

TABLE OF CONTENTS

DIVISION 22 – PLUMBING

22 05 00	Common Work Results for Plumbing
22 11 10	Facility Water Distribution Piping

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING

23 05 00	Common Work Results for HVAC	& 23 05 10	Basic Piping Materials
23 05 16	Expansion Fittings and Loops for HVAC Piping	& Methods	
23 05 23	General Duty Valves for HVAC Piping		
23 05 29	Hangers and Supports for HVAC Piping & Equipment		
23 05 53	Identification for HVAC Piping & Equipment		
23 07 00	HVAC Insulation		
23 11 16	Steam Specialties		
23 22 13	Steam and Condensate Piping		

DIVISION 26 – ELECTRICAL

26 05 00	Common Work Results for Electrical
26 05 29	Hangers and Supports for Electrical Systems

SECTION 22 05 00 – COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Refer to Section 23 05 00. All work of Division 22 shall be in accordance with the corresponding section of Division 23, unless otherwise addressed in this Division.

END OF SECTION 22 05 00

SECTION 221110 – FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This Section specifies the water distribution piping system, including potable cold, hot, and recirculated hot water piping, fittings, and specialties.
- B. Related Sections: The following Sections contain requirements that relate to this section.
 - 1. Refer to other Division 22 sections for piping materials; methods for sealing pipe penetrations through basement walls and fire and smoke barriers; thermometers, flow meters and pressure gauges; mechanical identification; plumbing pumps; and dielectric unions, strainers and pressure regulating valves.

1.2 DEFINITIONS:

- A. Water Distribution Piping: A pipe within the building or on the premises which conveys water from the water service pipe or meter to the points of usage.
- B. Water Service Piping: The pipe from the water main or other source of potable water supply to the water distributing system of the building served.
- C. Pipe Sizes used in this Specification are Nominal Pipe Size (NPS).

1.3 SUBMITTALS:

- A. Refer to Division 1 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.
- B. Provide data for each piping specialty and valve specified.
- C. Certification of Compliance with ASME and UL fabrication requirements.
- D. Test reports specified in Part 3 of this Section.
- E. Manufacturer and product data for lead free solder with material breakdown.
- F. Maintenance data for each piping specialty and valve specified for inclusion in operation and maintenance manual specified in Division 22.

1.4 QUALITY ASSURANCE:

- A. Regulatory Requirements: Comply with the provisions of the following:
 - 1. ASME B 31.9 "Building Services Piping" for materials, products and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - 2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for Qualifications for Welding Processes and Operators.
 - 3. Local Plumbing Code and Utility Department requirements.
 - 4. Local cross connection control manual.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Store pipe in a manner to prevent sagging and bending.
- B. Cap ends of piping when being stored.

1.6 SEQUENCING AND SCHEDULING:

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

1.7 EXTRA STOCK:

- A. Maintenance Stock: Furnish one valve key for each key operated wall hydrant, hose bibb, or faucet installed.

PART 2 - PRODUCTS

2.1 PIPE AND TUBE MATERIALS:

- A. General: Provide pipe material and pipe fittings complying with Division 22.

2.2 BASIC SUPPORTS AND ANCHORS:

- A. General: Provide supports and anchors complying with Division 22.

2.3 GENERAL DUTY VALVES:

- A. General: Provide valves complying with Division 22.

2.4 SPECIAL DUTY VALVES:

- A. Calibrated Balance Valve: Refer to Division 22.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION:

- A. Refer to Division 23, "Basic Piping Materials and Methods" for installation of piping.
- B. Install backflow preventers on plumbing lines where contamination of domestic water may occur and on boiler make-up lines, hose bibbs and flush valves.

3.3 HANGERS AND SUPPORTS:

- A. Refer to Division 23, "Supports and Anchors" for supports and anchors.

3.4 PIPE AND TUBE JOINT CONSTRUCTION:

- A. Refer to Division 23, "Basic Piping Materials and Methods" for pipe joints.

3.5 VALVE APPLICATIONS:

- A. General Duty Valve Applications: The drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:

1. Shut-off duty: Use gate, ball, and butterfly valves.
2. Throttling duty: Use globe, ball, and butterfly valves.

3.6 INSTALLATION OF VALVES:

- A. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2inch and smaller, use gate or ball valves; for sectional valves 2- 1/2inch and larger, use gate or butterfly valves.
- B. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated. For shutoff valves 2inch and smaller, use gate or ball valves; for shutoff valves 2- 1/2inch and larger, use gate or butterfly valves.
- C. Drain Valves: Install drain valves on each plumbing equipment item, located to completely drain equipment for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to completely drain distribution piping system. For drain valves 2inch and smaller, use gate or ball valves; for drain valves 2-1/2inch and larger, use gate or butterfly valves.
- D. Check Valves: Install non-slam spring loaded check valves on discharge side of each pump, and elsewhere as indicated. See Division 23 for valve application.

3.7 FIELD QUALITY CONTROL:

- A. Inspections: Inspect water distribution piping as follows:
 1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
 2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 48 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

3. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
 4. Reports: Prepare inspection reports, signed by the plumbing official.
- B. Test water distribution piping as follows:
1. Refer to Division 23 "Basic Piping Materials and Methods" for pipe test.
- 3.8 ADJUSTING AND CLEANING:
- A. Clean and disinfect water distribution piping as follows:
1. Purge all new water distribution piping systems and parts of existing systems, which have been altered, extended, or repaired prior to use.
 2. Use the purging and disinfecting procedure prescribed by the authority having jurisdiction, or in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:
 - a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
 - b. Fill the system or part thereof, with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system, or part thereof, and allow to stand for 24 hours.
 - c. Drain the system, or part thereof, of the previous solution, and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
 - d. Following the allowed standing time, flush the system with clean potable water until chlorine does not remain in the water coming for the system.
 - e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.

- B. Prepare reports for all purging and disinfecting activities.

3.9 COMMISSIONING:

- A. Fill the system.
- B. Check compression tanks to determine that they are not air bound and that the system is completely full of water.
- C. Before operating the system perform these steps:
1. Open valves to full open position. Close drain, valves, hydrants, and sill cocks.
 2. Remove and clean strainers.
 3. Check pump for proper direction of rotation. Correct improper wiring.
 4. Lubricate pump motors and bearings.

END OF SECTION 221100

SECTION 230510 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUBMITTALS:

- A. Refer to Division 1 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.
- B. Product Data: Submit industry standards and manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing pipe or tube weight, fitting type, and joint type for each piping system.
- C. Welding Certifications: Submit reports as required for piping work.
- D. Brazing Certifications: Submit reports as required for piping work.

1.2 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- C. Welding procedures and testing shall comply with the latest revisions of the applicable sections for B31, of the ANSI/ASME standard codes for pressure piping, noted as follows: B31.1 - Pressure Piping Code / B31.2 - Fuel Gas Piping Code / B31.5 - Refrigeration Piping / B31.9 - Building Service Piping Code.
- D. Before any welding is performed, the contractor shall submit to the Architect/Engineer, or his authorized, a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests and his Welding Procedure Specification together with the Procedure Qualification Record as required by ASME Boiler and Pressure Vessel Code.
- E. Each manufacturer or contractor shall be responsible for the quality of welding done by his organization and shall repair or replace any work not in accordance with these specifications.
- F. Soldering and Brazing procedures shall conform to ANSI Standard Safety Code for Mechanical Refrigeration.

PART 2 PRODUCTS

2.1 GENERAL:

- A. Piping Materials: Provide pipe and tube of type, pressure and temperature ratings, capacities, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.
- B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated,

comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

2.2 STEEL PIPES AND PIPE FITTINGS:

- A. Black Steel Pipe: ASTM A 53, Grade B, type E, electric resistance welded.
- B. Seamless Steel Pipe: ASTM A 53, Grade B, type S or A106 high temperature.
- C. Cast-Iron Flanged Fittings: ANSI/ASME B16.1, including bolting (Class 125 and 250).
- D. Cast-Iron Threaded Fittings: ANSI/ASME B16.4 (Class 125 and 250).
- E. Malleable-Iron Threaded Fittings: ANSI/ASME B16.3; plain or galvanized as indicated (Class 125 and 300).
- F. Malleable-Iron Threaded Unions: ANSI B16.39, Class 150, 250 or 300; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal- to-metal seats (iron, bronze or brass); plain or galvanized as indicated (Class 150, 250 and 300).
- G. Threaded Pipe Plugs: ANSI/ASME B16.14.
- H. Steel Flanges/Fittings: ANSI/ASME B16.5, ASTM A234 (Fire Protection) including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.

Material Group: Group 1.1.
End Connections: Buttwelding.
Facings: Raised-face.

- I. Steel Pipe Flanges for Waterworks Service: AWWA C207 (water service piping only).
- J. Corrosion-Resistant Cast Flanges/Fittings: MSS SP-51, including bolting and gasketing (threaded where pressure is not critical).
- K. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe (up to 4 inch pipe size).
- L. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.
- M. Stainless-Steel Buttwelding Fittings: MSS SP-43.
- N. Cast-Iron Threaded Drainage Fittings: ANSI B16.12.
- O. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.
- P. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2 inches, and where pipe size is less than 1-1/2 inches, and do not thread nipples full length (no close-nipples).

