: Pittsburg Standard, Triangle or Allied.
- O. Flexible Metal Conduit: International, AFC, or Alflex.
- P. Liquid Tight Flexible Conduit: Presheathed galvanized steel Anaconda Type UA, Electric-Flex Type LA, Appleton, or AFC.

2.2 CONDUIT FITTINGS

- A. Rigid Steel Conduit: ANSI/NEMA FB1.
- B. EMT: Steel compression type in new construction or where exposed to weather or dampness. Set-screw type fittings not acceptable. Die cast is not acceptable. Provide connectors with insulated throats
- C. Flexible Metal Conduit: ANSI/NEMA FB1.

- D. Liquid Tight Flexible Metal Conduit: ANSI/NEMA FB1.
- E. Nonmetallic Conduit: NEMA TC 3.
- F. Miscellaneous Fittings:
 - 1. Conduit Bodies: "Mogul" size conduit bodies for conduits are larger than or equal to 1 1/2" and terminate at equipment having a ground bus..
 - 2. Grounding Bushings:
- G. Threaded Rigid Conduit: Appleton Type "GIB", Crouse-Hinds Type "GLL" or Thomas & Betts 3800 series threaded, grounding type insulated metallic bushing, in combination with one exterior and one interior locknut.
- H. EMT: O.Z. Gedney Type SB.
 - 1. Expansion Fittings: O.Z. Gedney Type "AX" or "EX" with bonding jumper.
 - 2. Sealing Fittings: Standard conduit bodies with sealing materials or compound as recommended by Manufacturer.
 - 3. Hubs: Appleton "HUB" or "HUB-U" Series or Thomas & Betts "370" Series.
 - 4. Unions: Appleton Type "EC" or Thomas & Betts "Erickson coupling".
 - 5. Plastic Bushings:
- I. Threaded: Equal to Thomas & Betts 222 series.
- J. Threadless: Equal to Thomas & Betts TRIB series.

2.3 CONDUIT ACCESSORIES

- A. Fasteners: Hot-dipped galvanized one-hole straps or other Owner approved methods. No plastic anchors, tie-wires or tie wraps will be accepted.
- B. Pull Lines: Jet line #232.
- C. Sleeve Penetration Sealant: Refer to Division 07.
- D. Underground Warning Tape: 6" wide, red black letters, continuous message: "Caution - Buried Electrical Line".
- E. Floor, Ceiling and Wall Plates: Provide chrome-plated brass escutcheons around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas, sized to fit conduit and securely locked in place.

2.4 SURFACE METAL RACEWAY

- A. Manufacturers: Wiremold.
- B. Description: Sheetmetal channel with fitted cover, suitable for use as surface metal raceway.
- C. Size: As shown on Drawings.
- D. Finish: White enamel.
- E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories. Provide corner fittings which accommodate the minimum bending radius requirements of EIA/TIA 568A.

- F. Receptacles: As specified on the Drawings.
- G. Multioutlet Assembly:
 - 1. Sheetmetal channel with fitted cover, with pre-wired receptacles, suitable for use as multioutlet assembly.
 - 2. Size: As indicated on Drawings.
 - 3. Receptacles: NEMA WD 6, Type 5-15R, single receptacle.
 - 4. Receptacles Spacing: 12 inches on center.
 - 5. Receptacle Color: White.
 - 6. Channel Finish: White.
 - 7. Fittings: Furnish manufacturer's standard couplings, elbows, outlet and device boxes, and connectors.

2.5 WIREWAY

- A. Manufacturers: Square D, Hoffman, or Wiegmann.
- B. Description: General purpose or Raintight type wireway.
- C. Knockouts: Manufacturer's standard.
- D. Minimum Size: 6 x 6 inch length, as indicated on the drawings.
- E. Cover: Hinged cover.
- F. Connector: Slip in.
- G. Finish: Rust inhibiting primer coating with gray enamel finish.

2.6 BOXES

- A. Manufacturers: Raco, Steel City, or Appleton.
- B. Pull Boxes: Galvanized steel, sized in accordance with the National Electrical Code. Use standard outlet boxes for junction and pull boxes 45 cubic inches in size and smaller. Use cabinets, as specified below, for pull boxes larger than 45 cubic inches.
- C. Outlet Boxes:
 - 1. Galvanized steel, at least 2-1/8" inches deep, and of sufficient size to accommodate wiring devices.
 - 2. Handy boxes and single gang switch boxes will not be accepted.
 - 3. Allow 2.25 cubic inches per No. 12 conductor in each outlet box.
 - 4. Where 1" conduit terminates in outlet box, provide 4-11/16" square deep box.
 - 5. Furnish plaster rings where required.
 - 6. Conform to National Electrical Code Table 370-6.
 - 7. Extension boxes are not allowed.
 - 8. Outlet boxes in walls shall be supported between two studs.
- D. Outlet Boxes for Wall Brackets and Overhead lights : 4" square or octagon galvanized boxes, 2-1/8" deep, depending upon the number of conductors. Provide 3/8" fixture studs through back of box where required for mounting fixtures. Furnish plaster rings where required.
- E. Outlet Boxes in Masonry Walls: Sheet steel outlet boxes made specifically for masonry walls, in one to five gang widths, Raco Cat. No. 696 through 699. Single gang switch boxes and handy boxes will not be accepted.

- F. Cabinets:
 - 1. Construction: NEMA 250, Type 1, 3R, or 4 steel enclosure as indicated.
 - 2. Covers: Secured by screws.
 - 3. Enclosure Finish: Manufacturer's standard gray baked enamel or stainless steel.

2.7 MANHOLES AND IN-GROUND PULLBOXES

- A. Manufacturers: Brooks Products, Dalworth.
- B. General: Precast, constructed of 4500 psi reinforced red concrete, complete with precast neck (where required), manhole frame, cover, and all required hardware. Use pullboxes in lieu of handholes.
- C. Covers: Screw type, fully gasketed, hot-dipped galvanized checkered steel plate suitable for pedestrian or vehicular traffic duty as applicable. Use flush beveled screws.
- D. Minimum Size:
 - 1. Manholes terminating five (5) ducts or more: 6'w x 12'l x 7'h.
 - 2. Pullboxes terminating four (4) ducts or less: 4'w x 5'l x 4'h.
- E. Design Loads: Accommodate of dead load, live load, impact, loads due to water table, and other loads which may be imposed upon the structure.
- F. Reinforcing Steel: Hot dipped galvanized.
- G. Pulling Eyes: 7/8" diameter, set in the manhole opposite each duct entrance.
- H. Cable Racks: Provide each communication manhole with four (4) hot-dipped galvanized cable racks, two per long side, each equipped with two adjustable hookssized to adequately support the hardware.
- I. For manholes that cannot be drained practically, provide a "dry" sump 12" diameter 18" deep in one corner with floor sloped to sump.
- J. Provide a steel skid-resistant ladder, with hooked ends, in each manhole with headroom greater than five (5') feet. Provide ladder bracket support in the collar.
- K. Provide manhole bonding ribbon of annealed, tinned, copper and bonding ribbon clamps.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Locate all proposed underground utilities in accordance with Division 02.
- B. Perform all excavation, trenching and backfill in accordance with Division 02.

3.2 CONDUIT INSTALLATION

- A. Concealed: Run conduit concealed in all areas unless otherwise indicated or specified. Concealed conduits are those hidden from sight as in hung ceilings, walls, chases, furred spaces or trenches.
- B. Exposed: Run conduit exposed, parallel or perpendicular with building lines, in all mechanical rooms and chases and where indicated on the drawings.

- C. Joints: Cut all joints square, ream smooth, and draw up tight.
- D. Run concealed conduit as direct and with largest radius bends as possible. Run exposed conduit parallel with, or at right angles to, the lines of the building. Make all bends with standard conduit elbows or bend conduit to not less than equivalent radius. All bends shall be free from dents or flattening. Use no more than the equivalent of four quarter bends in any run between terminals and cabinets, or between outlets and junction or pull boxes.
- E. Use approved condulets in lieu of conduit elbows where installation conditions and appearance warrant their use. Make conduit joints with approved couplings and unions.
- F. Run conduits continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes. Secure conduits to all boxes in such manner that each system is electrically continuous throughout.
- G. Provide double lock nuts and bushings for all conduits terminated on hubs. Use of running threads is prohibited.
- H. Support all conduits at a maximum spacing of 10 feet, in accordance with NEC Art. 346-12 and 348-12. Support conduits above removable ceilings from the building structure as high as practicable so as not to restrict ceiling panel removal.
- I. Spring steel Caddy straps are not permitted. Provide mineral lack straps or one-hole straps only.
- J. Provide pull boxes for telephone and low voltage (example - Fire Alarm) conduit systems after four right angle bends and at intervals not exceeding 70 feet. Locate boxes in accessible locations. Do not use pull boxes at 90° bends.
- K. Install each complete conduit system prior to cover-up and before any conductors are drawn in.
- L. Terminate 1-1/2" conduits and larger at switchboards, motor control centers and panelboards with grounding bushings.
- M. Install hubs at panel top entries in all wet and damp locations, including fire pump controllers.
- N. Cut conduit square using a saw or pipe cutter. De-burr cut ends. Joints in steel conduit must be painted with T&B Kopr shield and drawn up tight. Threads for rigid metal conduit and IMC shall be deep and clean. Running threads shall not be used. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement with brush to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum. Spray type of cement is not acceptable. Install raceway and conduit system from point of origin in outlets shown, complete with support assemblies including all necessary hangers, beam clamps, hanger rods, turnbuckles, bracing, rolls, clips angles, through bolts, brackets, saddles, nuts, bolts, washers, offsets, pull boxes, junction boxes and fittings to ensure a complete functional raceway system. Where vertical drops of conduit are made to equipment in open space, the vertical conduit shall be rigidly supported from racks supported on the floor.
- O. Install rigid wall hot-dipped galvanized steel conduit or hot-dipped galvanized intermediate metal conduit for service entrance; feeders; wall or floor penetrations; mechanical rooms, electrical rooms and exposed locations where there is a high

potential subject to physical damage; exposed outdoor locations; damp locations or any location as per design drawing. The following exceptions permitted:

1. EMT:
 - a. In sizes up to and including 1-1/2 inch, may be used inside dry locations where not subject to mechanical damage. EMT may be used in air-conditioned spaces, such as accessible ceilings, dry wall partitions and exposed where 6 feet above the floor. EMT may not be used outside, in concrete, underground, in crawl spaces, in masonry walls, in locations likely to be damp, in electrical rooms subject to mechanical damage due to future installation, or exposed within 6 feet of the floor. EMT shall not be used for medium voltage circuits.
 - b. Where used for feeder circuits receptacle branch circuits and motor branch circuits EMT shall also contain a NEC grounding conductor.
 - c. All conduits shall be concealed in walls or ceilings unless otherwise noted.
 - d. PVC (underground use only):
 - e. Install PVC schedule 40 conduit where direct buried in earth.
 - f. Type DB, Utility Duct, encased in concrete.
 - g. Liquid-tight:
 - h. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Install external ground wire on flexible conduit with grounding bushings. Maximum length shall be 6 feet minimum of 2 feet.
 - i. Flexible Metal Conduit:
 - j. Install standard flexible metal conduit (not liquid-tight), which shall be only used for lighting fixture whips or motor vibrations, with internal ground wire. Install flexible conduit connection such that vibrations are not transmitted to adjoining conduit or building structure. Maximum length shall be 6 feet, minimum of 3 feet; minimum size shall be 3/4; and minimum size shall be 3/8 inch for lay-in light fixture whips.
- P. Ground and bond all conduits in accordance with section 26 05 26.
- Q. Install conduits parallel and supported on Unistrut, or equal, trapezes and anchored with split ring hangers, conduit straps or other devices specifically designed for the purpose. No raceways or boxes shall be supported using wire. Arrange conduit to maintain headroom and present a neat appearance. Conduit routes shall follow the contour of the surface it is routed on. Route exposed conduit and tray above accessible ceilings parallel and perpendicular to walls and adjacent piping. Maintain 12-inch clearance between conduit and heat sources, such as flues, steam pipes, and heating appliances. Wire ties or "wrap lock" are not permitted to support or secure conduit system. Fasten conduit with the following material:
 1. Wood screws on wood.
 2. Toggle bolts on hollow masonry.
 3. Bolts and expansion anchors in concrete or brick.
 4. Machine screws, threaded rods and clamps on steel.
 5. Conduit clips on steel joists.
 6. 4 inch x 4 inch penta-treated pine installed in pitch pans on roof, spaced at intervals not to exceed 5 feet..
- R. Identify all conduits in accordance with section 26 00 00. Install underground conduits with sealing glands at the point where conduits enter the building to prevent water seepage into the building.

- S. Fittings shall be approved for grounding purposes or shall be jumpered with copper grounding conductors of appropriate ampacity. Leave termination of such jumpers exposed.
- T. Install expansion fittings in metal and PVC conduit as follows:
 - 1. Conduit Crossing Building Expansion Joints:
 - a. EMT all sizes.
 - b. RMC all sizes.
 - c. PVC all sizes.
 - d. Conduits entering environmental rooms and other locations subject to thermal expansion and as required by NEC.
 - e. Unless expansion fitting has an integral bonding braid, as in Crouse-Hinds Type XC, a green insulated grounding conductor shall be pulled in the conduit. Both ends of these green grounding conductors shall be accessible for inspection.

3.3 CLEANING AND PULL LINES

- A. Clean and swab conduit runs to remove foreign matter and moisture prior to pulling in wire and cable. Clean boxes of concrete, mortar, and other foreign matter.
- B. Provide pull lines for full length of all active and empty conduits.
- C. Provide 200 lb. nylon cord full length in empty conduit

3.4 SURFACE RACEWAY AND WIREWAY INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.
- C. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- D. Support wireways in accordance with Section 26 00 00.
- E. Close ends of wireway and unused conduit openings.
- F. Ground and bond metal raceway and wireway under provisions of Section 26 05 26.

3.5 IDENTIFICATION OF BURIED CONDUITS

- A. Install underground warning tape for all buried conduits and ductbanks. Bury tape at 12" below grade directly above conduits or ductbanks.

3.6 DUCTBANK INSTALLATION

- A. Encase PVC or galvanized conduits a minimum of 3" red concrete on all sides in accordance with Division 03.
- B. Concrete: Minimum strength of 4,500 PSI, monolithic construction.
- C. Bond or dowel connections to concrete pull boxes and manholes.
- D. Provide duct spacers or duct tiers at ten (10) foot intervals for duct support during the concrete pour.

- E. Unless otherwise approved by the Owner, install conduit formations according to the following chart:

CONDUIT FORMATION CHART

Number of Ducts	Single Bore
4	2 Wide x 2 High
6	3 Wide x 2 High
9	3 Wide x 3 High
12	4 Wide x 3 High
16	4 Wide x 4 High
20	4 Wide x 5 High
24	4 Wide x 6 High
28	4 Wide x 7 High
32	4 Wide x 8 High
36	4 Wide x 9 High
40	4 Wide x 10 High
Over 40	Consult Physical Plant

- F. Install all ductbanks with a minimum of 30" cover and with clearance of 12" minimum between ductbank and any gas, water or other utilities, unless otherwise approved by the Owner.
- G. Thoroughly clean all conduits before installation within the trench. Cap or plug all conduit ends during construction until conductor installation. Spare ducts must remain capped.
- H. Provide minimum three (3) inches of clearance between the bottom tier of ducts and the trench bottom.
- I. In the event that the total number of ducts is significantly less than the capacity of the manhole, install the ducts to enter in the lower portion of the knockout slot in order to simplify future conduit additions.
- J. Provide manhole or in-ground pull box at intervals no greater than 400'.

3.7 BOX INSTALLATION

- A. Wall Installation: Where outlets are indicated adjacent to each other, mount in a symmetrical pattern, with tops of the boxes at the same elevation. Where outlets are shown adjacent to each other with different mounting heights, mount in a vertical symmetrical pattern.
- B. Verify final location of each box with the owner's representative on the job site before rough-in. Coordinate locations with equipment furnished under other Divisions and by the Owner.
- C. Noise Transmission Prevention: Do not connect boxes back to back with a nipple.
- D. Extension rings are not permitted. Calculate boxes for new construction.
- E. Mounting: Rigidly mount boxes. Provide appropriate covers and all mounting hardware. Mount recessed boxes so box front is flush with finished wall or ceiling. Provide plaster rings as needed. Close all unused knock-outs.

- F. Mounting Heights: Unless indicated otherwise, mount boxes as specified below:
1. Wall Switch: 48 inches above finished floor.
 2. Convenience Receptacle: 18 inches above finished floor.
 3. Convenience Receptacle: 6 inches above counter horizontal.
 4. Dimmer: 48 inches above finished floor.
 5. Telephone/Data Outlets: 18 inches above finished floor.
 6. Outlet for Wall Telephone: 48 above finished floor.

3.8 CONDUIT AND BOX IDENTIFICATION

- A. Identify conduits and outlet boxes by stencil and paint or stick-on labels.
1. Conduits: Mark circuit number on each side of a wall, each side of bends and a minimum every 20 feet of horizontal run.
 2. Boxes: Mark covers.
- B. Box Colors: Provide color coding per Specification 26 05 53

3.9 MANHOLE INSTALLATION

- A. Provide grounding and bonding within manholes in accordance with section 26 05 26.
- B. Erect barricades in accordance with Division 01 while manhole lids are open. Test for combustible gases prior to entrance. Ventilate manholes each time they are opened. Manhole lids shall not remain open overnight.
- C. Place manholes on a bed of clean dry sand or approved material no less than 6" thick. Backfill the excavated area between the walls of the structure and the sides of the trench with clean dry sand to a point 6" above the crown of the structure in accordance with Division 02.
- D. Provide racks and supports in existing manholes where new cable is installed.
- E. Support all splice cases located within manholes by a minimum of two cable hooks.
- F. Seal conduit to manhole joints for watertight bond in accordance with Division 07.

3.10 PENETRATION SEALS

- A. Seal all penetrations through fire rated floors in accordance with Division 07 and as required by Article 300-21 of the National Electrical Code.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Nameplates and tape labels
- B. Wire and cable markers
- C. Conduit color coding and labeling

1.2 REFERENCES

- A. NFPA 70 – National Electrical Code (latest edition)

1.3 SUBMITTALS

- A. Provide submittals in accordance with and in additional to Section 26 00 00.UT, Basic Electrical Requirements, and Division 01 for submittal requirement.
 - 1. Furnish nameplate identification schedules listing equipment type and nameplate data with letter sizes and nameplate material.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Equipment Nameplates:
 - 1. For normal power electrical equipment, provide engraved three-layer laminated plastic nameplates, engraved white letters on a black background.
 - 2. For emergency equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on a red background.
 - 3. For UPS powered equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on an orange background.
 - 4. For fire alarm system provide engraved three-layer laminated plastic nameplates with white letters on a yellow background.
 - 5. For security and CCTV system panels, provide engraved three-layer laminated plastic nameplates with white letters on a blue background.
- B. Underground Warning Tape
 - 1. Manufactured polyethylene material and unaffected by acids and alkalines.
 - 2. 3.5 mils thick and 6 inches wide.
 - 3. Tensile strength of 1,750 psi lengthwise.
 - 4. Printing on tape shall include an identification note BURIED ELECTRIC LINE, and a caution note CAUTION. Repeat identification and caution notes over full length of tape. Provide with black letters on a red background.
- C. Conductor Color Tape and Heat Shrink:
 - 1. Colored vinyl electrical tape shall be applied perpendicular to the long dimension of the cable or conductor.
 - 2. In applications utilizing tray cable, heat shrinkable tubing shall be used to obtain the proper color coding for the length of the conductor in the cabinet or

enclosure. Variations to the cable color coding due to standard types of wire or cables are not acceptable.

- D. Conduit Labels (5 kV and 15 kV Conduits Only): 2-inch black letters on yellow background reading "DANGER - 12,470 VOLTS" or "DANGER - 4,160 VOLTS". Labels shall have adhesive backing, and shall be installed at intervals not exceeding 50 feet and on all pull boxes located to be visible from floor.
- E. Conduit labels (600V and below): Mark circuit number on conduit at each side of a wall, each side of bends and a minimum every 20 feet of horizontal run. This applies for all new service feeders from new switch room to main switchboards MSBA and MSBB. Also for all new feeders serving existing loads.
- F. Warning labels: Provide warning labels with black lettering on red background with a minimum of 3/8" lettering.
- G. Tape Labels: Embossed adhesive tape, with minimum 3/8-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes and manual motor starter units, etc.
 - 1. White letters on black background for normal power.
 - 2. White letters on red background for emergency/standby power.
 - 3. White letters on orange background for UPS power.
- H. J-Box and Cover plate Voltage Labels: Black stenciled letters 3/8" high. Adhesive back tapes may be used if a clear tape is applied over the label for protection.
- I. Device Plates: Engrave device plates with 3/8-inch letters.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Degrease and clean surfaces to receive nameplates or tape labels.
- B. Install nameplates parallel to equipment lines.
- C. Secure plastic nameplates to equipment fronts using screws or rivets. Use of adhesives shall be per Owner's approval. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.

3.2 WIRE IDENTIFICATION

- A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits. Label control wire with number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.
- B. Conductors for power circuits to be identified per the following schedule:

Conductor	System Voltage			
	480/277V	208/120V	240/120V High Leg	Medium Voltage
Phase A	Brown	Black	Black	One White Band
Phase B	Purple	Red	Orange	Two White Bands
Phase C	Yellow	Blue	Blue	Three White Bands

Neutral	Gray	White	White	N/A
Grounding IG	Green N/A	Green Green w/Yellow	Green Green w/Yellow	Green N/A

3.3 NAMEPLATE ENGRAVING SCHEDULE

- A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same as equipment names indicated on the Drawings.
- B. Individual Circuit Breakers in Distribution Panelboards, Disconnect Switches, Motor Starters, and Contactors: 1/4-inch; identify source to device and the load it serves, including location.
- C. Dry Type Transformers Not in Substations: 3/8-inch; identify equipment designation. 1/4-inch; identify primary and secondary voltages, primary source, and secondary load and location.
- D. Automatic Transfer Switches: 3/8-inch; white letters and red background; identify equipment designation 1/4-inch; identify voltage rating, normal source, standby source and load served including location.
- E. Panelboards: 3/8-inch; identify equipment designation. 1/4 -inch; identify source, voltage and bus rating.

3.4 ENCLOSURE COLOR CODING

- A. The following systems shall have each junction and pull box cover completely painted per the following:

System	Color of Box Cover
Ethernet Backbone	Blue
Telecommunications	Brown
FCMS	Green
Emergency Power	Red
Security**	White
Fire Alarm	Yellow
Clock	Fluorescent Violet
U.P.S.	Orange

**Security shall include, but not be limited to, the following systems:

- Card Access
- Duress Alarms
- Perimeter Door Alarms
- CCTV

END OF SECTION

SECTION 26 14 00

PROTECTIVE RELAY AND DEVICE COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete short-circuit study and protective relay and device coordination study for the normal and stand-by electrical distribution systems. This work is to be performed by the manufacturer of the switchgear. In addition, provide a complete arc flash study for the 480/277V and 208/120V equipment.

1.2 SUBMITTALS

- A. Submit short-circuit study, phase and neutral current curves plotted on log-log paper with the proposed settings indicated. If equipment submittals such as switchgear, switchboards, panelboards etc. are submitted without a preliminary short circuit study, they will be returned.
- B. The submittal shall include one line diagrams complete with conductor sizes and lengths of conductor.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 Normal Electrical Distribution System:

- A. The normal distribution system shall be coordinated from the service entrance Main breakers through the feeder circuit breakers on the 480-volt switchgear. The arc flash study shall include switchgear, switchboards and panelboards, distribution panelboards, busway plug in units, enclosed circuit breakers, automatic transfer switches, dry-type main transformers. The arch flash study shall be based on IEEE 1584 and NFPA 70E. Affix a warning label to the front of the equipment as shown below.

3.2 Essential Electrical Distribution System:

- A. Overcurrent Protection and Device Coordination Study:
 - 1. The stand-by distribution system shall be selectively coordinated down to 0.1 seconds from the generator control panel at the Central Plant through the main feeder circuit breakers in the stand-by switchboards and branch circuit panelboards in the buildings.
 - 2. The emergency distribution system shall be selectively coordinated down to 0.1 seconds from the generator control panel at the Central Plant through the building emergency system down to the branch circuit level.
- B. Arc Flash Study:
 - 1. The arc flash study shall include switchgear, switchboards and panelboards, distribution panelboards, busway plug in units, enclosed circuit breakers, automatic transfer switches, dry-type main transformers. The arch flash study shall be based on IEEE 1584 and NFPA 70E. Affix a warning label to the front of

the equipment as shown below.

2. Equipment with a maintenance mode or adjustable relay modules for reducing trip settings to the minimum set points shall include a second label for the maintenance mode condition.
- C. This work shall be performed by a registered Professional Engineer.
- D. Submit report to Engineer for review. Based upon the Engineer's and CenterPoint Energy Company's review, different relay settings may be required pending this review. Comments shall be incorporated into a revised coordination package. All relays and trip settings shall be adjusted in accordance with the approved shop drawings.
1. Include in the report the settings for all equipment in "Maintenance Mode".

WARNING

Bus Electrical Shock and Flash Hazard

Appropriate PPE required

Shock Distance (Inches) – Limited = ____, Restricted = ____, Prohibited = ____

Volts ____ Max. Short circuit kA ____

PPE Based on ____ Inches Working Distance

(Arc Flash Boundary, PPE required within ____ Inches)

Clothing		____	Face		____
	Level			Shield	
Glove		____	Eye		____
	Class			Protection	
Insulated		____	Hair/Beard Net		____
Tools			Not Allowed		

- E. Submit report for review. Based upon this review, different breaker settings may be required by the Engineer. Comments shall be incorporated into a revised coordination package. All relays and trip settings shall be adjusted in accordance with the approved report.

END OF SECTION

SECTION 26 22 13

HIGH EFFICIENCY TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Copper-wound transformers meeting US Department of Energy 2016 mandated minimum efficiency.
- B. Compliance with full specification is required
- C. Basic compliance with NEMA TP1/EPACT2005, NEMA Premium, CEE Tier 1, is not sufficient to meet this specification due to the following:
 - 1. Efficiencies must meet or exceed the US DOE 2016 minimum requirement
 - 2. No load losses must comply with those defined in this specification
 - 3. Efficiency at low load and under nonlinear load must meet the minimum requirements of this specification
 - 4. Listing per UL 1561 is required
 - 5. Comprehensive testing under linear and nonlinear loading is required to verify specified performance
 - 6. Performance submittals are required
- D. The Work under this Section is subject to requirements of the Contract Documents including the Uniform General Conditions, Supplementary General Conditions, and Division One Sections.
- E. All work covered by this Section shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.
- F. Drawings and general provisions of the Contract, including Terms and Conditions, Supplementary Conditions, Special Conditions, and other Division One Sections, apply to this Section.

1.2 REFERENCES

- A. US Department of Energy, 10 CFR Part 431, April 18, 2013. Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule
- B. DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431.
- C. ANSI/NEMA ST 20 - Dry Type Transformers for General Applications.
- D. Consortium for Energy Efficiency (CEE): Specification for Low-Voltage, Dry-Type Distribution Transformers
- E. EPACT 2005 - United States Energy Policy Act 2005 / NEMA TP1 - Guide for Determining Energy Efficiency for Distribution Transformers

- F. IEEE C57.110-1998 – IEEE Recommended Practice for establishing transformer capability when feeding nonsinusoidal load currents
- G. IEEE Std C57.12.91-1995 Standard Test Code for Dry-Type Transformers
- H. IEEE-1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
- I. LEED – Leadership in Energy and Environmental Design, U.S. Green Building Council.
- J. ISO 9001:2008 – International Standards Organization - Quality Management System
- K. ISO 14001:2004 – International Standards Organization - Environmental Management System
- L. ISO 17025 – International Standards Organization - General requirements for the competence of testing and calibration laboratories

1.3 **RELATED SECTIONS**

- A. Section 26 05 26, Grounding and Bonding.
- B. Section 26 05 33, Raceways.
- C. Section 26 05 29, Metal Framing and Supports.
- D. Section 26 05 73, Overcurrent Protective Device Coordination Study.

1.4 **SUBMITTALS**

Submit product data including the following:

- A. Test Reports per US DOE 10 CFR Part 431, of previously manufactured units – representative of the kVA range on the project, tested in ISO 17025 Certified Efficiency Test Lab, or via UL Data Acceptance Program (DAP) signed by test engineer, documenting history of production capability to comply with performance requirements of this specification.
- B. Test Reports per factory ISO Nonlinear Load Test Program, or via Data Acceptance Program (DAP) signed by factory test engineer of previously manufactured units – representative of the kVA range on the project, tested in ISO 17025 Certified Efficiency Test Lab, or via Data Acceptance Program (DAT) documenting history of production capability to comply with performance requirement of this specification.
- C. ISO 17025 Efficiency Test Lab Certificate, or via Data Acceptance program (DAT) where testing is performed.
- D. Construction details including enclosure dimensions, kVA rating, primary & secondary nominal voltages, voltage taps, BIL, and unit weight.