2.3 COPPER TUBE AND FITTINGS:

- A. Copper Tube: ASTM B 88; Type K or L as indicated for each service; hard-drawn temper, except as otherwise indicated.
- B. DWV Copper Tube: ASTM B 306.
- C. ACR Copper Tube: ASTM B 280.
- D. Cast-Copper Solder-Joint Fittings: ANSI B16.18.
- E. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.
- F. Cast-Copper Solder-Joint Drainage Fittings: ANSI B16.23 (drainage and vent with DWV or tube).
- G. Wrought-Copper Solder-Joint Drainage Fittings: ANSI B16.29.
- H. Cast-Copper Flared Tube Fittings: ANSI B16.26.
- I. Bronze Pipe Flanges/Fittings: ANSI B16.24 (Class 150 and 300).
- J. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

2.4 CAST-IRON SOIL PIPES AND PIPE FITTINGS:

- A. Hubless Cast-Iron Soil Pipe: FS WW-P-401 and CISPI Standards 301 and 310. Pipe and fittings shall be marked with the collective trademark of the cast iron soil pipe institute or receive prior approval of the engineer.
- B. Cast-Iron Hub-and-Spigot Soil Pipe: ASTM A 74. Pipe and fittings shall be marked with the collective trademark of the cast iron soil pipe institute or receive prior approval of the engineer.
- C. Hubless Cast-Iron Soil Pipe Couplings: Neoprene gasket complying with ASTM C564, CISPI Standard 310 and stainless steel clamp holding band.
- D. Heavy Duty Hubless Cast Iron Soil Pipe Couplings: Neoprene gasket coupling with ASTM C564. 304 stainless steel shield, minimum 0.15 inches thick, minimum 3 inches wide with 4 sealing bands up to 4 inch pipe, minimum 9 inches wide with 6 sealing bands up to 10 inch pipe.
 - 1. Basis of Design: Husky SD 4000.
- E. Cast-Iron Hub-and-Spigot Soil Pipe Fittings: Match soil pipe units; complying with ASTM A 74.
- F. Neoprene Compression Gaskets: ASTM C 564.

2.5 PLASTIC PIPES AND PIPE FITTINGS:

- A. Acrylonitrile-Butadiene-Styrene Sewer Pipe (ABS): ASTM D-1527, 3 inch thru 12 inch; SDR 23.5, 4 and 6 inch; SDR 35, 3 inch, 4 inch, and 6 inch; SDR 42, 8 inches, 10 inch and 12 inch.
- B. ABS Pipe Fittings:

Schedule 40 Socket: ASTM D 2468.
Schedule 80 Socket: ASTM D 2469.
Schedule 80 Threaded: ASTM D 2465.
Solvent Cement: ASTM D 2235.
Solvent Cement (To Join ABS to PVC): ASTM D 3138.

- C. Polyvinylchloride Sewer Pipe (PVC): ASTM D-2729, 2 inch thru 6 inch; ASTM D2665, 1-1/2 inches thru 8 inches.

2.6 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

- A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.
 - 1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
- B. Soldering Materials: All soldering materials shall be lead free.
 - 1. 95-5 Tin-Antimony: ASTM B 32, Grade 95TA. Melting Range 450-470 degrees F.
 - 2. Silver-Tin Alloy: Fed. Spec. QQ-S-571E, NSFC2. Melting Range 430 to 530 degrees F.
 - 3. Flux: All flux shall be lead free, water soluble, and compatible with the solder and the materials being joined. ASTM B813-93.
- C. Brazing Materials: Except as otherwise indicated, provide brazing materials to comply with installation requirements.
 - 1. Comply with AWSA 5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.
 - a. Copper phosphorus -Bcup-5, 15 percent solver content, melting range 1190 to 1480 degrees F.
 - b. Silver - BAg-36, 45 percent silver, cadmium-free. Melting range 1195 to 1265 degrees F.
- D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.
- E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.
 - 1. Manufacturer: Subject to compliance with requirements, provide piping connectors of the following:
 - a. Husky Technologies (Husky SD 4000):
- F. Pipe Thread Sealant Material: Except as otherwise indicated, provide all pipe threads with the sealant material as recommended by the manufacturer for the service.
 - 1. Manufacturer: Subject to compliance with requirements, provide piping thread sealant material of the following:

- a. The Rectorseal Corporation

PART 3 EXECUTION

3.1 EXAMINATION:

- A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, and original design, and the referenced standards.
- B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION:

- A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerance.
 - 1. Comply with ANSI B31 Code for Pressure Piping.
 - 2. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures. Only piping serving this type of equipment space shall be allowed.
 - 3. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
 - 4. Use fittings for all changes in direction and all branch connections.
 - 5. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
 - 6. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
 - 7. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
 - 8. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
 - 9. Install drains in pressure pipe systems at all low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded end nipple and cap with chain.

10. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
11. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals (See Section 23 05 18). Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inches and larger shall be sheet metal.
12. Anchor piping to ensure proper direction of expansion and contraction.
13. Coordinate foundation and all other structural penetrations with structural engineer.

B. Hydronic Piping:

1. Make reductions in hydronic pipe sizes using eccentric reducer fitting installed with the level side up.
2. Install hydronic piping branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers which shall have take-off out the top of the main line. Install all hydronic piping level with manual air vent at all high points in direction of flow.
3. Install hydronic piping level except for gravity flow systems such as condenser water and condensate drain piping.

3.3 PIPING SYSTEM JOINTS:

- A. General: Provide joints of type indicated in each piping system.
- B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- C. Braze copper tube-and-fitting joints in accordance with ASME B31.
- D. Solder copper tube-and-fitting joints with silver solder or 95-5 tin-antimony. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- E. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31. Provide weld-o-let fittings for two pipe sizes less than main pipe size.
- F. Weld pipe joints in accordance with recognized industry practice and as follows:
 1. Weld pipe joints only when ambient temperature is above 0 degrees F (-18 degrees C) where possible.
 2. Bevel pipe ends at a 37.5 degrees angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
 3. Use pipe clamps or tack-weld joints with 1 inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inch to 20 inch.

4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
 5. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
- G. Weld pipe joints of steel water pipe in accordance with AWWA C206.
- H. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
- I. Hubless Cast-Iron Joints: Comply with coupling manufacturer's installation instructions. Use pre-set torque wrench set to 80 in-lbs on heavy duty couplings.
- 3.4 PIPING APPLICATION:
- A. Domestic Hot and Cold Water:
1. Above Grade Inside Tunnel:
 - a. 6 inches and Smaller: Type L / K, hard drawn copper tube with wrought copper or bronze fittings, 95-5 tin-antimony / silver tin alloy soldered joints.

3.5 PIPING TESTS:

- A. General: Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
- B. Test all piping systems as specified. Correct leaks by remaking joints. Remove equipment not able to withstand test procedure during test.
- C. Work to be installed shall remain uncovered until the required tests have been completed.
- D. Piping which is to be concealed shall be tested before being permanently enclosed.
- E. As soon as work has been completed, conduct preliminary tests to ascertain compliance with specified requirements. Make repairs or replacements as required.
- F. Give a minimum of twenty-four hours notice to Engineer of dates when acceptance test will be conducted. Conduct tests as specified for each system in presence of representative of owner, agency having jurisdiction or his representative. Submit three (3) copies of successful tests to the Engineer for his review. Report shall state system tested and date of successful test.
- G. Contractor shall obtain certificates of approval, acceptance and compliance with regulations of agencies having jurisdiction. Work shall not be considered complete until such certificates have been delivered by the Engineer to the Owner.
- H. All costs involved in these tests shall be borne by Contractor.

I. System Tests

1. Hydrostatic Test: The test shall be accomplished by hand pumping the system to the specified water pressure, and maintaining that pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four hours.
 - a. Domestic water systems: 100 psig or 150 percent of system pressure, whichever is greater.
 - b. Heating water: 100 psig or 150 percent of operating pressure, whichever is greater.
 - c. Chilled water: 100 psig or 150 percent of system pressure, whichever is greater.
 - d. Condenser water: 100 psig or 150 percent of system pressure, whichever is greater.
2. Compressed Air or Nitrogen Test: Compressed air tests may be substituted for hydrostatic tests only when ambient conditions or existing building conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing. For tests of this type, the piping system shall be subjected to the gas pressure indicated for that specific system. The piping capped or plugged and water-pumped with oil free air, or a nitrogen bottle shall be introduced into the entire system to the pressure specified. The system shall maintain that pressure for the duration of a soapy water test of each joint.
3. Waste, Drain and Vent Piping: All waste and vent piping, including building drain, roof drain and building sewer, shall be subjected to a water test. All openings in the piping system shall be tightly closed, except the highest opening, and the system filled with water to the point of overflow. The water shall be kept in the system, or in the portion under test, for at least 15 minutes before inspection starts; the system shall then be tight to all points. No section shall be tested with less than a ten foot head of water. Roof drain shall be closed at the lowest point and filled with water to the point of overflow.
4. Sump Pump Discharge: With water in sump and pump running at full capacity, check for leaks until satisfied that system is tight.
5. Test all refrigerant piping systems with nitrogen at 300 psig pressure on high side of system, and at 150 psig pressure on low side of system. Maintain pressure without loss for a time period of not less than 4 hours. After test has been completed, the piping shall be evacuated by means of a vacuum pump for a period of not less than 24 hours or until system has been completely evacuated.
6. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
7. Drain test water from piping systems after testing and repair work has been completed.

3.6 ADJUSTING AND CLEANING:

- A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
 1. Inspect pressure piping in accordance with procedures of ASME B31.

- B. Disinfect all potable water mains and water service piping in accordance with local and health department requirements. Submit test results report.
- C. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
- D. Chemical Treatment: Provide hydronic systems with a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

END OF SECTION 230510

SECTION 230516 – EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of expansion compensation products of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. EJMA Compliance: Construct expansion compensation products in accordance with standards of the Expansion Joint Manufacturer's Association (EJMA).

1.2 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of expansion compensation product. Submit expansion compensation schedule showing Manufacturer's figure number, size, location, and features for each required expansion compensation product.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of expansion compensation product, indicating dimensions, weights, required clearances and methods of assembly of components.
- C. Shop Drawings: Submit shop drawings for fabricated expansion loops indicating location, dimensions, pipe sizes, and location and method of attachment of anchors.
- D. Maintenance Data: Submit maintenance data and spare parts lists for each type of expansion compensation product. Include this data, product data, and shop drawings in Maintenance Manual; in accordance with requirements of Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pipe Alignment Guides:
 - a. Hyspan Precision Products, Inc.
 - b. Metraflex Co.
 - c. Keflex, Inc.
 - 2. Slip Joints
 - a. Slip type expansion joints are pre-purchased by the owner and to be installed by contractor.

2.2 PIPE ALIGNMENT GUIDES:

- A. General: Provide pipe alignment guides at locations and spacing indicated. Construct with 4-finger spider traveling inside guiding sleeve, with provision for anchoring to concrete substrate.

1. Grinnell Fig. 256

PART 3 EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which expansion compensation products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer. Coordinate anchor locations & loads with Structural Engineer.

3.2 EXPANSION JOINTS:

- A. Install expansion joints where indicated, for adequate expansion of installed piping system. Install in accordance with manufacturer's instructions. Provide pipe anchors and pipe alignment guides as indicated, and in accordance with manufacturer's recommendations. Align units properly to avoid end loading and torsional stress.

3.3 INSTALLATION OF PIPE ALIGNMENT GUIDES:

- A. Install pipe alignment guides on piping that adjoins expansion joints and elsewhere as indicated.
- B. Anchor to building substrate.

END OF SECTION 230516

SECTION 230523 - GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This Section includes general duty valves common to most mechanical piping systems.
- B. Valves tags and charts are specified in Division 23 Section "Mechanical Identification."

1.2 SUBMITTALS:

- A. Product Data: including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

1.3 QUALITY ASSURANCE:

- A. Single Source Responsibility: Comply with the requirements specified in Division-23 Section "Basic Mechanical Requirements," under "Product Options."
- B. MSS Standard Practices: Comply with the following standards for valves:
 - 1. MSS SP-45: Bypass and Drain Connection Standard
 - 2. MSS SP-67: Butterfly Valves
 - 3. MSS SP-70: Cast Iron Gate Valves, Flanged and Threaded Ends
 - 4. MSS SP-71: Cast Iron Swing Check Valves, Flanged and Threaded Ends
 - 5. MSS SP-72: Ball Valves with Flanged or Butt-Welding Ends for General Service
 - 6. MSS SP-78: Cast Iron Plug Valves, Flanged and Threaded Ends
 - 7. MSS SP-80: Bronze Gate, Globe Angle and Check Valves
 - 8. MSS SP-84: Steel Valves - Socket Welding and Threaded Ends
 - 9. MSS SP-92: MSS Valve User Guide

1.4 DELIVERY, STORAGE, AND HANDLING:

- A. Preparation for Transport: Prepare valves for shipping as follows:
 - 1. Ensure valves are dry and internally protected against rusting and galvanic corrosion.
 - 2. Protect valve ends against mechanical damage to threads, flange faces, and weld end preps.
 - 3. Set valves in best position for handling. Globe and gate valves shall be closed to prevent rattling; ball and plug valves shall be open to minimize exposure of functional surfaces; butterfly valves shall be shipped closed or slightly open; and swing check valves shall be blocked in either closed or open position.
- B. Storage: Use the following precautions during storage:
 - 1. Valves shall be stored and protected against all dirt, debris and foreign material at all times.
 - 2. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.

3. Protect valves against weather. Where practical store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement and protect in watertight enclosures.
- C. Handling: Valves whose size requires handling by crane or lift shall be slung or rigged to avoid damage to exposed valve parts. Handwheels and stems, in particular, shall not be used as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products by the manufacturers listed.
 1. Gate Valves:
 - a. Stockham
 - b. Vogt
 - c. Bonney Forge
 - d. Anvil
 2. Ball Valves:
 - a. Conbraco (Apollo)
 - b. Milwaukee
 - c. Nibco
 - d. Watts
 - e. Jomar
 - f. Dynaquip
 - g. Hammond
 - h. James Bury
 - i. Worcester
 3. Butterfly Valves:
 - a. Keystone/Tyco
 - b. Crane
 - c. Nibco
 - d. Dezurik
 - e. Fisher
 - f. Hammond
 - g. James Bury
 - h. Milwaukee
 - i. Posi-Seal
 4. Swing Check Valves
 - a. Conbraco
 - b. Grinnell Corp.
 - c. Nibco
 - d. Watts (screwed)
 - e. Stockham

2.2 VALVE FEATURES:

- A. General: Comply with MSS-92 1980 "Valve Users Manual".
- B. Valve Design: Valves shall have rising stem, or rising stem outside screw and yoke design; except, non-rising stem valves may be used where headroom prevents full operation of rising stem valves.
- C. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size. (Control valves shall be sized for required flow.)
- D. Operators: Provide the following special operator features:
 - 1. Handwheels, fastened to valve stem for valves other than quarter turn.
 - 2. Lever Handle on quarter turn valves 6 inch and smaller, except plug valves. Provide a wrench for every plug valve.
 - 3. Chainwheel operators for valves 2-1/2 inch and larger that are installed 96 inches or higher above finished floor elevation. Provide chains to an elevation of 6'-0" above finished floor elevation.
 - 4. Worm gear operators of an enclosed weather-proof design shall be provided on all quarter turn valves 8 inches and larger.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems to allow full operation of the valve without interference by the insulation.
- F. Bypass and Drain Connections: Comply with MSS SP-45.
- G. End Connections: As specified in the individual valves specifications.
 - 1. Threads: Comply with ANSI B2.1.
 - 2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze.
 - 3. Solder-Joint: Comply with ANSI B16.18.
 - a. Caution: Where soldered end connections are used, use solder having a melting point below 840 degrees F for gate, globe, and check valves and below 421 degrees F for ball valves.

2.3 GATE VALVES:

- A. Gate Valves – 2 inches and Smaller: MSS SP-80, Class 150 Class 200/300, body and bonnet of cast bronze ASTM B62 for 150# / B61 for 200/300, threaded ends, solid wedge disc, union bonnet, rising stem, bronze gland, TFE impregnated packing, malleable iron handwheel. Provide stainless steel seats on all steam service valves and class 200/300 gate valves.

Stockham Fig. B-120/B-124 B-132/B-145
- B. Gate Valves - 2-1/2 inches and Larger: MSS SP-70, Class 125 /Class 250, iron body conforming to ASTM A126 C1 B, Bronze trim, O S & Y design, Flanged ends, TFE

impregnated packing. Provide stainless steel seats on all steam service valves and class 250 gate valves.

Stockham Fig. G-623 /F-667

2.4 BALL VALVES:

- A. Ball Valves – [1inch and](#) Smaller: 150 WSP, 600 WOG, rated for 150 PSI at 350 degrees F, two piece end entry body style, bronze body conforming to ASTM B584, full port chrome plated brass ball, 15 percent glass reinforced PTFE seats, PTFE packing, adjustable packing nut blow-out proof stem, vinyl covered steel handle. Provide solder ends or threaded ends to match piping system. Company with NSF-61. Apollo 77C-100/200
- B. Ball valves for steam service: 250 WSP, 600 WOG rated for 250 psig saturated steam. Two piece and entry body style, bronze body conforming to ASTM B594, standard port 316 stainless steel ball and stem. Carbon and graphite reinforced PTFE blowout proof stem, vinyl covered steel handle. Threaded ends. Apollo 70-140-64.
- C. Ball valve options/accessories: Provide the following as required or as specifically indicated:
 - 1. Tee handle for tight fit applications (within enclosures, etc.).
 - 2. Locking handle.
 - 3. Drain.
 - 4. Stem extension.
 - 5. Mounting pads.

2.5 BUTTERFLY VALVES:

- A. Steam Service Butterfly Valves 2-1/2 Inch and Larger: MSS SP-67 and SP-68 carbon steel ASTM A216-WCB body, 316 stainless steel disc, 17-4 PH stainless steel stem, RTFE seat with stainless steel backup ring, 316 stainless steel nitrate bushing, TFE packing, steam trim accessories ANSI class 150/300 extended neck for 2 inches thick insulation. All valves shall be factory tested at their rated pressures. All butterfly valves shall be full lugged body, drilled and tapped.

Keystone K-Lok Series Fig. 362/372

2.6 CHECK VALVES:

- A. Swing Check Valves - 2-1/2 Inch and Smaller: MSS SP-80; Class 125/150 WSP 200/300, cast bronze body and cap conforming to ASTM B 62, ASTM B61 for 200/300 bronze, horizontal swing design, Y-pattern, with a bronze/teflon disc, stainless steel pin and having threaded or solder ends. Class 150 valves meeting the above specifications may be used where pressure requires or Class 125 are not available.
- B. Swing Check Valves - 2-1/2 to 3 Inch: MSS SP-71; Class 125 /250 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line. For sewage ejector and sump pump discharge swing check valves 2-1/2 inches and larger, provide outside lever with weight or spring to assist disc to close rapidly.

2.7 DRAIN VALVES: FOR HVAC AND PLUMBING HYDRONIC SYSTEMS PROVIDE BALL VALVE WITH THREADED HOSE END, AND CAP WITH CHAIN.

Apollo Fig. 78-100/78-200 Series

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Install valves in accordance with manufacturer’s instructions.
- B. Examine valve interior through the end ports, for cleanliness, freedom from foreign matter and corrosion. Remove special packing materials, such as blocks used which prevents disc movement during shipping and handling.
- C. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the position in which it was shipped.
- D. Examine threads on both the valve and the mating pipe for form (out-of-round or local indentation) and cleanliness.
- E. Examine mating flange faces for conditions which might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size and material, and for freedom from defects and damage.
- F. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.

3.2 VALVE SELECTION:

- A. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select valves with the following ends or types of pipe/tube connections:
 - 1. Copper Tube Size 2 Inch and Smaller: Solder ends, except in heating hot water and low pressure steam service which shall have threaded ends.
 - 2. Steel Pipe Sizes 2 Inch and Smaller: Threaded end.
 - 3. Steel Pipe Sizes 2-1/2 Inch and Larger: Flanged end.
 - 4. At all piping hot taps provide a gate valve with the hot tap and a butterfly valve for shut-off service. Hot taps shall be provided only where approved by the Engineer.
 - 5. Contractor shall provide and install hi-performance steam butterfly valves on sizes 6" and larger.