- E. Basic Performance characteristics including insulation class, temperature rise, core and coil materials, impedances & audible noise level, unit weight
- F. Documentation of UL listing of 2" clearance from ventilated surfaces
- G. Inrush Current (typical 3 cycle recovery)
- H. Short Circuit Current data: Primary & Secondary
- I. Efficiency, Loss & Heat output Data
- J. No load and full load losses per NEMA ST20
- K. Linear load data @ 1/4, 1/2, 3/4 & full load
- L. Efficiency under load profile at 25%, 50%, 75%, 100% of nameplate rating.
- M. Factory ISO 9001 procedure describing nonlinear load test program
 - 1. Meter and CT details including model, accuracy, serial numbers and calibration information.
- N. Copy of ISO 14001:2004 Certification or certification by UL Data Acceptance Program (DAP)
- O. Copy of ISO 9001:2008 Certification or certification by UL Data Acceptance program (DAT).
- P. Documentation that materials used for shipment packaging meet the environmental requirements of this specification.

1.5 **NONLINEAR LOAD TEST PROGRAM**

- A. Nonlinear Load Testing shall be carried out by an ISO 17025 Certified Efficiency Test Lab, or UL Data Acceptance Program (DAT) and follow a defined protocol, independently audited within the ISO or UL system.
- B. Efficiency shall be determined purely by measurements following IEEE Std C57.12.91-1995 Standard Test Code for Dry-Type Transformers. Other methods are not acceptable.
- C. Meters and CTs shall both be revenue class accurate and carry current calibration certificates. CTs shall be operated within their approved accuracy loading range. Dual meters shall gather simultaneous primary and secondary energy and harmonic data. Meter and CT details including model, accuracy, serial numbers and calibration information.
- D. Efficiency: Measurements shall be taken at multiple load levels and plotted to show compliance with specification and correlation to the designed efficiency curve.
- E. Harmonic data including current and Voltage THD at the different load levels shall be included with the test report.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Store and protect products
- B. Store in a warm, dry location with uniform temperature. Cover ventilation openings to keep out dust, water and other foreign material.
- C. Handle transformers using lifting eyes and/or brackets provided for that purpose. Protect against unfavorable external environment such as rain and snow, during handling.

1.7 WARRANTY

- A. Comply with the requirements of Division One and Section 26 00 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/PRODUCT

- A. EATON, Square D, General Electric, Powersmiths International Corp.
- B. Manufacturers wishing to have products evaluated for acceptability and conformance with the performance requirements of this specification, shall provide detailed compliance and/or exception statements, along with the documentation required in the submittal section, including test documentation, signed by an engineer, that confirms that the transformer(s) meets the specified performance.
- C. Failure to provide the required documentation no less than 7 days prior to the bid date will disqualify products from consideration for this project.

2.2 RATINGS

- A. Compatibility: This product must facilitate the ability of the electrical system to supply a sinusoidal voltage in order to improve the long-term compatibility of the electrical system with all types of linear and nonlinear connected loads today and in the future. All national and international standards on harmonics and power quality set limits on levels of voltage distortion to maintain compatibility.
- B. Copper-wound, 3-phase, common core, ventilated, dry-type, isolation transformer built to UL1561, NEMA ST20 and other relevant NEMA, UL and IEEE standards; 200% rated neutral; 60Hz rated; Transformers 750 kVA and less, 600 volt primary and less, shall be UL Listed and CSA Approved. All terminals, including those for changing taps, must be readily accessible by removing a front cover plate. Windings shall be continuous with terminations brazed or welded. 10kV BIL.
- C. Insulation: Class 220 degree
- D. Operating Temperature Rise: 115 degree C in a 40 degree C maximum ambient
- E. UL Listed & Labeled K-Rating: or higher

- F. Enclosure type: Indoor Ventilated NEMA 1, drip-proof [or select other: sprinklerproof, outdoor padmount, secure, outdoor public, totally enclosed, stainless steel]
- G. Rear Clearance: UL Listed for 2" clearance from the wall rather than standard 6". This capability shall be explicitly described on the nameplate of each unit.
- H. Exceed minimum efficiency requirements of US Department of Energy, 10 CFR Part 431, April 18, 2013, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule which takes effect January 1, 2016.
- I. Voltage Taps: For transformers 15kVA-750kVA, provide two 2-1/2% full capacity taps above and four 2-1/2% taps below nominal primary voltage.
- J. Impedance: Between 3.0% and 6.0% unless otherwise noted.
- K. Grounding: Ground the core of the transformer to the enclosure with a flexible grounding conductor sized according to NEC requirements.
- L. Integrated (IR) Viewing Port to address NFPA 70E/CSA-Z462 Arc Flash Standard
 - 1. Provide integrated rotatable IR viewing port that provides single point viewing point that enables the thermal scanning of all live connections including primary and secondary feeder terminations and taps without requiring opening of the transformer enclosure or exposure to live parts.
 - 2. The port shall be easily usable by a wide variety of makes and models of commercially available thermal scanning devices, without requiring any proprietary connectors, adapters or other components.
- M. Lug Kit: supply with Compression lugs configured as specified at time of order

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

- A. Delivery. Deliver transformers individually wrapped for protection and mounted on shipping skids.
- B. Storage. Store transformers in a clean, dry space, elevated above grade, and protected from weather, moisture, sunlight, and dirt. Maintain factory wrapping or provide an additional heavy canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Temporary Heating. Apply temporary heat for protection from insulation moisture absorption and metallic component corrosion in accordance with paragraph 3.2B of Section 26 00 00, Basic Electrical Requirements, and according to manufacturer's written instructions. Apply temporary heat 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.

- D. Stacking. Do not stack transformers.
- E. Work Surface. Transformers shall not be used as work tables, scaffolds, platforms, or ladders.
- F. Handling. Handle transformers carefully to avoid damage to material components, enclosure and finish. Use only lifting eyes and brackets provided for that purpose. Damaged transformers shall be rejected and not be installed on project.
- G. General Provisions. Refer to Part 3 of Section 26 00 00, Basic Electrical Requirements.

3.2 INSPECTION

- A. Installer shall examine the areas and conditions under which dry type transformers are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install dry type transformers in locations indicated on Drawings, in accordance with the applicable requirements of the NEC, NEMA, and ANSI.
- B. Set transformers plumb and level.
- C. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- D. Ventilation.
 - 1. Provide adequate clearance around transformer for ventilation of core, coil and internal components; minimum 2 inch all sides unless noted otherwise.
 - 2. Where transformers are proposed for installation vertically one above the other, provide sufficient vertical separation between transformers to permit adequate air circulation for proper cooling of each transformer, in accordance with manufacturer recommendations. Take temperature measurements of transformers under load and document temperature rise and temperature of each transformer where mounted in a vertical arrangement. Where the temperatures exceed manufacturer's recommendations or the requirements of this Section, relocate transformers to provide adequate cooling.
- E. Verify removal of coil shipping anchor bolts before transformer is energized.
- F. Check for damage and tight connections prior to energizing transformer.

3.4 FLOOR MOUNTING

- A. Provide concrete pad for floor-mounted transformers. Refer to structural Drawings and specifications for design criteria. Where not otherwise

indicated, and in addition to the requirements of Section 26 00 00, Electrical General Provisions, and Section 26 05 29, Metal Framing and Supports, construct pads of nominal 4 inch thick 2500 pound concrete reinforced with 6 inch x 6 inch steel wire mesh. Size pads 3 inches wider than transformer and chamfer edges to a 3/4 inch bevel.

- B. Maintain a minimum of 12 inches free air space between enclosure and walls.
- C. Vibration isolation. Provide vibration and sound isolation system suitable for isolating the transformer noise from the building structure.
 - 1. Provide spring-type isolators in suspension system sized to support the transformer weight, one at each corner of transformer lower mounting rails. Manufacturer: Korfund/Aeroflex type LK, or accepted substitution.
 - 2. Use one pad type Korfund Elasto-Grip, waffle, or accepted substitution, at each corner of the transformer, below the spring-type isolators, sized for load of 50 lbs./sq.-in.
- D. Secure the transformer and vibration isolators to the pad as recommended by the manufacturer.
- E. Refer to Section 26 05 29, Metal Framing and Supports.

3.5 CONDUIT CONNECTIONS

- A. Flexible Metallic Conduit. Attach incoming and outgoing conduits to the transformer enclosure with flexible metallic conduit (FMC), minimum length 24 inches.
 - 1. Make conduit connections to side panel of enclosure using an appropriately sized 90-degree elbow connector.
 - 2. Provide grounding-type coupling at each end of flexible metallic conduit. Provide a bonding jumper on outside of flexible conduit, sized per NEC Table 250.122 or NEC Table 250.66 as appropriate. The exterior bonding jumper shall be provided in addition to the grounding conductor run with the transformer circuit conductors inside the conduit. Where grounding conductor or jumper size is shown larger on Drawings, provide the larger size.
- B. Liquid Tight Flexible Metallic Conduit. Where indicated, use liquid-tight flexible conduit for connections to transformer case, maximum length 6 feet, minimum length 3 feet, with slack or dip to attenuate noise transmitted through conduit.
 - 1. Make conduit connections to side panel of enclosure using an appropriately sized 90-degree elbow connector.
 - 2. Provide grounding-type coupling at each end of liquid-tight flexible conduit. Provide a bonding jumper on exterior of liquid-tight flexible conduit, sized per NEC Table 250.122 or NEC Table 250.66 as appropriate. The exterior bonding jumper shall be provided in addition to the grounding conductor run with the transformer circuit conductors inside the conduit. Where grounding conductor or jumper size is shown larger on Drawings, provide the larger size.

3.6 CABLE CONNECTIONS

- A. Lugs. Make transformer cable connections with compression-type lugs suitable for termination of 90°C rated conductors. Position lugs so that field connections and wiring will not be exposed to temperature above 75°C.
- B. Grounding. Ground the neutral (X0) of the transformer secondary winding in accordance with the requirements of NEC-250.30, paragraph 3.3G of Section 26 05 26, and as indicated on Drawings. Connect equipment grounding conductors, and system bonding jumper(s), to transformer neutral (X0) bus. Provide equipment bonding jumper from transformer neutral (X0) bus to transformer metallic enclosure. Expose bare metal of transformer enclosure to ensure proper contact between transformer enclosure and equipment bonding jumper.

3.7 TAP SETTING

- A. Check for damage and tight connections prior to energizing transformer. Verify removal of all shipping anchor bolts and shipping supports prior to energizing transformer.
- B. Measure primary and secondary voltages and make appropriate tap adjustments.
- C. Select the appropriate tap setting on transformer so that the actual secondary voltage is $\pm 1/2$ of a tap span at full load.

3.8 TESTING

- A. Test and record no-load amperages of all dry type transformers. Replace at no cost to Owner all transformers with no load amperage exceeding four percent of rated full load.
- B. Submit record of field testing and tap settings to the Owner's Representative and to the Architect/Engineer, in accordance with the requirements of Division One and Section 26 00 00. Where not specified elsewhere, provide three copies of the record.

END OF SECTION

SECTION 26 23 00

LOW VOLTAGE SWITCHBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Main Switchboard - Furnish and install the Service Entrance switchboard(s) as herein specified and shown on the associated electrical drawings in a main-tie-main configuration.

1.2 REFERENCES

The switchboard(s) and overcurrent protection devices referenced herein are designed and manufactured according to the following appropriate specifications.

- A. ANSI/NFPA 70 - National Electrical Code (NEC).
- B. ANSI/IEEE C12.16 - Solid-State Electricity Metering.
- C. ANSI C57.13 - Instrument Transformers.
- D. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
- E. NEMA PB 2 - Deadfront Distribution Switchboards, File E8681
- F. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
- G. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.
- H. UL 50 - Cabinets and Boxes.
- I. UL 98 - Enclosed and Dead Front Switches.
- J. UL 489 - Molded Case Circuit Breakers.
- K. UL 891 - Dead-Front Switchboards.
- L. UL 943 - Standard for Ground Fault Circuit Interrupters.
- M. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.

1.3 SUBMITTALS

- A. Shop Drawings shall indicate front and side enclosure elevations with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; one-line diagrams; equipment schedule; and switchboard instrument details.

1.4 QUALIFICATIONS

- A. To be considered for approval, a manufacturer shall have specialized in the manufacturing and assembly of switchboards for at least fifty (50) years.

- B. Furnish products listed by Underwriters Laboratories Incorporated and in accordance with standards listed in Article 1.03 - References.
- C. The manufacturing facility shall be registered by Underwriters Laboratories Inc. to the International Organization for Standardization ISO 9002 Series Standards for quality.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products in conformance with manufacturer's recommended practices as outlined in applicable Installation and Maintenance Manuals.
- B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.
- C. Inspect and report concealed damage to carrier within their required time period.
- D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.7 MAINTENANCE MATERIALS

- A. Provide one (1) set of installation and maintenance instructions with each switchboard. Instructions are to be easily identified and affixed within the incoming or main section of the line-up.

1.8 WARRANTY

- A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one (1) year from date of installation or eighteen (18) months from date of purchase.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Shall be Square D Company, General Electric or EATON.
- B. Substitutions must be submitted in writing three (3) weeks prior to original bid date with supporting documentation demonstrating that the alternate manufacturer conforms to all aspects of the specifications herein.
- C. The manufacture of the switchboard shall be the same as the manufacturer of the circuit breakers or the switches mounted in the switchboard.

- D. All new panelboards and switchboards on this project shall be by the same manufacture as the switchboard for the purposes of stocking common breaker types, series ratings, etc.

2.2 SWITCHBOARD – GENERAL

- A. Short Circuit Current Rating: Switchboards shall be rated with a minimum short circuit current rating of 65,000 RMS symmetrical amperes at 480 VAC maximum.
- B. Future Provisions: All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
- C. Enclosure:
 - 1. Sections shall be aligned front and rear.
 - 2. Removable steel base channels (1.5 inch floor sills) shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.
 - 3. The switchboard enclosure shall be painted on all exterior surfaces. The paint finish shall be a medium gray, ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment.
 - 4. All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.
 - 5. Top and bottom conduit areas shall be clearly indicated on shop drawings.
- D. Nameplates: Provide 1 inch high x 3 inches engraved laminated (Gravoply) nameplates for each device. Furnish black letters on a white background for all voltages.
- E. Bus Composition: Shall be plated copper. Plating shall be applied continuously to all bus work. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 temperature rise requirements. The phase [and neutral] through-bus shall have an ampacity as shown in the plans. For 4-wire systems, the neutral shall be of equivalent ampacity as the phase bus bar. Tapered bus is not acceptable. Full provisions for the addition of future sections shall be provided. Bussing shall include all necessary hardware to accommodate splicing for future additions.
- F. Bus Connections: Shall be bolted with Grade 5 bolts and conical spring washers.
- G. Ground Bus: Sized per NFPA70 and UL 891 Tables 25.1 and 25.2 and shall extend the entire length of the switchboard. Provisions for the addition of future sections shall be provided.

2.2 A SWITCHBOARD - INCOMING MAIN SECTION DEVICES

- A. Two-step stored energy electronic trip molded case circuit breaker(s)
 - 1. Circuit protective devices shall be two-step stored energy type circuit breaker(s).
 - 2. Circuit breaker trip system shall be a microprocessor-based true rms sensing design with sensing accuracy through the thirteenth (13th) harmonic.

3. The integral trip system shall be independent of any external power source and shall contain no less than industrial grade electronic components.
4. Circuit breakers shall be equipped with back-up thermal and magnetic trip system.
5. The ampere rating of the circuit breaker shall be determined by the combination of an interchangeable rating plug, the sensor size and the long-time pickup adjustment on the circuit breaker. The sensor size, rating plug and switch adjustments shall be clearly marked on the face of the circuit breaker. Circuit breakers shall be UL Listed to carry 100% of their ampere rating continuously when applied in QED switchboards.
6. The following time/current response adjustments shall be provided. Each adjustment shall have discrete settings and shall be independent from all other adjustments.

Long Time Pickup & Long Time Delay

Short Time Pickup & Short Time Delay (I^2t IN & I^2t OUT)

Instantaneous Pickup

Ground Fault Pickup & Ground Fault Delay (I^2t IN and I^2t OUT)

7. A means to seal the rating plug and trip unit adjustments in accordance with NEC Section 240-6(b) shall be provided.
8. Local visual trip indication for overload, short circuit and ground fault trip occurrences shall be provided.
9. An ammeter to individually display all phase currents flowing through the circuit breaker shall be provided. Indication of inherent ground fault current flowing in the system shall be provided on circuit breakers with integral ground fault protection]. All current values shall be displayed in True rms with 2% accuracy.
10. Long Time Pickup indication to signal when loading approaches or exceeds the adjusted ampere rating of the circuit breaker shall be provided.
11. The trip system shall include a Long Time memory circuit to protect against intermittent overcurrent conditions above the long time pickup point. Means shall be provided to reset Long Time memory circuit during primary injection testing.
12. Circuit breaker trip system shall be equipped with an externally accessible test port for use with a Universal Test Set. Provide one (1) Universal Equipment Test Set for this project job for final inspection. This test set shall be suitable for testing all electric circuit breakers specified for this project. No disassembly of the circuit breaker is required for testing.
13. Communications capabilities for remote monitoring of circuit breakers trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings and trip history information shall be provided.
14. Circuit breakers shall be provided with Zone Selective Interlocking (ZSI) communications capabilities on the short time and ground fault functions

compatible with all other electronic trip circuit breakers and external ground fault sensing systems.

15. True two-step stored energy mechanism with five (5) cycle closing time shall be provided. All circuit breakers shall have multiple CHARGE/CLOSE provisions allowing the following sequence:

CHARGE, CLOSE, RECHARGE, OPEN/CLOSE/OPEN

16. Local control pushbuttons to OPEN and CLOSE circuit breaker shall be provided. Color coded visual indication of contact position (OPEN or CLOSED) shall be provided on the face of the circuit breaker. Local manual charging following CLOSE operation shall be provided. Color coded visual indication of mechanism CHARGED and DISCHARGED position shall be provided on the face of the circuit breaker. Visual indicator shall indicate CHARGED only when closing springs are completely charged.
17. Each circuit breaker shall be electrically operated to permit remote CHARGE, CLOSE, and OPEN capabilities. Electrically operated circuit breaker shall be equipped with charge contact switch for remote indication of mechanism charge status.
18. Provide the following interlocking capabilities:
 - a. cell door interlock
 - b. key interlock for main-tie-main
 - c. lock off
19. Equipment Ground Fault Protection
 - a. Circuit breaker(s) shall be provided with integral equipment protection for grounded systems.
 - b. The ground fault system shall be of the residual type.
20. Terminations
 - a. All lugs shall be UL Listed to accept solid and/or stranded copper conductors. Lugs shall be suitable for 75° C rated wire, sized according to the 75° C temperature rating in the NEC.
 - b. All circuit breakers shall be UL Listed to accept field installable/removable compression type lugs.

- B. Individually fixed mounted through 5000 A
 1. Mains and Tie circuit breaker shall be individually fixed mounted.

2.2 B SWITCHBOARD - DISTRIBUTION SECTION DEVICES

- A. Group mounted circuit breakers through 1200A.
 1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

2. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
3. Circuit breaker(s) equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breaker(s) shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breaker(s) of different frame sizes shall be capable of being mounted across from each other.
4. Line-side circuit breaker connections are to be jaw type.
5. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
6. Electronic trip molded case full function 100% rated circuit breakers.
 - a. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup, Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - b. Circuit breaker trip system shall be a microprocessor-based true rms sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated [schedule] [drawing].
 - c. Local visual trip indication for overload, short circuit and ground fault trip occurrences.
 - d. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
 - e. Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.
 - f. Circuit breaker shall be provided with Zone selective Interlocking (ZSI) communications capabilities on the short-time and ground fault functions compatible with all other electronic trip circuit breakers and external ground fault sensing systems as noted on [schedules] [drawings]
 - g. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

2.3 METERING (CUSTOMER)

- A. Manufacturers:
 1. Square D Model PM 8000 series or equivalent by GE or EATON>.
 2. Ethernet Modbus TCP/IP Communication

3. Substitutions: substitutions shall be made only after proper verification

2.4 METERING TRANSFORMERS

- A. Manufacturer: Shall be Square D Company.
- B. Current Transformers: ANSI C57.13; 5 ampere secondary.
- C. Voltage Transformers: ANSI C57.13; 120 V single secondary, (Not required for type PM meters)

2.5 ACCESSORIES

- A. For switchboards installed outdoor only, provide thermostatically-controlled electric heaters in each section. Provide terminals for separate source connection of heater power circuit. Voltage Rating: 120 V. Provide control power transformer with the total VA rating of the electric heaters in the switchboard.
- B. Provide a Masterpack NW Remote Racking Device with mounting bracket kit for NW remote racking for all breakers. Provide mounting brackets modification/installation and all required accessories for a complete breaker racking system.

2.6 RELATED SECTION

- A. Section 26 43 13- TRANSIENT VOLTAGE SURGE SUPPRESSION DEVICES IN SWITCHBOARDS

2.7 MAIN PROTECTIVE DEVICES

- A. The main breakers and the tie breaker are to 100 percent rated 3-pole insulated case with two step stored energy mechanism. Breakers shall be able to be electrically operated from a remote mounted control station. In addition to the electrical operators installed on the front of the switchboard, the remote mounted station shall consist of open/closed momentary contact pushbuttons mounted in lockable NEMA 1 wall enclosure.
- B. Mount remote operators on wall-mounted enclosure inside the electrical room and provide a label on the front of the enclosure with the inscription. "MAIN SWITCHBOARDS REMOTE OPERATOR"

2.8 INTEGRATED ROTATABLE INFRARED (IR) VIEWING PORT

Provide integrated rotatable IR viewing port that provides single point viewing point that enables the thermal scanning of all live connections without requiring opening of the main bus enclosure or exposure of live parts.

The port shall be easily usable by a wide variety and modules of commercially available thermal scanning devices, without requiring any proprietary connectors, adapters or other components.

For the installation of one or more fixed IR windows to be considered an acceptable alternative on this project, the manufacturer shall provide detailed drawings prepared by a qualified engineer detailing how all live terminals will be viewable. The manufacturer shall commit that should all terminals not be viewable once installed, the manufacturer shall rectify the situation at his own expense.

Infrared ports/windows must be factory installed with full manufacturer warranty. Aftermarket or contractor installed kits are not acceptable.

2.9 LISTING

The switchgear shall be UL listed as suitable for use as service entrance equipment.

2.8 FACTORY TESTING

The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the completed switchgear shall be tested to assure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground between opposite polarities. The manufacturer shall notify the Owner's Representative two weeks prior to the date the tests are to be performed

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine area to receive switchboard to provide adequate clearance for switchboard installation.
- B. Check that concrete pads are level and free of irregularities.
- C. Start work only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install switchboard in accordance with manufacturer's written guidelines, the NEC, and local codes.

3.3 FIELD QUALITY CONTROL

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure, using a Megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1000 VDC; minimum acceptable value for insulation resistance is 1 megohms. NOTE: Refer to manufacturer's literature for specific testing procedures.
- C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- D. Physically test key interlock systems to check for proper functionality.
- E. Test ground fault systems by operating push-to-test button.

3.4 ADJUSTING

- A. Adjust all operating mechanisms for free mechanical movement per manufacturers specifications.
- B. Tighten bolted bus connections in accordance with manufacturer's instructions.

- C. Adjust circuit breaker trip and time delay settings to values as indicated on the coordination study.

3.5 TESTING

- A. After installation and before acceptance by Owner, this Contractor shall provide the services of an independent organization (independent from the Contractor) to performance test of all ground trips in accordance with NEC 230.95©. this test shall involve passing a primary current through the current sensor with a suitable, low voltage test set and timer, which shall allow verification that the trip units track their published curves and that they actually trip the devices on which they are applied. This shall include the polarity of the current sensors and give an indication of satisfactory operation of all instruments.
- B. The contractor shall notify the Owner's Representative of this test five days in advance so the test can be properly witnessed.

3.6 CLEANING

- A. up scratched or marred surfaces to match original finish.

END OF SECTION

SECTION 26 24 16

BRANCH CIRCUIT PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 REFERENCES

- A. NECA 1-2000 – Standard Practices for Good Workmanship in Electrical Contracting.
- B. NEMA AB 1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- D. NEMA PB 1 - Panelboards.
- E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- F. NFPA 70 - National Electrical Code. IEEE C62.41-1991 - IEEE Recommended Practice on Surge Voltage in AC Power Circuits.
- G. ANSI/IEEE C62.45-1987 - IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
- H. UL 1449 Third Edition - Standard for Transient Voltage Surge Suppressors.
- I. UL 1283 - Standard for Electromagnetic Interference Filters.

1.3 RELATED SECTIONS

- A. Section 26 00 00 – Basic Electrical Requirements.
- B. Section 26 05 26 – Grounding.
- C. Section 26 43 15 - Surge Protection Devices in Panelboard Extensions

1.4 SUBMITTALS

- A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide short circuit rating as required per Selective Coordination and Arc Flash Study. All devices shall be fully rated. Series rated devices are not allowed.

2.2 MANUFACTURERS

- A. Square D.
- B. General Electric.
- C. Cutler-Hammer.
- D. Siemens.

2.3 BRANCH CIRCUIT PANELBOARDS

- A. Construction: NEMA PB1, circuit breaker type, NEMA 1 enclosure unless indicated otherwise. Factory installed knockouts are not allowed.
- B. Rating: As indicated on drawings.
- C. Bus: Tin plated copper, ratings as indicated. Provide copper ground bus in each panelboard. Use 1000 amps per square inch for all busses.
- D. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents.
- E. Short Circuit Rating: Provide minimum integrated short circuit interrupting capacity unless noted higher on the drawings.
 - 1. 240 Volts and Below: 10,000 amperes RMS symmetrical.
 - 2. Above 240 Volts: 14,000 amperes RMS symmetrical.
- F. Molded Case Circuit Breakers:
 - 1. NEMA AB 1, bolt-on type, thermal magnetic trip circuit breakers, with common trip handle for all poles.
 - 2. Provide circuit breakers UL listed as Type SWD for lighting circuits.
 - 3. Provide circuit breakers UL listed as Type HID for circuits serving high intensity discharge luminaires.
 - 4. Provide UL Class A ground fault interrupter circuit breakers where scheduled.
 - 5. Do not use tandem circuit breakers.
 - 6. Breakers feeding 120 volt shunt trip circuits shall be provided with breaker handle locking devices.
 - 7. Provide maximum number of circuit breakers for which the panelboard is configured.
- G. Cabinet Front: Surface cabinet front with concealed trim clamps, concealed hinge, "door-in-door" construction with flush lock. Key all locks alike.
- H. Finish: ANSI 61 gray enamel.

2.4 ELECTRONIC GRADE PANELBOARDS

- A. Description: NEMA PB1, circuit breaker type panelboard with integral transient voltage surge suppression unit, NEMA 1 enclosure. Factory installed knockouts are not allowed.
- B. Rating: As indicated on drawings.
- C. Bus: Tin plated copper; use 1000 amps per square inch.
- D. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.
- E. Neutral Bus: Rated 200% of phase bus capacity; use 1000 amps per square inch.
- F. Ground Bus: Provide one safety ground bus and one insulated ground bus, both with connection points equal to number of panelboard positions. Use 1000 amps per square inch.
- G. Short Circuit Rating: Provide minimum integrated short circuit interrupting capacity unless noted higher on the drawings.
 - 1. 240 Volts and Below: 10,000 amperes rms symmetrical.
 - 2. Above 240 Volts: 14,000 amperes rms symmetrical.
- H. Molded Case Circuit Breakers:
 - 1. NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles.
 - 2. Provide circuit breakers UL listed as Type SWD for lighting circuits.
 - 3. Provide circuit breakers UL listed as Type HID for circuits serving high intensity discharge luminaires.
 - 4. Provide UL Class A ground fault interrupter circuit breakers where scheduled.
 - 5. Do not use tandem circuit breakers.
 - 6. Breakers feeding 120 volt shunt trip circuits shall be provided with breaker handle locking devices.
 - 7. Provide maximum number of circuit breakers for which the panelboard is configured.
- I. Cabinet Front: Surface cabinet front with concealed trim clamps, concealed hinge, "door-in-door" construction with flush lock. Key all locks alike.
- J. Finish: ANSI 61 gray enamel.
- K. Integral Surge Protection Device (SPD) Unit:
 - 1. Provide SPD per Section 26 43 15.

2.5 ISOLATED DISTRIBUTION SYSTEM PANELS

- A. Manufacturers
 - 1. Post Glover.
 - 2. Square D.
- B. Description
 - 1. Factory wired and tested.
 - 2. Shielded low leakage isolating transformer.
 - 3. Primary and secondary circuit breakers.
 - 4. Line Isolation Monitor.