3.3 VALVE INSTALLATIONS:

Valve Application Table

(Where sizes overlap, contractor has choice of either type)

SERVICE	VALVE TYPE
Plumbing Water Services; 3" or smaller	Ball Valve

Plumbing Water Services; 2-1/2" and larger	Butterfly Valves
HVAC & Plumbing Check Valves; 2" and smaller	Swing Check
Steam and Condensate Piping Shut-off; 3" and smaller	Steam Ball Valves or Gate Valves
Steam and Condensate Piping Shut-off; 2-1/2" and larger	Steam Butterfly Valves or Gate Valves
Steam and Condensate Piping Check Valves; All Sizes	Swing Check

- A. Locate valves for easy access and provide separate support where necessary.
- B. Install valves and unions for each fixture and item of equipment in a manner to allow equipment removal without system shut-down. Unions are not required on flanged devices.
- C. Install 3-valve bypass around each pressure reducing valve using throttling type valves.
- D. Gate and globe valves shall be installed with the stem in the upright position. In overhead horizontal piping, ball valves shall be installed with the handle in the side or bottom of the piping. Butterfly valves shall be installed with the stem within 45 degrees of the horizontal position. The handle of quarter turn valves shall open in the direction of flow. Quarter turn valves with hand wheels or chain wheels shall be located so that the position indicator is visible from the floor without the use of a ladder or climbing on equipment or piping.
- E. Installation of Check Valves: Install for proper direction of flow as follows:
 - 1. Swing Check Valves: Install in horizontal position with hinge pin level.

3.4 SOLDER CONNECTIONS:

- A. Cut tube square and to exact lengths.
- B. Clean end of tube to depth of valve socket, using steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket in same manner.
- C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.
- D. Open gate and globe valves to fully open position.
- E. Remove the cap and disc holder of swing check valves with composition discs.
- F. Insert tube into valve socket making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to insure even distribution of the flux.
- G. Apply heat evenly to outside of valve around joint until solder will melt upon contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating the valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.5 THREADED CONNECTIONS:

- A. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
- B. Align threads at point of assembly.

- C. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 - D. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
- 3.6 FLANGED CONNECTIONS:
- A. Align flanges surfaces parallel.
 - B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using a torque wrench.
- 3.7 GROOVED CONNECTIONS:
- A. Assemble valves with grooved end in accordance with manufacturers published instructions.
 - B. Clean pipe ends from indentations, projections, burrs and roll marks from pipe to groove.
 - C. Provide gasket, flanges, fittings, bolts, nuts, lubrication applied per manufacturer's instructions for intended service.
- 3.8 FIELD QUALITY CONTROL:
- A. Testing: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks; replace valve if leak persists.
- 3.9 ADJUSTING AND CLEANING:
- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare to receive finish painting or insulation.

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
 - 2. NFPA Compliance: Hangers and supports shall comply with NFPA standard No. 13 when used as a component of a fire protection system.
 - 3. UL and FM Compliance: Hangers, supports, and components shall be listed and labeled by UL and FM where used for fire protection piping systems.
 - 4. Duct Hangers: SMACNA Duct Manuals
 - 5. MSS Standard Compliance:
 - a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-69.

1.2 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
- C. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.
- D. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pipe Hangers and Supports:

- a. B-Line Systems Inc.
 - b. ANVIL International
 - c. PHD Manufacturing, Inc.
 - d. Unistrut Metal Framing Systems
 - e. Hubbard Enterprises (Supports for domestic water piping)
 - f. Specialty Products Co. (Supports for domestic water piping).
 - g. Erico
2. Saddles, Shield and Thermal Shield Inserts:
 - a. ANVIL International
 - b. Pipe Shields, Inc.
 - c. B-Line
 - d. Snapp Itz
 - e. Erico
 - f. Value Engineered Products, Inc.
 3. Concrete Inserts and Anchors:
 - a. Unistrut Metal Framing Systems
 - b. Power-Strut
 - c. ITW Ramset/Red Head
 - d. Hilti
 - e. B-Line
 - f. Erico
- 2.2 PIPE HANGERS & SUPPORTS:
- A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-69.
 1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
 2. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
 - B. Adjustable Clevis Hanger: MSS Type.
 1. Steel Pipe, size 3/8" thru 30", Type 1.
 2. Non-insulated Copper Pipe, size 1/2" thru 4", Type 1. (PVC Coated)
 3. Cast Iron Pipe, size 4" thru 24", Type 1.
 - C. Adjustable Swivel Ring for Non-insulated Pipe: MSS Type .
 1. Steel Pipe, size 1/2" thru 8", Type 7.
 2. Copper Pipe, size 1/2" thru 4", Type 7 (PVC Coated)
 - D. Pipe Clamps: MSS Type .
 1. Steel Pipe, size 3/4" thru 24", Type 8.
 2. Copper Pipe, size 1/2" thru 4", Type 8 (PVC Coated).
 - E. U Bolts: MSS Type .

1. Steel Pipe, size 1/2" thru 30" Type 24
 2. Copper Pipe, size 1/2" thru 8", Type 24 (PVC Coated).
- F. Straps: MSS Type 26.
- G. Pipe Stanchion Saddle: MSS Type 37.
- H. Yoke & Roller Hanger: MSS Type 43
- I. Hanger Rods: Continuous threaded steel, sizes as specified.
- J. Hangers:
1. Hot Pipes:
 - a. 1/2" through 1-1/2": Adjustable wrought steel ring.
 - b. 2" through 5": Adjustable wrought steel clevis.
 - c. 6" and Over: Adjustable steel yoke and cast iron roll.
 2. Cold Pipes:
 - a. 1/2" through 1-1/2": Adjustable wrought steel ring.
 - b. 2" and Over: Adjustable wrought steel clevis.
 3. Multiple or Trapeze: Structural steel channel (with web vertical and engineered for the specific applications), with welded spacers and hanger rods. Provide cast iron roll and base plate for hot pipe sizes six inches and over. Provide hanger rods one size larger than for largest pipe in trapeze. If the deflection at center of trapeze exceeds 1/360 of the distance between the end hangers, install an additional hanger at mid-span or use a larger channel.
- K. Wall Supports for Horizontal Steel Pipe:
1. 1/2 inch through 4inches: Offset or straight j-hook.
 2. 4 inches and Over: Welded steel bracket Type 31, 32 or 33 and wrought steel clamp. Provide adjustable steel yoke and cast iron roll Type 44 for hot pipe 200° F and over and for sizes six inches and over.
- L. Supports for Vertical Pipe: Steel riser clamp. Type 8.
- M. Upper Attachments:
1. For attaching hanger rods to structural steel I-beams:
 - a. Provide adjustable beam clamp, MSS-Type 21. Attach to bottom flange of beam.
 2. For attaching hanger rods to bar joists:
 - a. When bottom chord is constructed of structural steel angles, provide square washer. Place hanger rod between backs of the two angles and support with the washer and dual locking nuts on top of the angles. Spot weld washer to angles.
 - b. When bottom chord is constructed of round bars, provide Elcen No. 137 bar joint washer or equal.

2.3 CONCRETE INSERTS AND ANCHORS:

- A. Inserts: Case shall be of galvanized carbon steel with square threaded concrete insert nut for hanger rod connection; top lugs for reinforcing rods, nail holes for attaching to forms. This type of upper attachment is to be used for all areas having poured in place concrete construction.
 - 1. Size inserts to suit threaded hanger rods.
- B. Provide fasteners attached to concrete ceilings that are vibration and shock resistant. Provide hangers for piping attached to concrete construction with one of the following types.
 - 1. Concrete insert per MSS SP 69, Type 18.
 - 2. Powder driven fasteners subject to approval Structural Engineer. Each fastener shall be capable of holding a test load of 1000 pounds whereas the actual load shall not exceed 50 pounds.
 - 3. Self-drilling expansion shields. The load applied shall not exceed one-fourth the proof test load required.
 - 4. Machine bolt expansion anchor. The load applied shall not exceed one-fourth the proof test load required.
- C. Anchors: Carbon steel, zinc plated. Installation shall be in holes drilled with carbide-tipped drill bits or by use of self-drilling anchors.
 - 1. Provide anchors suitable for the location of installation and designed to withstand all forces and movements acting in the anchor. Manufacture pipe anchors in accordance with MSS SP 69. Provide a safety factor of four for the anchor installation.

2.4 SADDLES AND THERMAL SHIELD INSERTS:

- A. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
- B. Protection Shields: MSS Type 40; 180 degrees arc, galvanized steel, minimum 12 inches long, to prevent crushing of insulation.
- C. Thermal Shield Inserts: Provide 100-psi minimum compressive strength, waterproof, asbestos free calcium silicate, encased with a sheet metal enclosure. Insert and shield shall cover the entire circumference or the bottom half circumference of the pipe as required by Part 3 of this Specification, and shall be of length recommended by the manufacturer for pipe size and thickness of insulation. For cold piping, calcium silicate shall extend beyond the sheet metal shield to allow overlap of the vapor barrier. Where piping 4 inches and larger is supported on trapeze or pipe rollers, provide double thickness shields. For piping 12 inches and over, provide 600 psi calcium silicate structural insert.

2.5 MISCELLANEOUS MATERIALS:

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

- C. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.
- D. Pipe Alignment Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PREPARATION:

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments. Review Structural Drawings to obtain structural support limitations.
- B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified. Provide Shop Drawing showing method and support locations from structure.

3.3 INSTALLATION OF BUILDING ATTACHMENTS:

- A. Install building attachments within concrete or on structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.
- B. Existing Construction:
 - 1. In existing concrete construction, drill into concrete slab and insert and tighten expansion anchor bolt. Connect anchor bolt to hanger rod. Care must be taken in existing concrete construction not to sever reinforcement rods or tension wires.

3.4 INSTALLATION OF HANGERS AND SUPPORTS:

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on field fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install

intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.
- C. Support fire-water piping independently from other piping systems.
- D. Prevent electrolysis and abrasion in support of copper tubing by use of hangers and supports which are plastic coated, or with EPDM isolation strips. Duct tape or copper coated hangers are not acceptable.
- E. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, to facilitate action of expansion joints, expansion loops, expansion bends and similar units and within 1'-0" of each horizontal elbow.
- F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.9 Building Services Piping Code is not exceeded.
- H. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Saddles: Install Protection saddles where supported by pipe rollers. Fill interior voids with segments of insulation that match adjoining pipe insulation.
 - 3. Shields: Install galvanized steel protection shields, on all insulated piping 2 inches and less, except where required to be clamped. Where necessary to prevent dislocation, strap shield to pipe with wire ties or "Zip Strips".
 - 4. Thermal Inserts: Provide thermal shield inserts at all supports for all insulated piping over 2 inches and for all piping required to be clamped. Provide 180 percent inserts at clevis and roller hangers. Provide 360 percent inserts for all trapeze and clamped supports.
- I. Install horizontal hydronic and steam piping with the following minimum rod sizes and maximum spacing:

SIZE (NPS)	MAX. SPAN IN FEET		MIN. ROD SIZE-INCHES
	Steel	Copper	
1	7	6	3/8
1-1/2	9	8	3/8
2	10	8	3/8
3	12	10	1/2
4	14	12	5/8

5 SIZE (NPS)	16 MAX. SPAN IN FEET		5/8 MIN. ROD SIZE-INCHES
	Steel	Copper	
6	17	14	3/4
8	19	16	7/8
10	22	18	7/8
12	23	19	7/8
14	25	-	1"
16	27	-	1"
18	20	-	1"
20	30	-	1-1/4"
24	32	-	1-1/4"
30	33	-	1-1/4"

- J. Place a hanger within one foot of each horizontal elbow.
- K. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.
- L. Support vertical steel and copper piping at every story height but at not more than 15 foot intervals for steel and 10 feet for copper.
- M. Where several pipes can be installed in parallel and at same elevation, provide trapeze hangers.
- N. Where practical, support riser piping independently of connected horizontal piping.
- O. Support steam supply and condensate return pipe runs on adjustable roller hangers.
- P. Each pipe drop to equipment shall be adequately supported. All supporting lugs or guides shall be securely anchored to the building structure.
- Q. Securely anchor and support plumbing domestic water piping in chases or walls. Use factory manufactured clamps and brackets connected to fixture s, waste/vent piping or brackets connected to studs. Wires or straps will not be permitted.
 - 1. When copper supplies are connected to flush valves, support the tubing by the studs or by a fixture, not by clamping to waste/vent piping.
 - 2. Prevent copper tubes from making contact with steel brackets using fire retardant polyethylene inserts or other dielectric insulating material. Duct tape shall not be used.
- R. Install anchors and fasteners in accordance with manufacturer's recommendations and the following:
 - 1. In the event a self-drilling expansion shield or machine bolt expansion shield is considered to have been installed improperly, the Contractor shall make an acceptable

replacement or demonstrate the stability of the anchor by performing an on-site test under which the anchor will be subjected to a load equal to twice the actual load.

2. Powder-driven fasteners may be used only where they will be concealed after the construction is complete. Where an occasional fastener appears to be improperly installed, additional fastener(s) shall be driven nearby (not closer than 6 inches) in undisturbed concrete. Where it is considered that many fasteners are improperly installed, the Contractor shall test load any 50 successively driven fasteners. If 10 percent or more of these fasteners fail, the Contractor shall utilize other fastening means as approved and at no additional cost to the Owner.
3. Hangers for piping and ducts shall be attached to cellular steel floor decks with steel plates and bolted rod conforming to the steel deck manufacturer's requirements. Where the individual hanger load exceeds the capacity of a single floor deck attachment, steel angles, beams or channels shall be provided to span the number of floor deck attachments required.
4. Welding may be used for securing hangers to steel structural members. Welded attachments shall be designed so that the fiber stress at any point of the weld or attachment will not exceed the fiber stress in the hanger rod.

3.5 INSTALLATION OF ANCHORS:

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.9, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.9 and with AWS Standards D1.1.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to control movement to compensators.
- D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping. Provide shop drawing for review by Engineer.

3.6 SHEET METAL DUCT HANGERS AND SUPPORTS:

- A. Provide in accordance with SMACNA HVAC duct construction standards.
- B. Additional Hanger Requirements:
 1. 2" to 24" from flexible connections of fans.
 2. 2" to 24" from the outlets or flexible connections of VAV control units or mixing boxes.
 3. 12" to 36" from the main duct to the first hanger of long branch ducts.
 4. 2" to 12" from the ends of all branch ducts and linear diffuser plenums.
 5. 2" to 24" from fire damper break-away joints.
 6. Hangers at throat and heel of round or square elbows 48" or greater in width.

3.7 EQUIPMENT SUPPORTS:

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

- B. Grouting: Place grout under supports for piping and equipment.
- C. Concrete bases for the mechanical equipment indoors or outdoors will be provided by the General Contractor only if shown on the architectural or structural drawings. Otherwise, all bases shall be provided by this Contractor.
- D. For inertia bases, see Section 23 05 48.
- E. Housekeeping bases shall be 4 inches thick minimum, extended 4 inches beyond machinery bedplates.
- F. This Contractor shall be responsible for the proper size and location of all bases and shall furnish all required anchor bolts and sleeves. If bases are provided by the General Contractor, furnish him with templates showing the bolt locations.
- G. Equipment shall be secured to the bases with anchor bolts of ample size. Bolts shall have bottom plates and pipe sleeves and shall be securely imbedded in the concrete. All machinery shall be grouted under the entire bearing surface. After grout has set, all wedges, shims and jack bolts shall be removed and the space filled with non-shrinking grout. This Contractor shall provide lead washers at all equipment anchor bolts.
- H. Construct equipment supports above floor of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- I. Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment. See also Section 23 05 48.

3.8 METAL FABRICATION:

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- 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 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 at welded surfaces match adjacent contours.

3.9 ADJUSTING:

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe. Cut off the bottom of threaded rods so they are no more than one rod diameter below the bottom nut.

- B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- C. For galvanized surfaces clean welds bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Existing Building Standards: Comply with the existing lettering size, length of color field, colors and identification method as presently exists in the existing building unless other wise indicated.

1.2 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), size of valve, and variations for identification (if any). Only tag valves which are intended for emergency shut-off and similar special uses, such as valve to isolate individual system risers, individual floor branches or building system shut off valves. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
- B. Mechanical Identification:
 - 1. Allen Systems, Inc.
 - 2. Brady (W.H.) Co.; Signmark Div.
 - 3. Brimar Industries, Inc.
 - 4. Industrial Safety Supply Co., Inc.
 - 5. Seton Name Plate Corp.
 - 6. PVC Specialties

2.2 MECHANICAL IDENTIFICATION MATERIALS:

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS:

- A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping or to match existing size in existing building, but not less than 1-1/4" high letters for ductwork and not less than 3/4" high letters for access door signs and similar operational instructions.
- B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
- C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated comply with ANSI A13.1 for colors or to match existing building standard identification.

2.4 PLASTIC PIPE MARKERS:

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.
- B. Insulation: Furnish 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F. (52 degrees C.) or greater. Cut length to extend 2inches beyond each end of plastic pipe marker.
- C. Small Pipes: For external diameters less than 6 inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2inch.
- D. Large Pipes: For external diameters of 6inches and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - 1. Steel spring or non-metallic fasteners.
 - 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2inches wide; full circle at both ends of pipe marker, tape lapped 3inches.
 - 3. Strapped-to-pipe (or insulation) application of semi- rigid type, with manufacturer's standard stainless steel bands.
- E. Lettering: Comply with piping system nomenclature as specified, scheduled, shown, or to match existing building lettering nomenclature system and abbreviate only as necessary for each application length.
- F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.5 PLASTIC TAPE:

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2inches wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6inches, 2-1/2inches wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.6 VALVE TAGS:

- A. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4inch high letters and sequenced valve numbers 1/2inch high, and with 5/32inch hole for fastener.
 - 1. Provide 1-1/2inch diameter tags, except as otherwise indicated.
 - 2. Fill tag engraving with black enamel.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), and solid brass S- hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16 inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8 inch center hole to allow attachment.

2.7 VALVE SCHEDULE FRAMES:

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with non-glare type sheet glass.

2.8 ENGRAVED PLASTIC-LAMINATE SIGNS:

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16 inch, except as otherwise indicated.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.9 PLASTICIZED TAGS:

- A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4inch x 5-5/8 inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large- size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.10 LETTERING AND GRAPHICS:

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified, scheduled and approved by the Owner/Engineer. Provide numbers, lettering and wording as indicated and approved by the Owner/Engineer for proper identification and operation/ maintenance of mechanical systems and equipment.
- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as designated on the drawings or schedule as well as service.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION:

- A. General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow. Existing building identification shall match the existing method which exists in the building.
- B. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non- insulated pipes.
- C. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
- D. Near each valve and control device.
- E. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
- F. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
- G. At access doors, manholes and similar access points which permit view of concealed piping.
- H. Near major equipment items and other points of origination and termination.
- I. Spaced intermediately at maximum spacing of 25 feet along each piping run, except reduce spacing to 15' in congested areas of piping and equipment.
- J. On piping above removable acoustical ceilings.

3.3 UNDERGROUND PIPING IDENTIFICATION:

- A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground- type plastic line marker, located directly over buried line at 6 inches

to 8 inches below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16 inches, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 VALVE IDENTIFICATION:

- A. General: Provide valve tag on valves in each piping system. List each tagged valve in valve schedule for each piping system.
 - 1. Building services main shut-off valves.
 - 2. Each individual system main shut-off valves.
 - 3. Each individual system riser shut-off valves.
 - 4. Each individual system floor shut-off valves.
 - 5. Each individual system major branch shut-off valves.
- B. Mount valve schedule frames and schedules in mechanical equipment rooms where directed by Architect/Owner/Engineer.
- C. Where more than one major mechanical equipment room is shown for project, install mounted valve schedule in each major mechanical equipment room, and repeat only main valves which are to be operated in conjunction with operations of more than single mechanical equipment room.