- C. Enclosures: 12 gauge steel which shall be degreased, phosphatized, primed and finish painted with a coat of baked enamel, except for the front trim which is to be of Type 304 stainless steel with a No. 4 brushed finish. Flush mounting unless otherwise stated on the plans; units through 5 KVA shall have a maximum depth of eight inches. The flush trim panels shall contain a hinged door, with keyed lock, to provide access to the circuit breakers and line isolation monitor along with its provisions for testing. The front panel shall not contain any type of grille or louver for the purpose of ventilation. The panel and transformer shall be so designed that the heat generated by the transformer under full load conditions shall not affect the normal operation of the circuit breakers and ground detector. The maximum front panel temperature shall not exceed 48 degrees Centigrade under full load continuous operation. Certification of this temperature test shall be provided with the shop drawings submittal. The entire section behind the hinged door shall be of dead front design. All hinges shall be of the concealed type.
- D. Transformer:
1. Wound with an electrostatic shield between the primary and secondary windings which are grounded to the enclosure. The electrostatic shield to be of such design that it will prevent direct shorting of the primary winding to the secondary winding and reduce the coupling of harmonic distortions between the primary circuit and secondary circuits. The total leakage current to ground from the transformer secondary winding not exceed 10 microamperes on units 5 KVA and smaller. Regulation to be certified not to exceed 2.6% at 0.8 PF at 20 degrees C above the full load continuous operating temperature in accordance with NEMA-ANSI Standards.
 2. Single phase 60 Hz with primary and secondary voltages as listed in the drawings and/or schedule. Class H rated insulation. Temperature rise limited to 55 degrees C above ambient under full load conditions when tested in accordance with NEMA-ANSI Standards. 220 degrees C UL recognized insulation system. The core and coil to be vacuum impregnated and have a final wrap of insulating materials so as not to expose any bare conductor.
 3. The core to be of stacked design and securely clamped and bolted. The core and coils to be internally isolated from the enclosure by means of suitable vibration dampening system. The design sound level of the completed units not in excess of 27 decibels for units up to 5 KVA. Furnish certified sound level reports for each individual unit with the shop drawing submittal.
- E. Circuit Breakers: 2 pole and have a minimum interrupting capacity of 10,000 amperes. Refer to the panelboard schedule for quantity and sizes of breakers.
- F. Line Isolation Monitor: (LIM)
1. Capable of detecting all combinations of capacitance and resistive faults, including balanced, unbalanced and hybrid faults. Incorporate two channel circuitry designed to continually monitor the impedance from both lines to ground. LIM's which internally switch between either line to ground will not be accepted.
 2. Provide a meter to continuous visual indication of the total hazard current in the monitored system. Incorporate a momentary test switch to insure operational integrity. Test switches which require manual reset will not be accepted. The LIM to display a green safe light and red hazard light on the front panel. The unit is to be fused and the fuses shall be accessible from the front panel.
 3. Provide an external set of normally open and normally closed dry contacts on the LIM. In addition, provide a means for audible and visual alarm when the

- ground connection to the unit is broken. Under any fault or system condition, the current contribution to the system by the LIM shall not exceed 25 microamperes.
4. The alarm point to be set for a threshold value of 5 milliamperes total hazard current under nominal line voltage conditions. The alarm band differential shall not exceed 100 microamperes at nominal line voltage.
 5. UL recognized under UL Subject 1022.
 6. Indicator Alarm and Micro-Ammeter: Built into the front face of the isolation panels. When the flow to ground is within the predetermined limits for the circuits being monitored, a constant green light shall remain illuminated. When the figure is exceeded, the green light shall extinguish, a red indicator shall illuminate and an audible signal shall sound. A silencing switch for the audible signal shall be provided, which, when operated, will cause an amber warning light to illuminate indicating that the audible signal has been disconnected. When the current flow to ground returns to an acceptable level, the unit shall automatically reset. Provide test switch.
- G. UL Listing: The entire hospital panel assembly shall be UL listed under Section 1047, entitled "Isolated Power Systems Equipment".
- H. Wiring: Wiring within all panels shall be in accordance with applicable NEC Code Standards. Low leakage insulation shall be used on all wire. The total panel leakage for a 3 or 5 KVA panel shall not exceed 30 microamperes when energized and assembled. The manufacturer of the panel shall provide certified test data on each individual panel as to maximum leakage of each complete assembly.

2.6 POWER AND GROUND MODULES

- A. Post Glover Model RRP - 1D2. For the correct location and quantity of modules, refer to the drawings.
- B. The back box is to be galvanized and have knockouts located on all four sides of the box. The trim of the box is to be a minimum of 14 gauge, Type 304 stainless, having a No. 4 brushed finish. The only exposed screws on the trim are to be the four screw holding the trim plate to the back box.
- C. All receptacles shall be parallel blade, hospital grade devices and are to be firmly attached with concealed screws that do not appear on the surface of the trim.
- D. The equalizer ground bus contained within these modules is to be made of heavy copper bar and contain lugs suitable for connection of #10 wire and larger. The latter are for connection and grounding of non-electrical conductive surfaces in the area, as well as connection of the ground terminal on all power receptacles with the module or in the area.
- E. All wiring in the module shall be color coded in compliance with the National Electrical Code.

2.7 GROUNDING CORD SETS

- A. Each set shall consist of single conductor, extra flexible copper grounding conductor insulated with green neoprene having a grounding plug on one end and grounding terminal on the other, in accordance with applicable documents. Overall resistance on the cord set, measured from the tip of the grounding plug to the connector, shall not exceed 0.03 ohms.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1.
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Ground and bond panelboards under the provisions of Section 26 05 26.
- D. Height: 6 ft to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory, matching the actual circuit breaker arrangement, for each branch circuit panelboard under provisions of Section 26 00 00. Revise directory to reflect circuiting changes required to balance phase loads. All panelboards shall be furnished with metal directory holders.
- G. Provide engraved plastic nameplates under the provisions of Section 26 00 00.
- H. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Minimum spare conduits: One 3/4 inch empty conduit for every three spare or space circuits. Identify each conduit as SPARE.
- I. Provide compression lugs to accept service feeders.
- J. Provide field drilled holes in all panelboards in lieu of factory installed knockouts to ensure mechanical continuity and a solid grounding connection.

3.2 ISOLATION DISTRIBUTION PANELS

- A. Certified Testing by Manufacturer:
 - 1. Include the cost of and make all arrangements for the testing of all ungrounded isolated systems in the hospital by a qualified factory technician provided by the manufacturer of the isolation systems. The testing shall include a complete inspection of all connections and materials used, and the Contractor shall be prepared to demonstrate to the factory technician that proper polarity was observed, and installation practices were in accordance with the drawings and specifications of these systems. The factory technician shall then check and record system current leakages and mark the system leakage in each individual panel. The factory technician shall further simulate faults at each of the outlets being served by the isolating panel of a magnitude high enough to just bring the total leakage, which the LIM sees above the calibrated point, to verify correct operation of the LIM. The faults simulated at each outlet shall include single resistive, single capacity, balanced capacitance, balance resistive and hybrid fault. The factory technician shall instruct the hospital maintenance staff in the use of the panel and LIM as a leakage measuring device and instruct them as to how all their instrumentation used in electrically sensitive areas can be measured and labeled as to leakage and a periodic test made to ascertain good equipment performance. After all tests have been made, written certification shall be given to the hospital and the Architect that the system is in accordance with all codes and all good installation practices and in accordance with the specifications.

2. Upon completion of all tests the factory technician shall hold a meeting with hospital medical and maintenance staff and thoroughly explain the operation of the equipment installed, and the need and procedure of periodically testing and logging test results. He shall furnish log books to the maintenance department and enter the first readings of all panels in these log books and clearly instruct the hospital maintenance staff as to how future entries should be made. All questions that the hospital staff might have shall be answered completely and thoroughly at this time. Proper notification of testing dates and items shall be made to Architect so that he may, at his discretion, witness any of the tests or meetings conducted by the factory technician.
- B. Panel Rough-In and Installation:
1. Panel back box shall be shipped to the job site for rough-in. The transformer and prewired control panel shall be shipped at a later date.
 2. After the building has been weatherproofed and is dust free, the transformer and prewired control panel shall be installed and connected. The back can shall be cleaned of all dirt and dust prior to installation of the transformer and control panel.
- C. Remote Receptacle and Ground Panels Rough-In and Installation:
1. Back boxes shall be shipped to the job site for rough-in. The receptacle panel shall be shipped at a later date.
 2. After the building has been weatherproofed and is dust free, the receptacle panel shall be installed and connected. The back boxes shall be cleaned of all dirt and dust prior to installation of the receptacle panel.
- D. Spare Fuses and Lamps: Furnish spare fuses and lamps. These shall be neatly labeled and packaged. Spares shall be as follows: 25% of total number of lamps used.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 01.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

3.4 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.
- C. SCHEDULES: Refer to the Drawings.

END OF SECTION

SECTION 26 28 13

FUSES, 600 VOLT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 REFERENCES

- A. ANSI/UL 198E - Class R Fuses.
- B. ANSI/UL 198C - High-Interrupting-Capacity Fuses, Current Limiting Types, Class L.
- C. NFPA 70 – National Electrical Code.
- D. NECA 1-2000 – Standard Practices for Good Workmanship in Electrical Contracting.

1.3 SUBMITTALS

- A. Submit manufacturer's data in accordance with Division 01.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Buss.
- B. Gould.
- C. Little Fuse.

2.2 MATERIAL AND EQUIPMENT

- A. Motors and Transformers, 0 to 600 Amp: Size fuses serving motor loads as specifically recommended by motor or equipment manufacturer or 125% of motor nameplate rating, or the next standard size.
 - 1. 250 volt - Buss LPN-R, UI Class RK1.
 - 2. 600 volt - Buss LPS-R, UI Class RK1.
- B. Lighting Loads, 0 to 600 Amp:
 - 1. 250 volt - Buss KTN-R, UL Class RK1.
 - 2. 600 volt - Buss KTS-R, UL Class RK1.
- C. All Applications, 601 to 6000 Amp: 600 volt - Buss KRP-C, UL Class L.
- D. Interrupting Rating: 200,000 RMS Amps.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses where indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NFPA 70 and the NECA 1-2000.

END OF SECTION

SECTION 26 28 16
DISCONNECT SWITCHES

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Disconnect switches, fusible and non-fusible.
- B. Enclosures.

1.2 REFERENCES

- A. Federal Spec. W-S-865 - Switch, Box (Enclosed), Surface-Mounted.
- B. NEMA KS 1 - Enclosed Switches.
- C. NFPA 70 - National Electrical Code
- D. NFPA 70E - Electrical Safety Requirement for Employee Workplaces
- E. UL 98 - Enclosed Switches1.

1.3 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.
- B. Submit manufacturer's product data. Submit dimensioned drawings and equipment ratings for voltage, capacity, horsepower, and short circuit.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver switches individually wrapped in factory-fabricated water-resistant type containers.
- B. Handle switches carefully to avoid damage to material components, enclosure and finish. Damaged switches shall not be installed on project.
- C. Store switches in a clean and dry space and protected from weather.

PART 2 – PRODUCTS

2.1 FABRICATED SWITCHES

- A. NEMA KS 1; Type HD quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Handle lockable in ON position for service entrance disconnect. Provide defeater so that qualified personnel can open door while switch is in the closed position.
- B. Use switches that have number of poles required as per drawings.

- C. Switches shall be Underwriters' approved for duty shown and enclosure type per drawings. NEMA 3R switches shall be provided where exposed to weather. NEMA 3R switches shall have weatherproof threaded hubs for all conduit entries into switch.
- D. Use fuse clips that are rejecting type to accept Class RK or L fuses only.
- E. Identify switches, as to equipment served, with engraved laminated plastic plates. Refer to 26 05 53 Electrical Identification Section of this Specification.
- F. Voltage rating: 240VAC or 600VAC as per drawings.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Installer shall examine the areas and conditions under which safety and disconnect switches are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SAFETY AND DISCONNECT SWITCHES

- A. Install safety or disconnect switches, where required by NEC, where indicated on drawings, and where required by equipment manufacturer, in a location convenient for maintenance on switch and adjacent equipment.
- B. For equipment with motors larger than 1/8 hp, install disconnect switches within sight of the motor.
- C. Provide fused disconnect switches, whether or not indicated on drawings, when required to maintain equipment manufacturer's warranty. Coordinate with Division 23 for warranty requirements of equipment approved by submittal.
- D. Install fuses in fusible disconnect switches. Provide permanent marking inside switch enclosure for fuse type.
- E. Wall mount switches, where possible, or mount on unistrut supports.

END OF SECTION

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SECTION 26 35 33

AUTOMATIC HARMONIC POWER FACTOR CORRECTION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This Section contains the minimum requirements for the design, manufacturer and testing of automatic, 480V polyphase, power factor correction capacitors. Provide a unit with a KVAR rating to meet or exceed rating shown on plans.

1.2 REFERENCE STANDARDS

- A. Standard Capacitor assemblies, enclosures, and wiring shall conform to the standards stated herein, and also, as applicable, with the following:
1. Underwriters Laboratory Standard 810.
 2. National Electric Code.
 3. Underwriters Laboratory Standard 508.
 4. IEEE Standard 18.

1.3 SUBMITTALS

- A. Provide complete product data for entire capacitor bank assembly.

1.4 QUALITY ASSURANCE

- A. Qualifications of Manufacturer: Equipment shall be produced by a manufacturer regularly engaged in the successful production of power factor improvement capacitor equipment for five years, and completely familiar with the requirements described herein.

1.5 GUARANTEE

- A. Manufacturer shall warrant the electric and electrical equipment to be free from defects in material or workmanship for a period of one (1) year from the date of installation not to exceed eighteen (18) months from the date of shipment.

PART 2 - PRODUCTS

2.1 CAPACITOR ASSEMBLY

- A. Ratings:
1. Voltage: 550V, 3 phase 60Hz for use on a 480VAC,3-Phase,60Hz system.
 2. System Kvar rating as noted on plans at operating voltage, connected in Delta.
 3. The total Kvar shall be divided into 50 Kvar groups, automatically switched.
- B. Enclosure:
1. Capacitor assembly and related components shall be housed in a free standing UL Listed enclosure. The enclosure shall be rated NEMA type 1.
 2. Grounding Lug: One lug shall be provided to accommodate a grounding wire as shown on plans.
 3. Lifting Eyes: A minimum of 2 removable lifting eyes shall be provided per enclosure.