3.5 ADJUSTING AND CLEANING:

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 230553

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products and systems, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.
- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove that fire hazard ratings for materials proposed for use do not exceed those specified.
- D. Codes and Standards:
 - 1. International Energy Conservation Code 2006

1.2 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, density, and furnished accessories for each mechanical system requiring insulation. Submit detail product information and installation information for all jacketing systems specified in this section.

1.3 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide product by one of the following:
 - 1. Mechanical Insulation:
 - a. Johns Manville Corp.
 - b. Owens-Corning Fiberglas Corp.
 - c. Knauf Fiber Glass
 - d. Manson
 - e. CertainTeed
 - f. Einsulation

- g. Armacel
- h. Pittsburgh Corning Corp.
- i. PABCO, Inc.
- j. Rubatex Corp.
- k. Thermal Ceramics
- l. Thermal Structures

2. Jacketing & Covering Products:

- a. Childers
- b. Ceel-Co
- c. Zeston
- d. Alpha Associates, Inc.

2.2 PIPING INSULATION MATERIALS:

- A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated. "K" factor shall be maximum 0.24 at 75 degrees F. mean temperature, jacket with tensile strength of 35 lbs/in, mullen burst 70 psi, beach puncture 50 oz. in/in, permeability .02 perm factory applied vapor barrier jacket and adhesive self-sealing lap joint.
- B. Cellular Glass Piping Insulation: ASTM C 552, Type II, Class 2. "K" factor shall be maximum 0.29 at 75 degrees F mean temperature.
- C. Calcium Silicate Piping Insulation: ASTM C 533, Type I. "K" factor shall be maximum 0.45 at 500 degrees F. mean temperature, compression strength 200 psi for 5 percent compression, transverse strength 200 psi for 5 percent compression, flexural strength 60 psi.
- D. Flexible Closed Cell Piping Insulation: ASTM C 534, Type I. "K" factor shall be maximum 0.27 at 75 degrees F. mean temperature, with a water vapor permeability of 0.10 perm inches or less. Insulation shall be pre-installed on piping, or un-slit to be slipped over piping as a single piece.
- E. Jackets for Piping Insulation: ASTM C 921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.
 - 1. Fitting Covers: UV resistant PVC, pre-molded fitting covers, flame spread 25, smoke developed 50. PVC tape for cold systems, serrated tacks or PVC tape for hot systems.
 - 2. Aluminum Jacketing: Manufactured from T3003 (or T/5005) H14 to H19 aluminum alloy with 3/16" corrugations and shall have a factory attached 1 mil thick polyethylene moisture barrier continuously laminated across the full width of the jacketing. Jacketing shall be .016" thick minimum. Provide matching factory fabricated covers for 90 degrees and 45 degrees elbows, tee fittings, flange fittings valve bodies, blind ends, reducers and other fittings necessary to make the covering system complete, waterproof and weatherproof.
- F. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.
- G. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated and additional finishes as specified.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Workmanship shall be first class and of the highest quality, poor installation or bad appearance as determined by the engineer shall be due cause to reject the entire project in whole and retainage will be withheld until corrective action is completed to the engineer's satisfaction.

3.2 PLUMBING PIPING SYSTEM INSULATION:

- A. Insulation Omitted: Omit insulation on unions, balance cocks, flow regulators, drainage piping located in fire protection piping, and pre-insulated equipment.
- B. Cold Piping:
 - 1. Application Requirements: Insulate the following cold plumbing piping systems:
 - a. Potable and non-potable cold water piping.
 - 2. Insulate each piping system specified above with the following types and thicknesses of insulation:
 - a. Fiberglass; ½ inch thickness.
- C. Hot Piping:
 - 1. Application Requirements: Insulate the following hot plumbing piping systems:
 - a. Potable hot water and tempered piping.
 - b. Potable hot water and tempered recirculating piping.
 - 2. Insulate each piping system specified above with the following types and thicknesses of insulation:
 - a. Fiberglass: (IECC) 1 inch thick for all pipe sizes.

3.3 HVAC PIPING SYSTEM INSULATION:

- A. Insulation Omitted: Omit insulation on steam condensate piping between steam trap and union; and on hot piping unions, flexible connections, and expansion joints. Insulation may be omitted inside of cabinet unit heaters, convectors and fan coils for hot piping. Cold piping insulation inside fan coil unit cabinet may be omitted provided piping is located over drain pan. Hot and cold piping routed inside air handler units shall be insulated. Omit insulation on strainers in heating water strainers operating below 200 degrees F.
- B. Heating System Piping (to 200 degrees F (90 degrees C)):
 - 1. Application Requirements: Insulate the following heating piping systems:
 - a. Hot water supply and return piping.
 - b. Low pressure steam vent & relief piping.

2. Insulate each piping system specified above with the following type and thicknesses of insulation:
 - a. Fiberglass: (IECC): 1 inch thick for pipe sizes up to and including 1-1/2", 2 inch thick for pipe over 1-1/2 inches.
 - C. High Temperature, Low Pressure Piping (200 to 250 degrees F (90 to 120 degrees C)):
 1. Application Requirements: Insulate the following hot low pressure HVAC piping.
 - a. Low pressure steam (up to 15 psig).
 - b. Steam condensate piping (all pressures).
 2. Insulate each piping system specified above with the following type and thicknesses of insulation:
 - a. Fiberglass: (IECC): 1-1/2 inch thick for pipe sizes up to and including 1-1/2 inch, 3 inch thick for pipe sizes 2 inch and over.
 - D. High Temperature, Medium and High Pressure Piping (250 to 350 degrees F (120 to 175 degrees C)):
 1. Application Requirements: Insulate the following hot high pressure HVAC piping:
 - a. Medium and High pressure (16 to 125 psig) steam piping.
 2. Insulate each piping system specified above with the following type and thicknesses of insulation:
 - a. Fiberglass: 1-1/2 inches thick for pipe sizes up to and including 1-1/2 inch, 3 inch thick for pipe sizes 2 inch and over.
- 3.4 INSTALLATION OF PIPING INSULATION:
- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
 - B. Install insulation on pipe systems subsequent to installation of heat tracing, testing, and acceptance of tests.
 - C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
 - D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
 - E. Maintain integrity of vapor-barrier jackets on cold pipe insulation, and protect to prevent puncture or other damage.
 1. Do not use staples or tacks on vapor barrier jackets.
 2. Seal vapor barrier penetrations with vapor barrier finish recommended by the manufacturer.

3. Seal fitting covers with PVC tape.
 4. Cover all unions, check valves, and other in-line devices. Mark outer covering with indelible marker to identify item covered.
- F. Neatly bevel and seal insulation at all exposed edges.
- G. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- H. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- I. See equipment insulation for removable insulation on accessible piping components.
- J. See Section 23 05 29 for insulation inserts and shields. Butt pipe insulation against pipe hanger insulation inserts. For all piping apply wet coat of vapor barrier lap cement on butt joints and seal all joints and seams with 3 inch wide vapor barrier tape or band.
- K. Flexible Elastomeric Piping Insulation:
1. Install unslit, by slipping over piping prior to joining, or install pre-insulated soft copper tubing.
 2. Seal butt ends with adhesive.
- L. Cellular Glass Insulation:
1. Apply in a single layer. Secure to pipe with ½ inch wide aluminum bands.
 2. For indoor applications, apply all purpose Kraft paper/aluminum foil/vinyl coating jacket. Seal all lap and butt joints with self seal vapor barrier tape.
 3. For outdoor applications, apply aluminum rubber/Tedlar jacketing as described below.
- M. Calcium Silicate Insulation:
1. Apply in a single layer. Secure to pipe with 1/2 inch wide aluminum bands.
 2. For indoor applications, provide canvas jacketing. Adhere joints of jacketing and provide a finish coat of sealant as recommended by the manufacturer.
- N. Piping Exposed to Weather: Protect outdoor insulation from weather by aluminum jacketing.
1. Jacketing shall be secured by 1/2 inch wide stainless steel bands located on 24 inch centers. All joints and seams shall be caulked with clear silicone. Locate all longitudinal seams at the bottom of piping to minimize joint exposure to weather. Contractor may propose pre-fabricated sealing and fastening systems, submit samples and product data for approval.

3.5 EXISTING INSULATION REPAIR:

- A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation, install new jacket lapping and sealed over existing.

3.6 PROTECTION AND REPLACEMENT:

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 230700

SECTION 231116 - STEAM SPECIALTIES

PART 1 GENERAL

1.1 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of steam and condensate specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Steam and Condensate Specialty Types: Provide steam and condensate specialties of same type by same manufacturer.
- C. Steam and condensate specialties furnished as part of factory-fabricated equipment shall meet or exceed requirements of this section.
- D. Codes and Standards:
 - 1. ASME Compliance: Manufacture and install steam and condensate specialties in accordance with ASME B31.9 "Building Services Piping."

1.2 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of steam and condensate specialty. Submit schedule indicating manufacturer's figure number, size, location, rated capacities, and features for each required steam and condensate specialty.
- B. Shop Drawings: Submit manufacturers' assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components.
- C. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Divisions 1 and 23.
- D. Maintenance Data: Submit maintenance data and spare parts lists for each type of steam and condensate specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Divisions 1 and 23

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steam Traps:
 - a. Armstrong International
 - 2. Steam Vents:
 - a. Armstrong International
 - b. Hoffman Specialty ITT; Fluid Handling Div.
 - c. Nicholson Steam

2.2 STEAM AND CONDENSATE SPECIALTIES:

- A. General: Provide factory-fabricated steam and condensate specialties recommended by manufacturer for use in service indicated. Provide steam and condensate specialties of types, capacities, and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by the manufacturer to make the system complete and operating properly. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. All traps on the project shall be supplied by one manufacturer, multiple manufacturers of different trap types will not be accepted.

2.3 TRAP SIZING:

- A. For constant steam pressure applications using either inverted buckets or float and thermostatic traps as indicated on the drawings, use a 2:1 safety factor at the operating pressure differential between the supply pressure and the return line pressure the trap discharges into.
- B. For modulating steam pressure using either inverted buckets or float and thermostatic traps as indicated on the drawings use the following sizing criteria:
 - 1. For 0-15 psig supply steam service, size traps at .5 psi pressure differential using a 2:1 safety factor.
 - 2. For 16-30 psig supply steam service, size traps at 2 psi pressure differential using a 2:1 safety factor.
 - 3. For 31 psig at greater supply steam service, size traps at 1/2 of the maximum pressure differential across the trap using a 3:1 safety factor.