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2.2 ELECTRICAL COMPONENTS

- A. Capacitors
1. Style: Element shall be single phase industrial grade, possessing self-clearing characteristics with a design life of 20 years.
 2. Dielectric System:
 - a. Materials: Elements shall be constructed from metallized polypropylene film.
 - b. Dielectric: No fluid of any kind shall be used in the capacitor construction.
 3. Internal Protected Element: Every capacitor element shall be equipped with a thermal fuse link designed to provide a safe and selective disconnecting method.
 4. Self-Healing: Capacitor elements shall have self-healing capabilities.
 5. Vermiculite Filler: Capacitors shall be filled with vermiculite, a non-toxic, fire retardant material.
 6. Internal Discharge Resistors: Internal discharge resistors shall be provided to drop residual voltage to 50 volts, or less, within one minute after the capacitor is disconnected.
 7. Temperature and Operating Tolerances:
 - a. Capacitors shall be capable of operating in an ambient temperature of 14°F to +86°F.
 - b. Capacitors shall be rated for 115% continuous overvoltage.
 - c. Capacitors shall be capable of continuously operating at 140% of their rated capacitive reactive power due to the combined effects of frequency variation, over-voltage, and harmonics.
- B. Reactors:
1. The reactor's inductance shall result in a capacitor/reactor combination to prevent resonance. The filter shall be tuned to just below the 5th harmonic.
 2. Reactors shall consist of a complete epoxy resin vacuum impregnation to reduce noise and promote proper heat dissipation.
 3. The reactor shall have Class H insulated copper windings.
 4. All reactors shall be supplied with normally open thermal switches having a 145°C closing temperature with automatic reset to normal open conditions. One switch shall be installed in the hot spot of each phase winding.
 5. Each reactor shall be open frame construction.
- C. Wire: Power circuit wiring within the enclosure shall be black, single conductor, stranded copper, 90°C temperature rated. All control wire shall be red.
- D. Branch Circuit Protection: Fuses shall be provided on three phases of each capacitor step. Fuses shall be connected ahead of the feeding contactor. Fuses shall have a 100,000 amp interrupting capacity.
- E. Main Lugs: Main lugs shall be provided to terminate incoming conductors as indicated on plans.
- F. Contactors: Contactors shall be rated at 690V. Contactors shall be capable of capacitive switching without derating. Standard IEC and NEMA contactors shall not be used. Contactors shall be rated for the capacitor's full inrush current. Inductors shall not be required to limit the inrush current to within the contactors rating. Contactors shall not produce any harmful switching transients that will disrupt existing equipment.

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- G. Control Transformer: UL Listed control transformer rated 480 to 120 VAC and fused on its primary and secondary shall be used.
- H. Current Transformer: "A" phase of the current transformer in the Main Switchgear shall be connected to the Power Factor Controller. This current transformer is also used for the electronic metering. See plans.

2.3 POWER FACTOR CONTROLLER

- A. One UL approved microprocessor based controller shall be provided to automatically monitor power factor, maintain a specified power factor set point, and provide other pertinent system and network conditions.
- B. Performance Parameters:
 - 1. Continuously calculate the power factor by measuring the phase angle difference between the voltage and current.
 - 2. Switch capacitor steps in and out to maintain the power factor set point.
 - 3. Capable of operating in normal or integral modes and progressive or direct modes.
 - a. Normal mode operation to provide traditional stepping operations where the demand is continuously present for all of the programmed switching delay time.
 - b. Integral mode operation to provide stepping operations for rapid varying loads by providing compensation based on the average value of the rapid load.
 - c. Progressive switching to provide compensation through a step-by-step sequence utilizing typical delay times between each step until desired power factor is obtained.
 - d. Direct switching provides compensation by determining the required number of steps to reach the set power factor and energizing the required steps in twelve second intervals to quickly reach the set power factor. Upon a sudden reduction in load, the required number of steps will be disconnected to maintain the set power factor with minimum delay.
 - 4. The controller shall provide automatic CT phase rotation adjustment.
 - 5. Controller shall automatically determine c/k ratio.
 - 6. Alarm Conditions:
 - a. Activate an alarm LCD and output relay if all of the capacitor steps are connected and the target power factor is not reached within the programmed time (1 sec to 120 minutes).
 - b. A programmable alarm reset time delay between 1 sec and 120 minutes shall be provided.
 - c. Automatically disconnect all capacitors within 40ms of power loss.
 - d. Automatically disconnect all capacitors on exceeding user programmable high and low voltage limits.
 - e. Automatically disconnect all capacitors on exceeding user programmable high temperature limit.
 - f. Provide the option to selectively disable any capacitor step from the system without affecting the normal operation of the remaining steps.
 - 7. User Defined Parameters:
 - a. The controller shall allow user to program log threshold limits for minimum and maximum voltage, network current, network KVA, network KVAR, voltage total harmonic distortion, network current total

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- harmonic distortion, and internal temperature of capacitor bank enclosure.
- b. The controller shall allow the user to set the desired power factor between the range of 0.8 inductive to 0.8 capacitive.
8. Logging:
 - a. In the event a programmed threshold limit has been exceeded, the controller shall log the total time and peak value of the exceeded threshold value in a non-volatile memory.
 - b. In the event that insufficient KVAR is present to maintain the set minimum power factor, the controller shall log the level of KVAR missing and the number of steps required to maintain the set minimum power factor in a non-volatile memory.
 - c. All accumulated logged data shall have the option of being deleted.
 9. Plotting: The controller shall provide a means for plotting the basic measurements - voltage, network current, KVA, KVAR, voltage THD, current THD, network power factor, and internal enclosure temperature - through an analog voltage output.
 10. A lockout feature shall be provided to prevent unauthorized changes to the power factor controller.
- C. The following indicators and displays shall be provided:
1. 16 character alphanumeric LCD readout of the following parameters: Power Factor, Required Power Factor, Voltage, Network Current, KVA, KVAR, Reactive Current, Voltage Total Harmonic Distortion, Current Total Harmonic Distortion, and Temperature Inside Capacitor Bank Enclosure.
 2. Capacitor State Indicator: LCD display shall show the number of steps activated.
 3. LCD display indicating the need for additional steps or the need to remove additional steps.
 4. LCD indicating activation of fan control or alarm relay.
 5. LCD indication of lockout status.
 6. A dry alarm contact shall be provided for connection to the building DDC system for remote monitoring of capacitor bank in the event of an alarm.

2.4 INFORMATION TAGS

- A. Product Identification: Permanent nameplates shall show:
1. Manufacturer's name.
 2. Kvar rating, model number & serial number.
 3. Number of steps.
 4. Rated voltage, phase, and frequency.
 5. Internal Discharge Resistor Notice.
 6. Enclosure rating (1,12 or 3R).
 7. Operating temperature range (-40°C / +40°C).
 8. Note: Self-Healing, Dry Type, No PCB.
- B. Precautionary Data: A red caution tag (2" x 4") with white lettering shall be affixed to the front of the enclosure access door and shall read.

DANGER
HAZARDOUS VOLTAGES
ARE LOCATED INSIDE

HAZARD OF ELECTRICAL SHOCK OR BURN

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DISCONNECT POWER AND WAIT
ONE MINUTE BEFORE OPENING

CAPACITORS MUST DISCHARGE FOR
ONE MINUTE PRIOR TO OPENING

2.5 ACCEPTABLE MANUFACTURERS

- A. Square D.
- B. General Electric.
- C. Eaton Cutler Hammer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated by the manufacturer's recommended Installation and Operation Instructions and applicable codes.
- B. Mount capacitor bank on a 4 inch concrete housekeeping pad.

3.2 FLOOR MOUNTING

- A. Construct concrete pad for capacitor bank in accordance with Section 26 05 00, Electrical General Provisions. Maintain a minimum of 6 inches free air space between enclosure and walls.
- B. Provide nameplates as specified in Section 26 05 53.

END OF SECTION

SECTION 26 43 13

SURGE PROTECTION DEVICE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 SUMMARY

- A. This Section specifies the furnishing and installing of type 1 Surge Protective Devices (SPDs), used as a component of a facility-wide suppression system implemented in conjunction with type 2 SPDs in branch circuit panelboards. The specified unit installed in the facility-wide suppression system shall provide effective high-energy transient voltage suppression, surge current diversion, and line control in high-exposure ANSI/IEEE C62.41-1991 environments on the load side of the facility main overcurrent protective device (OCPD). Units installed in the facility-wide suppression system are indicated by the designation SPD (Surge Protection Device) on Drawings.

1.3 STANDARDS

- A. The specified units installed in the facility-wide suppression system shall be designed, manufactured, tested, and installed in compliance with the following standards:
- B. American National Standards Institute and Institute of Electrical and Electronic Engineers:
 - 1. ANSI/IEEE C62.41.1, Recommended Practice for Surge Voltages in Low-Voltage AC power Circuits.
 - 2. ANSI/IEEE C62.45, Guide for Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
- C. IEEE Standard 1100-1999 (Emerald Book): Powering and Grounding Sensitive Electronic Equipment.
- D. Federal Information Processing Standards Publication 94 (FIPS PUB 94).
- E. Military Standards (MIL-STD 220A).
- F. National Electrical Manufacturers Association (NEMA LS1-1992/R2000).
- G. National Fire Protection Association (NFPA):
 - 1. NFPA 75, Protection of Information Technology Equipment.
 - 2. NFPA 70, National Electrical Code (NEC), Article 285.
- H. Underwriters Laboratories (UL):
 - 1. UL 248, Low Voltage Fuses.
 - 2. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - 3. UL 1449 Third Edition, Surge Protection Devices.

1.4 RELATED WORK

- A. Section 26 24 16, Panelboards – Distribution and Branch Circuit.
- B. Section 26 43 13, Surge Protection Device.
- C. Section 26 05 73, Overcurrent Protective Device Coordination Study.

1.5 SUBMITTALS

- A. Factory Tests: Furnish certified documentation for the following tests:
 - 1. Package must include shop drawings complete with all technical information unit dimensions, detailed installation instructions, maintenance manual, recommended replacement parts list and wiring configuration.
 - 2. Copies of Manufacturer's catalog data, technical information and specifications on equipment proposed for use.
 - 3. Copies of documentation stating that the Surge Protection Device is listed from a Nationally Recognized Testing Laboratory (NRTL) (UL, ETL, etc) and are tested and multi-listed to UL 1449 3rd Edition and UL 1283.
 - 4. Copies of actual let through voltage data in the form of oscilloscope results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.
 - 5. Copies of Noise Rejection testing as outlined in NEMA LS1-1992 (R2000) Section 3.11. Noise rejection is to be measured between 50 kHz and 100 MHz verifying the devices noise attenuation. Must show multiple attenuation levels over a range of frequencies.
 - 6. Copies of test reports from a recognized independent testing laboratory, capable of producing 200kA surge current waveforms, verifying the suppressor components can survive published surge current rating on a per mode basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20 kV/10kA). Test data on an individual module is not acceptable.
 - 7. Copies of test reports from a recognized independent testing laboratory indicating the results of nominal discharge current test at values 20 kA/mode. The nominal discharge current test must be conducted per UL 1449 Third Edition.
 - 8. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.
- B. Product Data: Submit complete product data and catalog cutsheets describing each unit provided. Make submittals in accordance with the requirements of Division 01 and Section 26 00 00, Electrical General Provisions.
- C. Field Testing: Submit written procedures and forms to be used for field testing to demonstrate compliance with these specifications, as required under Part 3 of this Section. Testing procedures and forms shall include range of permissible values for each recorded parameter. Include list of test instruments and materials to be used for field testing, to include manufacturer, model, accuracy, and applicable steps of field testing procedures.
- D. Submittals after fabrication:
 - 1. Instruction manual describing each unit provided. Manual shall conform to the requirements of Operations and Maintenance (O&M) manuals per Section 26 00 00, Electrical General Provisions.
 - 2. Spare Parts: A list of customer-replaceable spare parts for each unit installed in the facility-wide suppression system shall be included in the unit installation, operation and maintenance instructions. Spare parts shall be quickly and easily field-replaceable.

- 3. Field Testing: Submit to the Owner's Representative and to the Architect/Engineer documentation of field testing performed in accordance with Part 3 of this Section, demonstrating compliance with the requirements of this Section. Where not specified otherwise, provide three copies to the Architect/Engineer and one copy to the Owner's Representative.
- E. Panelboards: Refer to Section 26 24 16, Panelboards – Distribution and Branch Circuit, for submittal requirements for distribution and branch circuit panelboards as indicated in Construction Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Square D
- B. GE
- C. Current Technology
- D. Eaton.

2.2 SPD RATINGS

- A. Refer to drawings for operating voltage, configuration.
- B. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 3rd Edition, section 37.7.3. MCOV values claimed based on the component's value or on the 30-minute 115% operational voltage test, section 38 in UL1449 will not be accepted.
- C. Unit shall have not more than 10% deterioration or degradation of the UL1449 3rd Edition Voltage Protection Rating (VPR) due to repeated surges. Unit shall have a monitoring option available to be able to test and determine the percentage of protection available at all times.
- D. Protection Modes of UL1449 3rd Edition Voltage Protection Rating (VPR) (6kV, 3kA) for grounded WYE/delta and with voltages of (480Y/277). 3-Phase, 4 wire circuits.
- E. Provide equipment with an integral disconnect with the following ratings:

System Voltage	Mode	MCOV	B3 Ringwave	C3 Comb. Wave	UL 1449
					Third Edition VPR Rating
120/208	L-G	150	400	650	700
	N-G	0	350	500	900
	L-L	300	400	950	900
277/480	L-N	320	550	1125	900
	L-G	320	850	1075	1200
	N-G	0	700	900	1200
	L-L	550	650	1950	1800

- F. If SPDs are submitted with integral disconnect ratings must be adjusted to comply with UL 1449 3rd Edition.
- G. Provide SPDs with nominal discharge current rating of 20kA/mode.
- H. Surge Rating - Provide SPDs with a minimum surge rating of 200kA per mode.
- I. Electrical Noise Filter- each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric noise shall be as follows using the MIL-STD-220A insertion loss test method.
 - 1. 100 kHz at 41 db.
 - 2. All other frequencies should be 31 db or better.
- J. Each Unit shall provide the following features:
 - 1. Phase Indicator lights, Form C dry contacts, counter and audible alarm.
 - 2. Field testable while installed.
- K. Suppression/Filter System: UL 1283 minimum insertion loss obtained utilizing MIL-STD-E220A 50 ohm insertion loss methodology. (100 kHz - 1 MHz): 34 dB (50:1).

2.3 FUSING

- A. Fuse Components Identification and Surge Rating: The surge rating (8 x 20 μ sec) of the fuse shall be greater than the combined surge current rating of downstream connected suppression elements.
- B. Suppression Components Identification and Surge Rating: The suppression elements connected in series with fuse elements shall provide the suppression elements published 8 x 20 μ sec surge current rating. The rating of the suppression elements shall be less than the rating of upstream fusing elements.
- C. Surge Performance: Fusing shall be required to meet the single pulse surge current testing requirements described above.
- D. Isolation: The unit shall have each MOV fused and designed to operate only in the event of a MOV failure within the unit.
- E. UL Rating: Fusing shall be 200kAIC UL248 Recognized.

2.4 BUSSING

- A. Transient Conduction Path: Full magnitude transient currents shall be conducted on low-impedance solid copper bussing. Printed circuit boards traces shall not be used to conduct or shunt transient voltage surge currents.

2.5 MONITORING

- A. Visual: Monitoring shall include one set of status monitoring lights that will provide visual indication of voltage present to the SPD for each phase of protection. The lights shall also indicate when suppressor protection has degraded to a value of less than 50%.
- B. Alarm: The unit shall include an audible alarm with battery backup, a current-sensing surge counter, and two sets of Form C contacts for remote monitoring.