NOTE: When determining maximum pressure differential, the outlet pressure after the control valve shall be used.

- C. Sizing of steam traps is to be based on condensate discharge at saturated steam temperatures. Water discharge capacities are not acceptable.

2.4 THERMOSTATIC TRAPS:

- A. General: Provide thermostatic traps as indicated, with body constructed of cast brass, with integral ball joint union, and screw-in top. Provide thermostatic element of diaphragm or bellows type, with stainless steel valve cone and renewable stainless steel valve seats. Design trap for discharging condensate, air, and other non-condensable gases without loss of steam at steam operating pressures.

2.5 FLOAT AND THERMOSTATIC TRAPS:

- A. General: Provide float and thermostatic traps as indicated, with body and cover constructed or cast iron or semi-steel, pressure rated to 175 psig, designed so all internal parts are accessible without disturbing piping. Provide thermostatic air vent shall be austenitic stainless steel and brass cage with a phosphor-bronze balanced pressure bellow. Provide austenitic stainless steel float with positive snap-action valve mechanism, stainless steel valve and renewable seat. Design trap for discharging condensate, air, and other non-condensable gases without loss of steam at system operating pressures.
- B. F & T traps shall have the following features:
 - 1. Integral vacuum breaker

2.6 INVERTED BUCKET TRAPS:

- A. General: Provide inverted bucket traps with body and cover constructed of cast iron pressure rated for 250 psi, designed so internal parts are accessible without disturbing piping. Construct bucket of austenitic stainless steel, and lever mechanism of heat treat stainless steel, operating on knife edges for friction-free performance. Construct removable seats and plungers of heat treated stainless steel. Trap shall continuously vent non-condensable gases.
- B. Inverted bucket traps shall have the following features:
 - 1. Scrub wire bucket with a vent scrub wire.
 - 2. Bucket with a thermostatically controlled air vent.
 - 3. Integral stainless steel check valve.
 - 4. Pop drain condensate drain for low pressure/freezing applications.
 - 5. LV bucket with increased air-venting capacity.

2.7 THERMODYNAMIC TRAPS:

- A. General: Provide thermodynamic traps as indicated, with body and cover constructed of stainless steel, pressure rated for 600 psi, designed so internal parts are accessible without disturbing piping. Construct disc of heat treated stainless steel.
 - 1. Strainer: Provide integral inlet strainer built into trap body.
 - 2. Blow Down Valve: Provide blow down valve fitted on strainer blow down connection.
 - 3. Insulated Cap: Provide insulated cap sized to fit over trap cover.

2.8 STEAM VENTS:

- A. General: Provide steam vents for venting of air and non-condensable gases from steam piping system.
 - 1. Quick Vents: Cast-brass body and bottom, with thermostatic bellows, and removable vent port with vacuum check.
 - 2. Float Vents: Cast-iron body, cast-brass bottom, seamless-brass float, thermostatic bellows, removable stainless steel seat, monel metal plunger, and vacuum check disks.

2.9 STRAINERS:

- A. See Section 23 05 18 - "Piping Specialties".

PART 3 EXECUTION

3.1 INSPECTION:

- A. General: Examine areas and conditions under which steam and condensate specialties are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF STEAM AND CONDENSATE SPECIALTIES:

- A. General: Install steam and condensate specialties as indicated, and in accessible locations to permit service. When located behind heating enclosures, center steam and condensate specialties on access door. Install in neat and workmanlike manner. Use only wrenches

having square flat jaws, or non-metallic strap wrenches on brass specialties; wrench marks will not be permitted.

- B. Each trap shall have a check valve on its downstream side or exiting pipe.
- C. Thermostatic Traps: Install on outlet of each steam heating terminal unit, and elsewhere as indicated.
- D. Float and Thermostatic Traps: Install where indicated. Install strainer ahead of trap, union and shut-off valve on inlet and outlet.
- E. Inverted Bucket Traps: Install on high pressure steam piping and where indicated. Install strainer ahead of trap, union and shut-off valve on inlet and outlet.
- F. Thermodynamic Traps: Install on high pressure steam piping as indicated. Install strainer ahead of trap, union and shut-off valve on inlet and outlet.
- G. Steam Terminal Inlet Valves: Install on inlet to each steam heating room terminal which is not automatically controlled, and elsewhere as indicated. Install with stem in vertical upright position and in accessible position. Install stem extension in top of radiation cover where indicated.
- H. Provide inverted bucket trap for steam drip for all low points in the piping system and all other locations where condensate may collect whether shown on the drawings or not. Provide all piping accessories per piping details shown on drawings.
- I. Strainers: Install upstream of control valves, pressure reducing valves, and temperature/pressure regulating valves and as shown on drawings. Install in horizontal position to prevent strainer from trapping liquid.

END OF SECTION 231116

SECTION 232213 - STEAM AND CONDENSATE HEATING PIPING

PART 1 GENERAL

1.1 DESCRIPTION OF WORK:

- A. This section includes low and high pressure steam and condensate piping for system. Materials and equipment specified in this Section include:
 - 1. Pipes and fittings
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Refer to other Division 23 sections for materials and methods for sealing pipe penetrations through basement walls and fire/smoke barriers, gauges, thermometers, flow meters, mechanical identification, mechanical insulation, condensate pumps and receiver sets, and temperature control valves and sensors.

1.2 SYSTEMS DESCRIPTION:

- A. The steam and condensate piping systems for this project is a two-pipe, mechanical flow.

1.3 SUBMITTALS:

- A. Shop drawings, detailing dimensions, methods of assembly of components, and location and size of each field connection for flash tanks.
- B. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 23.
- C. Maintenance data, including data for steam and condensate specialties and special duty valves. Refer to Division 23.
- D. Welders' certificates certifying that welders meet the quality requirements specified in Quality Assurance below.
- E. Certification of compliance with specified ASTM, ASME, and ANSI manufacturing requirements for pipe, fittings, and specialties.
- F. Test reports specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of steam and condensate piping products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Personnel with at least 3 years of successful installation experience on projects with steam and condensate piping work similar to that required for the project.
- C. Regulatory Requirements: Comply with the provisions of the following:
 - 1. ASME B 31.9 "Building Services Piping: for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

2. ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.
3. Local Mechanical Code.
4. UMC Compliance: Fabricate and install steam and condensate piping in accordance with IAPMO "Uniform Mechanical Code."

PART 2 PRODUCTS

2.1 MATERIALS AND PRODUCTS:

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ASME B31.9 Code for Building Services Piping where applicable, base pressure rating on steam and condensate piping systems maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings and materials which match pipe materials used in steam and condensate piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.

2.2 PIPE AND TUBE MATERIALS:

A. Steam and Condensate Piping:

1. Low (15 psig and under) and Medium (15 psi to 100 psig) Pressure Steam Supply:
 - a. Piping, 2 Inches and Under:
 - 1) Pipe: Schedule 40, black steel, threaded and coupled.
 - 2) Joint: Screwed, above ground; welded, below ground.
 - 3) Fittings: Screwed, black cast-iron, 125 lb.; welded, forged steel socket weld type, 300 lb. (WOG).
 - b. Piping, 2-1/2 Inches and Over:
 - 1) Pipe: Schedule 40, black steel, beveled ends.
 - 2) Fittings: Schedule 40 steel, butt weld type.
 - 3) Flanges: 150 lb. forged steel, welding neck type.
2. Low (15 psig and under) and Medium (15 psi to 100 psig) Pressure Steam Condensate:
 - a. Piping, 2 Inches and Under:
 - 1) Pipe: Schedule 80, black steel threaded and coupled.
 - 2) Joints: Screwed above ground, welded below ground.
 - 3) Fittings: Black cast iron, 125 lb.
 - b. Piping, 2-1/2 Inches and Over:
 - 1) Schedule 80, black steel, beveled ends.
 - 2) Fittings: Schedule 80, steel, butt weld type.
 - 3) Flanges: 150 lb. forged steel, welding neck type with bore to match pipe.
3. High (above 100 psig) Pressure Steam Supply:

- a. Piping, 2 Inches and Under:
 - 1) Pipe: ANSI/ASTM A53, Grade B, Schedule 40, seamless, black steel, plain ends.
 - 2) Joints: Screwed, above ground; welded, below ground.
 - 3) Fittings: Black Iron, 250 lb.
 - b. Piping, 2-1/2 Inches and Over:
 - 1) Schedule 40, seamless, black steel, beveled ends.
 - 2) Fittings: Schedule 40, seamless, black steel, butt weld type.
 - 3) Flanges: 300 lb. forged steel, welding neck type.
4. High (above 100 psig) Pressure Steam Condensate:
- a. Piping, 2 Inches and Under:
 - 1) Pipe: Schedule 80, seamless, black steel, plain ends.
 - 2) Fittings: Forged steel socket weld type, 300 lb. (WOG).
 - b. Piping 2-1/2 Inches and Over:
 - 1) Pipe: Schedule 80, seamless, black steel, beveled ends.
 - 2) Fittings: Schedule 80, seamless, steel, butt weld type.
 - 3) Flanges: 300 lb. forged steel, welding neck type with bore to match pipe.