2.6 ENCLOSURE

- A. Provide a SPD assembly that is UL listed.
- B. If required to maintain a UL listing of both the SPD and the associated distribution equipment, then provide the SPD in a separate NEMA Type 12 enclosure sized per the SPD manufacturer's recommendations. Install the SPD per manufacturer recommendations. Install the externally mounted SPD so that the conductor length is a maximum of 5'-0".
- C. Where UL listed for installation in the equipment, the arrangement of the SPD within the enclosure shall match and maintain the full wiring gutter fill capacity of the associated electrical equipment.
- D. Finish: Exterior and interior steel surfaces shall be cleaned and finished with electrostatically applied "powder coat" thermoset enamel baked over a rust-inhibiting phosphatized coating. Exterior finish color shall be manufacturer's standard gray, ANSI 49 or ANSI 61, to match finish of associated panelboard.

2.7 LISTING

- A. Units shall be UL 1449, Third Edition, listed and labeled as a Type 1 Surge Protection Device.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Deliver surge protection devices, components and accessories individually wrapped, on pallets or in factory-fabricated fiberboard type containers, and protected from weather and damage.
- B. Store surge protection devices, components and accessories in a clean and dry space, elevated above grade, and protected from weather, sunlight, moisture, dirt, and corrosion.
- C. Surge protection devices, components, and accessories shall not be used as work tables, scaffolds, or ladders.
- D. Handle surge protection devices, components, and accessories carefully to avoid damage to material components, enclosure and finish. Use only lifting eyes and brackets provided for that purpose. Damaged products shall be rejected and not be installed on project.
- E. Refer to Section 26 00 00, Electrical General Provisions.

3.2 INSTALLATION

- A. General: Install surge protection device (SPD) internal to the electrical distribution equipment in accordance with manufacturer's wiring diagrams and written instructions and the applicable requirements of the NEC, NEMA, ANSI, local codes, and Owner requirements.
- B. Install the SPD enclosure, or enlarge enclosure to house SPD as required, to the top or bottom of the panelboard at end opposite from the main circuit breaker or main lugs. Extend phase conductors from SPD to disconnecting means in the electrical equipment, as indicated on Drawings. Extend neutral and ground conductors from SPD to lugs at the

neutral and ground busses, in accordance with manufacturer instructions. Connection leads shall not exceed 18 inches from the SPD to the circuit breakers:

1. Where not otherwise indicated or specified, terminate SPD phase conductors to three single-pole circuit breakers in the panelboard connected by a handle tie.
 2. Where manufacturer instructions and UL-listing require a 3-pole circuit breaker as disconnecting means and overcurrent protection for the surge protection device, provide a 3-pole circuit breaker as the disconnecting means between the SPD and main bus.
 3. Provide overcurrent device for SPD connection to panelboard main bus, sized in accordance with manufacturer recommendations. Refer to Section 26 24 16, Panelboards – Distribution and Branch Circuit.
- C. Wire Size: Manufacturer's recommended wire size for unit supplied. Where wire size is not indicated by manufacturer, provide conductors of same size as grounding conductor connected to the ground bus of the panelboard, #2 AWG minimum per phase, neutral, and ground. Use stranded copper conductor with THWN insulation, unless otherwise noted.
- D. Equipment interiors shall be maintained clean until final Owner acceptance. Equipment exteriors shall be maintained free of mud, spray-on insulation, paint spray and other substances not placed on the exterior surface by the equipment manufacturer.
- E. Inspection: Thoroughly inspect surge protection device and panelboard for items such as loose connections and presence of foreign materials and remedy prior to energizing the panelboard. Bolted connections shall be torqued to the manufacturer's recommendations.

3.3 SYSTEM TESTING

- A. Upon completion of installation, provide the start-up and testing services of a factory-authorized and factory-trained local service representative. The tests shall include:
1. Off-Line testing: Impulse injection to verify the system tolerances as well as verification of proper facility neutral-to-ground bond. Compare field test results to factory benchmark test parameters supplied with each individual unit.
 2. On-Line testing: Verification that suppression and filtering paths are operating with 100% protection as well as verification of proper facility neutral-to-ground bond by measuring neutral-to-ground current and voltage and by visual inspection.
 3. Voltage measurements from Line-to-Ground (L-G), Line-to-Neutral (L-N), Line-to-Line (L-L), and Neutral-to-Ground (N-G), taken at the time of the testing procedure.

3.4 DOCUMENTATION AND REPORTING

- A. Record results of field testing and compare to factory benchmark test parameters supplied with each individual surge protection device. Indicate that the integrity of neutral-to-grounds bonds was verified through testing and visual inspection, and that grounding bonds were observed to be in place.
- B. Submit to the Owner's Representative and to the Architect/Engineer copies of the startup test results and the factory benchmark testing results for confirmation of proper suppression filter system function, as required by paragraph 1.5D.3, this Section. Provide number of copies as required by Division One and Section 26 00 00, Electrical General Provisions; and three copies where not otherwise specified.

3.5 SYSTEM WARRANTY

- A. The SPD system shall be warranted against defective materials and workmanship for a period of ten years.
- B. Warranties shall conform to the requirements of Division 01 and Section 26 00 00, Electrical General Provisions.

END OF SECTION

SECTION 26 51 00

INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Interior lighting fixtures and accessories
- B. Exterior lighting fixtures and accessories
- C. Emergency lighting units
- D. Emergency exit signs
- E. Lamps
- F. Ballasts
- G. Lighting controls

1.2 REFERENCES

NOTE TO SPEC WRITER: INCLUDE ONLY REFERENCE STANDARDS THAT ARE TO BE INDICATED WITHIN THE TEXT OF THIS SECTION. EDIT THE FOLLOWING, ADDING AND DELETING AS REQUIRED FOR PROJECT AND PRODUCT SELECTION.

- A. NEPA 101 - Code for Safety to Life from Fire in Buildings and Structures
- B. NEMA WD1 - General-Purpose Wiring Devices
- C. ANSI C82.1 - Specification for Fluorescent Lamp Ballasts
- D. ANSI C82.4 - Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type)
- E. NEMA LE - H-I-D Lighting System Noise Criterion (LS-NC) Ratings
- F. UL 844 - Electric Lighting Fixtures for Use in hazardous (classified) Locations
- G. UL 924 - Emergency Lighting and Power Equipment
- H. UL 935 - Fluorescent-Lamp Ballasts
- I. UL 1029 - High-Intensity-Discharge Lamp Ballasts
- J. UL 1572 - High Intensity Discharge Lighting Fixtures
- K. UL 1574 – Track Lighting Systems
- L. IESNA – Lighting Handbook
- M. NEMA WD 1 - General Color Requirements for Wiring devices
- N. NEMA LE 5B – Procedure for Determine Luminaire Efficacy Ratings for High-Intensity Discharge Industrial Luminaires

- O. NFPA 70 – National Electrical Code
- P. ASHRAE/IES 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- Q. Standards For State-Funded Outdoor Lighting Fixture – Texas House Bill 916 (1999)
- R. UT System OFPC – Security Planning and Design Guidelines (2002 release)

1.3 DESIGN CRITERIA

- A. Lighting level design shall be per IESNA (Illuminating Engineering Society of North America) recommendation.
- B. The power consumption for interior and exterior lighting shall not exceed power allowance as per ASHRAE 90.1 latest revision.
- C. Outdoor lighting for state-funded project shall meet “cutoff luminaire” criteria set forth by Texas House Bill 916 (1999).
- D. Design for exterior lighting shall meet security criteria required by UT System OFPC – Security Planning and Design Guidelines (2002 release).

1.4 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 26 00 00.UT, Basic Electrical Requirements, and Division 1 for submittal requirement.
- B. Submit manufacturer's data on interior and exterior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by luminaire "type" in alphabetical order, with the proposed fixture and accessories clearly labeled.
- C. Submit dimensioned drawings and performance data including complete photometric test data for each luminaire, candlepower distribution curves in two or more planes, candlepower chart zero to 90 degrees, lumen output zonal summary chart, average and maximum brightness data, and coefficients of utilization for zonal cavity calculations, , spacing to mounting height ration, efficiency and visual comfort probability. Also provide luminaire weights, mounting data, and accessory information for each luminaries type.
- D. Lamps: Catalog cuts showing voltages, colors, approximate hours life, approximate initial lumens, lumen maintenance curve, lamp type and base.
- E. Ballasts: Catalog cuts showing type, wiring diagram, nominal watts, input voltage, starting current, input watts, sound rating, power factor and low temperature characteristics.
- F. Site lighting pole data and catalog cuts, including wind loading, complete dimensions and finish.
- G. Shop drawings for site lighting luminaries showing pertinent physical characteristics, including fastening details, ballast type and location.
- H. Controls: Catalog cuts and/or shop drawings showing dimensions, voltage capacity, contact ratings, wiring diagrams, operating levels, and temperature ratings.

- I. Lighting design shall be in compliance with power allowance for lighting, which is stipulated by ASHRAE 90.1. Compliance forms along with engineering data associated with it shall be submitted for Owner's review during design phase.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver lighting fixtures individually wrapped in factory-fabricated fiberboard type containers. Parabolic louvers shall be shipped in thermally sealed polyethylene wrapper.
- B. Handle lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.
- C. Store lighting fixtures in a clean, dry space and protected from the weather.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Lighting fixtures and accessories shall comply with the design and function requirements of the project. Design characteristics shall be as noted in manufacturer's submittal data.
- B. Provide lighting fixtures of the size, type and rating as scheduled, complete with, but not limited to, lamps, lamp holders, reflectors, ballasts, poles and wiring.

2.2 INTERIOR LIGHTING FIXTURES

- A. Fluorescent Fixtures
 1. Lenses shall be UV stabilized, injection-molded, clear, 0.150- inch minimum thickness virgin acrylic. Provide a minimum of 8 hold-down lens retaining clips for troffers utilizing framed diffuser lenses.
 2. Parabolic aluminum louvers shall be semi-specular, low-iridescence finish silver anodized aluminum, 2 or 3 inches deep as per drawings. Louvers shall be roll formed with roll grain horizontal to view plane. Louver intersections shall be of a close-fitting, tab-and-slot construction permitting no light leaks.
 3. Parabolic plastic louvers shall be vacuum-metalized polystyrene with specular finish and antistatic properties.
 4. Lighting fixture door frames shall be flush steel hinged and equipped with rotary-action cam latches.
 5. Lighting fixture housing shall be minimum 22-gauge, cold-rolled steel with pre-punched knockouts and access plate for electrical connections. End plates shall be minimum 20-gauge with pre-punched hanger holes. Ballast mounts shall be separated for heat dissipation.
 6. Three lamp luminaries for dual level switching shall have outer two lamps on one ballast, inner lamp on second ballast, shared with adjacent luminaire's inner lamp if practical.
- B. Light Emitting Diode (LED) T8 Linear Tube lamped fixtures
 1. Manufacturer shall as part of the manufacturing process pre-wire lamp holders for LED T8 Retrofit lamps to line voltage. No ballast or external driver shall be required for proper operation of the lamps. Ballasts shall be removed from the fixture to ensure that no incidental connection to lamps or lampholders is possible.
 2. Fixtures shall not require contractor intervention to perform re-wiring of the fixture in the field, including, but not limited to, removal of ballast or re-wiring of lamp holders

3. If modifications to luminaires are required by LED T8 linear tube manufacturer in order for luminaires to accept LED T8 linear tube manufacturer's lamps, the LED T8 linear tube manufacturer shall provide a warranty of both the lamps and the luminaires for a period of 5 years in addition to the lamp warranty described below.
 4. Lenses shall be UV stabilized, injection-molded, clear, 0.150- inch minimum thickness virgin acrylic. Provide a minimum of 8 hold-down lens retaining clips for troffers utilizing framed diffuser lenses.
 5. Parabolic aluminum louvers shall be semi-specular, low-iridescence finish silver anodized aluminum, 2 or 3 inches deep as per drawings. Louvers shall be roll formed with roll grain horizontal to view plane. Louver intersections shall be of a close-fitting, tab-and-slot construction permitting no light leaks.
 6. Parabolic plastic louvers shall be vacuum-metalized polystyrene with specular finish and antistatic properties.
 7. Lighting fixture door frames shall be flush steel hinged and equipped with rotary-action cam latches.
 8. Lighting fixture housing shall be minimum 22-gauge, cold-rolled steel with pre-punched knockouts and access plate for electrical connections. End plates shall be minimum 20-gauge with pre-punched hanger holes. Ballast mounts shall be separated for heat dissipation.
- C. Board lamped fixtures
1. Provide luminaire package with color temperature variance limited to three MacAdam step as defined in ANSI C78.377.
 2. Provide luminaire that is factory tested as a complete package with a LM-79 and LM-80 report.
 3. Provide luminaire with individual LED boards. Replacement of individual LED boards shall be capable to be performed in the field and shall not require replacement of the entire unit or fixture.
 4. Provide fixture with minimum 5 year warranty covering complete luminaire package.
 5. Provide LEDs with phosphorous coating, for creation of white LEDs, at the individual LEDs and not at the luminaire lens or housing.
 6. Provide luminaire with quick disconnect for LED drivers and individual LED boards.
 7. Where indicated on the luminaire schedule, provide LED fixtures compatible with 0-10V non-proprietary dimming controls.
 8. Provide LED luminaires with appropriately sized LED heat sink to maintain chip manufacturer's recommendations for junction temper
- D. UL Listing
1. All Luminaries and components shall be UL tested, listed, and labeled.
 2. Luminaries installed under canopies, roofs, or similar damp or wet locations shall be UL listed and labeled as suitable for damp or wet locations.
 3. Recessed luminaries installed in fire rated ceilings and using a fire rated protective cover shall be thermally protected for this application and shall be approved for the installation in a fire-rated ceiling.

2.3 EXTERIOR LIGHTING FIXTURES

- A. Enclosures shall be complete with gaskets to form weatherproof seal and UL approved for wet locations.
- B. Provide low temperature ballasts with reliable starting to 0 degrees F.

2.4 BATTERY BACKED EMERGENCY LIGHTING UNITS

- A. Acceptable Manufacturers
 - 1. Dual Lite
 - 2. Lithonia
 - 3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 16010, and Division 1 for substitution requirement.
- B. General Requirements
 - 1. Provide emergency lighting units self-contained complete with batteries, charger, and lamps to provide automatic emergency lighting upon failure of normal power.
 - 2. Battery shall be 6 or 12 volts, sealed maintenance free, nickel cadmium type, 24-watt rated capacity, with 1.5 hours minimum capacity to supply the connected lamp load.
 - 3. Charger shall be solid state capable of maintaining the battery fully charged during normal conditions, and capable of recharging discharged battery to full charged within 24 hours.
 - 4. Lamps shall be 12 watt minimum, sealed beam Tungsten Halogen type.
 - 5. Unit housing shall be thermoplastic or steel with beigefinish.
 - 6. Indicators: Provide lamps to indicate AC ON and RECHARGING.
 - 7. Provide test switch to manually transfer unit from normal supply to battery supply.
 - 8. Unit shall be 120 or 277 volt.

2.5 EXIT SIGNS

- A. Acceptable Manufacturers
 - 1. Dual Lite
 - 2. Lithonia
 - 3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 16010, and Division 1 for substitution requirement.
- B. General Requirements
 - 1. Provide red LED with red diffuser exit signs at the locations per drawings. Exit signs shall have stencil face, 6-inch high red letters on white background, or as specified otherwise, with red Chevron type directional arrows as indicated on drawings.
 - 2. Battery backed exit signs shall be provided with integral battery-operated emergency power supply, including power failure relay, test switch, AC ON pilot light, battery, and fully-automatic charger. Provide test switch to manually transfer unit from normal supply to battery supply.
 - 3. Battery shall be sealed maintenance free, nickel cadmium type, 6 or 12 volts, 24-watt rated capacity, with 1.5 hour minimum capacity to supply connected lamp load.
 - 4. Unit shall be 120 or 277 volt.

2.6 LAMPS

- A. Acceptable Manufacturers
 - 1. General Electric Company
 - 2. Philip Lighting Company
 - 3. Sylvania

4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 16010, and Division 1 for substitution requirement.

B. Fluorescent:

1. Philips #F32T8/TL841/ALTO; CRI-86; 4100K; TL80.
2. Philips #F25T8/TL841/ALTO; CRI-85; 4100K; TL80.
3. Philips #FB32T4/TL841/ALTO; CRI-85, 4100K; TL80.

C. LED T8 Linear Tube Lamps

1. PRUFled #140-02; 4500K; 18W
2. No substitutions

D. LED T8 Linear Tube Lamp Requirements

1. Wattage: Maximum 18 Watt LED Linear Tubes
2. Lumen Output: Minimum 1710 lm
3. Lumen Efficacy: Minimum 93 lm/W
4. Lighting Beam Angle: Minimum 120 Degrees
5. Color Accuracy: Minimum 80 CRI
6. Color Temperature: 4500K Natural White
7. Color Temperature Deviation: LED T8 Retrofit lamps shall maintain a color temperature consistency of 3.5 step macadam ellipse.
8. Light Emitting Diode: SMD Epistar, Samsung, Philips, Uchio, or Cree Diodes
9. Operating Temperature: As appropriate for enclosed fixture as installed
10. Ambient Humidity: 90%
11. Light Decay: Maximum 4% after 3000 hours
12. Lamp Efficiency: 90%
13. Working Voltage: 120 - 277V
14. Lamp Size: T8 Linear Tube
15. Lens Reflector Style: Clear
16. Base Type: Bi-Pin
17. Life Expectancy: 50,000 hours
18. Safety Rating: ETL rated
19. Power Supply: Internal Driver

Warranty: 5 year product replacement warranty for failure of driver or failure of lamp to maintain 70% of initial lamp lumen output

E. General Requirements

1. Lamps including linear fluorescent, compact fluorescent, and HID shall be low mercury type and shall pass all federal TCLP (Toxicity Characteristic Leaching Procedure) test requirements in effect at the time of manufacture. All lamps shall be energy saving and rapid start type.
2. General use incandescent lamps shall be inside frosted type, 120 volts, 750 hour minimum.
3. Linear fluorescent lamps shall be T8 lamps. Compact lamps shall be twin or double twin tubes. All lamps for one project shall be provided by the same manufacturer with color temperature as indicated on drawings. Operation voltage and wattage shall be as indicated on drawings..
4. Mercury vapor HID lamps shall not be used.
5. Metal halide HID lamps shall be phosphor coated, suitable for the burning position required.
6. High-pressure sodium HID lamps shall be clear or diffuse coated.
7. Maintenance Stock: Furnish a stock of replacement lamps in the original cartons or packing sleeves, amounting to 10% (but not less than two lamps in each case)

of each type and size lamp used in each fixture type. Deliver replacement stock as directed to Owner's storage space.

2.7 BALLASTS

- A. Acceptable Manufacturers
 - 1. Valmont
 - 2. Advance
 - 3. Magnetek
 - 4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 16010, and Division 1 for substitution requirement.

- B. General Requirements
 - 1. All ballasts shall be UL listed and have the UL symbol on the label.
 - 2. Ballasts for fluorescent lamps
 - a. 277 Volts:
 - 1) Advance VEL 2P32-LW-RH-TP.
 - 2) Advance VEL 3P32-LW-RH-TP.
 - 3) Advance VEL 4P32-LW-RH-TP.
 - 4) Advance Powerkut VK2532.
 - b. 120 Volts:
 - 1) Advance REL 2P32-LW-RH-TP.
 - 2) Advance REL 3P32-LW-RH-TP.
 - 3) Advance REL 4P32-LW-RH-TP.
 - 4) Advance Powerkut RK2532,
 - 3. COORDINATE FOLLOWING REQUIREMENT WITH FIXTURE SCHEDULE. PROVIDE SPECIFIC FIXTURE TYPE FOR DUAL LEVEL APPLICATIONS.
 - a. Serving Compact Fluorescent Lamps:
 - 1) Description: ANSI C82.1, electronic high power factor, high frequency, rapid start type ballast, suitable for lamps specified.
 - 2) Voltage: Match luminaire voltage.
 - 3) Total Harmonic Distortion: Less than 20 percent. Third harmonic: Less than 10 percent.
 - 4) Sound Rating: "A" as established by Certified Ballast Manufacturers.
 - 5) EMI and RFI: Within the limits established by the FCC.
 - 6) Crest Factor: 1.7 or less.
 - 7) Ballast Factor: 1.20.
 - 8) Provide end of lamp life shutdown circuitry.
 - 9) Provide low temperature rated ballasts for exterior applications.
 - b. Provide 277V ballasts for all operations except for under-counter fixtures that shall be rated for 120V operation. Ballasts shall be electronic type, rapid start, and power factor of 95 percent or greater, suitable to operate at 60 Hz input frequency.
 - c. Electronic ballasts shall comply with all FCC and NEMA limits governing EMI and RFI, and shall have Total Harmonic Distortion (THD) of less than 20 percent.
 - d. Ballasts shall be Class P thermally protected.
 - e. Sound level criteria
 - 1) Nominal 430 mA Lamps: Class A sound rated.
 - 2) Nominal 800 mA Lamps: Class B sound rated.
 - 3) Nominal 1500 mA Lamps: Class D sound rated. Provide

isolation mounting and insulation to reduce sound transmission and radiation.

- f. Electronic Dimming Ballasts: Compatible with lamp and dimming system, labeled for use and listed as compatible by dimmer manufacturer with a minimum full-to-20 percent dimming range.
- g. Exterior Fluorescent Ballasts: Provide zero degree starting rating.

2.8 LIGHTING CONTROL

- A. Refer to Section 26 76 26 Wiring Devices and Floor Boxes for lighting switch, dimming control, and occupancy sensor.
- B. Photocell shall be automatic dawn on, dusk off switching; moisture, temperature, and vibration-resistant die-cast aluminum housing; time delay feature to prevent false switching; field adjustable to control operating levels.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to order lighting fixture, check the building electrical system requirements, architectural finishes, and the type of ceilings that lighting fixture will be installed. Any discrepancies of compatibility pertaining trim, frames, color, mounting, ballast, voltage and etc. shall be brought to the attention of A/E by written notice. Do not proceed with procurement until discrepancies are resolved in a satisfactory manner.
- B. Installer shall examine the areas and conditions that light fixtures are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LIGHTING FIXTURES

- A. Install light fixtures in accordance with the manufacturer's written instructions, the applicable requirements of NEC and national and local code, standard, and regulations. Install lamps in accordance with manufacturer's instructions.
- B. Install luminaires at locations as shown on the Drawings; install aligned, aimed, and leveled. Install fixtures in accordance with manufacturer's installation instructions complete with mounting accessories, trim and support materials. Fasten fixtures securely to structural support members of the building; solid pendant fixtures shall be plumb.
- C. Coordinate with other crafts to avoid conflicts between luminaires, supports, fittings and mechanical equipment.
- D. Surface Mounted Fluorescent Fixture:
 - 1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of fixtures.
 - 2. Where ceiling system has not been certified to support weight of fixtures, fixtures shall be supported at four points near each corner of fixtures.
 - 3. Provide a minimum 5/8" air space between the fixture and the ceiling.
- E. Recessed Fluorescent Fixtures:
 - 1. Handle specular/semi-specular louvers and down light cones using only new clean white cotton or silk gloves. Do not touch louvers or cones with bare hands.

- Leave luminaries clean and free of any visible dust, debris, or fingerprints with all lamps operational at time of acceptance of work.
2. All recessed fluorescent fixtures shall be supported from building structure above ceiling with galvanized steel wire at not less than 4 points near corners of fixture. Size of wire shall be capable of supporting weight of fixtures.
 3. Recessed luminaries trims shall fit snugly to the mounting surface and shall not exhibit light leaks or gaps. Provide feed-through junction boxes or provide separate junction boxes. All components shall be accessible through the ceiling opening.
 4. Connect recessed luminaries to junction box with flexible steel conduit and fixture wire.
- F. Lighting Fixtures Adjustment
1. Adjust to illuminate intended areas as directed.
 2. Adjust exterior fixtures during hours of darkness.
- G. Immediately before final observation, clean all fixtures, inside and out, including plastics and glassware, and adjust all trim to properly fit adjacent surface, replace broken or damaged parts, and lamp and test all fixtures for electrical as well as mechanical operation.
- H. Protect installed fixtures from damage during the remainder of the construction period.
- I. Upon completion of installation of interior lighting fixtures, and after circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- J. Lamp Disposal
1. The procedure of disposal of lamps that are mercury containing shall follow the guideline set by EPA (definitions in Title 40 Code of Federal Regulations 261 Subpart C, January 2000).

END OF SECTION

SECTION 26 76 26

WIRING DEVICES AND FLOOR BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including "Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts", and Division 01 sections apply to the work of this Section.

1.2 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles
- C. Plates.

1.3 RELATED SECTIONS

- A. Section 26 05 19 – Conduits, Raceway, Boxes.
- B. Section 26 05 26 – Grounding.

1.4 REFERENCES

- A. NEMA WD 1 – General-Purpose Wiring Devices.
- B. NEMA WD 2 – Semiconductor Dimmers for Incandescent Lamps.
- C. NEMA WD 5 – Specific-Purpose Wiring Devices.
- D. Americans with Disabilities Act (ADA).
- E. ANSI/UL 20 – General Use Snap Switches.
- F. ANSI/UL 498 – Attachment Plugs and Receptacles.
- G. ANSI/UL 943 – Ground Fault Circuit Interrupters.

1.5 SUBMITTALS

- A. Refer to Division 01. Submit manufacturer's product data for wiring devices and floor boxes.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Arrow-Hart.
 - 3. Leviton.
 - 4. Pass & Seymour.

- B. Switches:
 - 1. Single Pole: 20 ampere, Hubbell 1221.
 - 2. Three Way: 20 ampere, Hubbell 1223.
 - 3. Four Way: 20 ampere, Hubbell 1224.
 - 4. Two Pole: 20 ampere, Hubbell 1222.
- C. Provide red toggle switches where served by emergency circuits.

2.2 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Arrow-Hart.
 - 3. Leviton.
 - 4. Pass & Seymour.
- B. Receptacles:
 - 1. Duplex: 20A, 125V, 2P, 3W, Grounding, NEMA Configuration 5-20R, Hubbell 5262.
 - 2. Single: 20A, 125/250V, 3P, 4W Grounding, NEMA Configuration 14-20R, Hubbell 8410.
 - 3. Single: 30A, 125/250V, 3P, 4W Grounding, NEMA Configuration 14-30R, Hubbell 9430A.
 - 4. Single: 50A, 125/250V, 3P, 4W Grounding, NEMA Configuration 14-50R, Hubbell 9450A.
 - 5. Ground Fault Interrupting: 20A, 125V, 2P, 3W, Grounding, Hubbell GF5262.
- C. Provide red receptacles where served by emergency circuits.

2.3 FLOOR BOXES AND OUTLETS

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Walker.
 - 3. Thomas & Betts.
- B. Boxes: Shallow, semi-adjustable cast iron boxes, Hubbell B-2524.
- C. 120V Outlets: Brass cover, Hubbell S2930, and single short strap 15A-125V-2P-3W grounding receptacle, Hubbell 5284. Provide adaptors, carpet flanges and fittings as required.
- D. Telephone Outlets: Brass cover, Hubbell S2530. Provide adaptors, carpet flanges and fittings as required

2.4 PLATES

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Arrow-Hart.
 - 3. Leviton.
 - 4. Pass & Seymour.
- B. General: Furnish plates suitable for the device.
- C. Finished Areas: Type 302/304 stainless steel 18% chrome, 8% nickel as follows:

1. Switch Plates: Hubbell Type S1.
2. Duplex Receptacles: Hubbell Type S8.
3. GFCI: Hubbell Type S26.
4. Blank: Hubbell Type S14.
5. Other: Hubbell Type S as appropriate for device.
6. Use ganged plates for adjacent devices.

D. Emergency Circuits: Furnish red device plates.

2.5 WEATHERPROOF COVERS

A. Provide weatherproof while in use covers per NEC.

B. Manufacturers:

1. Hubbell.
2. Arrow-Hart.
3. Leviton.
4. Pass & Seymour.

C. Description: Cast aluminum.

1. Vertical Duplex: Hubbell WP8M.
2. Vertical GFCI: Hubbell WP26M.
3. Horizontal Duplex: Hubbell WP8MH.
4. Horizontal GFCI: Hubbell WP26MH.

2.6 EXPOSED WORK COVERS

A. Manufacturers:

1. Steel City.
2. Crouse-Hinds.
3. Appleton.

B. Description: Stamped steel with edges flush against sides of box, suitable for indicated device, Steel City Type RS.

2.7 SPECIAL PURPOSE OUTLETS

A. As noted on the plans.

2.8 WIRING DEVICES IN SPECIAL WALLS

A. Coordinate color of devices in paneled walls, walls covered with carpet or walls covered with vinyl with Owner's Representative.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions under provisions of Division 01.
- B. Verify outlet boxes are installed at proper height.
- C. Verify wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify floor boxes are adjusted properly.

- E. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- E. Do not share neutral conductor on load side of dimmers.
- F. Install receptacles with grounding pole on top.
- G. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor. Delete bonding jumper for isolated ground receptacles.
- H. Connect wiring devices by wrapping conductor around screw terminal.
- I. Use jumbo size plates for outlets installed in masonry walls.
- J. Install no more than six receptacles on a single circuit. Do not combine corridor receptacles with circuits serving other rooms.
- K. Identify receptacles in accordance with section 26 00 00.

3.4 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

END OF SECTION