PART 3 EXECUTION

3.1 INSPECTION:

- A. General: Examine areas and conditions under which steam and condensate piping materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PIPING INSTALLATIONS:

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install piping at right angles and parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

- F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, ¾" ball valve, and short ¾" threaded nipple and cap.
 - G. Wall Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 23 for sealers and materials.
 - H. Install steam supply piping at a uniform grade of 1 inch in forty feet downward in the direction of flow.
 - I. Install branch connections to supply mains using 45 degree fittings in main with take-off out the top of the main. Use of 90 degree "tee" fittings is permissible, where use of 45 degree fittings are not practical. Where the length of a branch takeoff is less than 10 feet, pitch branch line down toward mains, 1 inch per twenty feet.
 - J. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side down.
 - K. Install unions in pipes 2 inches and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
 - L. Install flexible connectors at inlet and discharge connections to pumps and other vibration producing equipment.
 - M. Anchor piping to ensure proper direction of expansion and contraction. Install expansion loops and joints as indicated on the Drawings and specified in Division 23 Section "Anchors and Supports."
 - N. Install drip legs at low points and natural drainage points in the system, such as at the ends on mains, bottom of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.
 - 1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 200 feet where pipe is pitched down in the direction of the steam flow and a maximum of 150 feet where the pipe is pitched up so that condensate flow is opposite of steam flow.
 - 2. Extend drip legs at vertical risers beyond the rise.
 - 3. Provide an 18 inch long drip leg. For steam mains smaller than 6 inches, provide line size drip leg. In steam mains 6 inches and larger, provide drip legs sized 2 pipe sizes smaller than the main, but not less than 4 inches.
 - 4. Strainer blowdowns shall be equipped with ball valves with hose end and cap to allow removal of dirt and scale.
 - 5. Install steam traps close to drip legs.
- 3.3 HANGERS AND SUPPORTS:
- A. General: Hanger, supports, and anchors devices are specified in Division 23 Section "Supports and Anchors."
 - B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.

2. Adjustable roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe roller complete - MSS Type 44 for multiple horizontal runs, 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

3.4 PIPE JOINT CONSTRUCTION:

- A. Welded Joints: Comply with the requirements in ASME Code B31.9 - "Building Services Piping."
- B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:
 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 2. Align threads at point of assembly.
 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
 5. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

3.5 FIELD QUALITY CONTROL:

- A. Preparation for testing: Prepare steam and condensate piping in accordance with ASME B 31.9 and as follows:
 1. Leave joints including welds uninsulated and exposed for examination during the test.
 2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
 3. Flush system with clean water. Clean strainers.
 4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
 5. Install relief valve set at a pressure not more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

- B. Testing: Test steam and condensate piping as follows:
1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
 2. Use traps installed at high points in the system to release trapped air while filling the system. Use drip legs installed at low points for complete removal of the liquid.
 3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
 4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9.
 5. Hydrostatic Test: The test shall be accomplished by hand pumping the system to the specified water pressure, and maintaining that pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four hours.
 - a. Steam and Condensate Systems: 100 psig or 150 percent of system pressure, whichever is greater.
 6. After the hydrostatic test pressure has been applied for at least 4 hours, examine piping joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

3.6 CLEANING:

- A. After testing a hydronic system for proper operation of all automatic devices and controls, operate the entire system for one week, then drain and wash out with caustic soda. Immediately rinse system with water. Clean the strainer baskets and refill the system with system media and leave in proper working order. After the system has been in operation for one month, thoroughly check all automatic control valves for water or steam leakage and where necessary, clean and repair same.

END OF SECTION 232213

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section and all subsequent Division 26 sections.

1.2 SUMMARY:

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in sections of Division 1 through 23.

1.3 ACCESSIBILITY:

- A. Install equipment and materials to provide required code clearances and access for servicing and maintenance. Coordinate the final location with piping, ducts, and equipment of other trades to insure proper access for all trades. Coordinate locations of concealed equipment, disconnects, and boxes with access panels and doors. Allow ample space for removal of parts, fuses, lamps, etc. that require replacement or servicing.
- B. Extend all conduits so that junction and pull boxes are in accessible locations.
- C. Install access panel or doors where equipment or boxes are concealed behind finished surfaces.

1.4 ROUGH-IN:

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 23 for rough-in requirements.

1.5 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Electrical installations, inspections, and testing shall meet, at a minimum, the versions of the following in effect at the date of these contract documents except where otherwise specified:

1. Underwriters Laboratories (UL)
2. Federal and State Regulations
3. OSHA
4. NFPA
5. NEMA
6. IEEE
7. ANSI
8. NESG
9. CBM
10. NECA
11. ICEA
12. NETA

- B. All material used on this project shall be UL listed and labeled and be acceptable to the authority having jurisdiction as suitable for the use intended.

- C. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.
- 1.6 PERMITS AND FEES:
- A. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.
- 1.7 ELECTRICAL INSTALLATIONS:
- A. Drawings are diagrammatic in character and do not necessarily indicate every required conduit, box, fitting, etc.
 - B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both.
 - C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.
 - D. Before any work is begun, determine that equipment will properly fit the space and that conduit can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.
 - E. Verify all dimensions by field measurements.
 - F. Arrange for chases, slots, and openings in other building components to accommodate electrical installations.
 - G. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - H. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring an access path for positioning prior to closing-in the building or space.
 - I. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
 - J. Where mounting heights are not detailed or dimensioned, install electrical conduits, boxes, and overhead equipment to provide the maximum headroom possible. In general, keep installations tight to structure.
 - K. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting and removal with minimum of interference with other installations.
- 1.8 CUTTING AND PATCHING:
- A. This Article specifies the cutting and patching of electrical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.
 - B. Refer to the Division 1 Section covering cutting and patching for general requirements.

- C. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
 - D. When coring is required or identified, an x-ray of the area is to be taken prior to the performance of the work operation. X-ray work requires an MOP and protection.
 - E. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.
 - F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
 - G. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work;
 - 2. Remove and replace defective Work;
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents;
 - 4. Remove samples of installed Work as specified for testing;
 - 5. Install equipment and materials in existing structures;
 - 6. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
 - H. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to removal of conductors, conduit, luminaires, boxes, devices and other electrical items made obsolete by the new Work.
 - I. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 - J. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 - K. Locate identify, and protect mechanical and electrical services passing through remodel or demolition area and serving other areas required to be maintained operational.
- 1.9 TEMPORARY FACILITIES:
- A. Light, Heat, Power, Etc.
 - 1. Responsibility for providing temporary electricity, heat and other facilities shall be as identified in these specifications, as shown on the drawings and as specified in Division 1.
 - B. Building distribution equipment and devices (existing or new) shall not be used without written permission of the Owner. If used for temporary power, the equipment shall be properly maintained and any damage resulting from use shall be repaired by the Contractor. The guarantee period for new equipment shall not begin until the equipment is turned over to the Owner.

1.10 ELECTRICAL SUBMITTALS:

- A. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 Section covering shop drawings, product data, and samples for submittal definitions, requirements, and procedures.
- B. The manufacturer's material or equipment listed first in the specifications or on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the first names, the cost of any changes in construction required by their use shall be borne by this Contractor.
- C. All equipment shall conform to the State and/or local Energy Conservation Standards.
- D. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Each submittal shall be reviewed for general conformance with contract requirements and stamped by the respective contractor prior to submittal to the Architect/Engineer. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed unless written prior approval is obtained by the Contractor.
- E. Before starting work, prepare and submit to the Architect/Engineer four (4) sets of all shop drawings, descriptive product data, and samples required for the project. Continue to submit four (4) sets, after each Architect/Engineer's action, until a "No Exception Taken" or "Make Correction Noted" action is received with the exception of Fire Alarm submittals which must be submitted until a "NO EXCEPTION TAKEN" action is received. The Engineer will complete an initial review and, if required, a single subsequent review of the resubmittal. If the submittal requires a third review or additional reviews, the University may withhold amount(s) necessary from Contractor's final request for Payment to reimburse the Engineer at their standard hourly rates. Submittals shall include the following specified materials and, in addition, any materials not listed below but which are specified in the individual sections of Division 16 which follow.
 - 1. Lamps
 - 2. Supporting devices
- F. Mark submittals with designations as shown on the drawings and identify as required by Specification Sections.
- G. All electrical submittals shall be assembled into a single package.
 - 1. Submittals shall be provided in expandable, three-post, hard back binders.
 - 2. Each submittal shall be tabbed by the electrical specification section it is specified in.
 - 3. An index shall be provided which includes:
 - a. Product
 - b. Plan Code (if applicable)
 - c. Specification Section
 - d. Manufacturer and Model Number
- H. Submittals shall be provided for review within four (4) working weeks from award of contract to successful bidder.

1.11 PRODUCT OPTIONS AND SUBSTITUTIONS:

- A. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.
- B. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture.

1.12 PRODUCT LISTING:

- A. Prepare a list of major electrical equipment and materials for the project. A sample schedule is included at the end of this Section to complete this requirement.
- B. Provide a product listing within one (1) week from award of contract to successful bidder.
- C. Submit this listing as a part of the submittal requirement specified in the Division 1 Section on Products and Substitutions.
- D. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, sheet metal, steel bar stock, welding rods, solder, fasteners and similar items used in Work, except as otherwise indicated.
- E. Conduit and Fittings: All conduits and fittings installed exposed within the same room or immediate area shall be of the same manufacturer.
- F. Provide products which are compatible within systems and other connected items.

1.13 DELIVERY, STORAGE AND HANDLING:

- A. Refer to the Division 1, Sections on Transportation and Handling and Storage and Protection.
- B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage and weather.
- D. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.14 RECORD DOCUMENTS:

- A. Refer to the Division 1 Section on Project Closeout or Project Record Documents for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment,

dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices, and any other relevant deviations from the Contract Documents.

- C. During construction, the contractor shall maintain at the job site a set of updated construction documents for the singular purpose of recording the above information. All record drawings shall be completed in erasable pencil. These changes shall be updated weekly.
 - D. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme.
 - 1. Red shall indicate new items, deviations and routing.
 - 2. Green shall indicated items removed or deleted.
 - 3. Blue shall be used for relevant notes and descriptions.
 - E. The Contractor shall have available at the job site current information on the following at all times:
 - 1. Addenda
 - 2. Change Orders
 - 3. Submittals
 - 4. Inspection Reports
 - 5. Test Results
 - 6. Outage Information and Requests.
 - F. At the completion of the project, submit these documents to the Architect/Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the Architect/Engineer.
- 1.15 OPERATION AND MAINTENANCE DATA:
- A. Refer to the Division 1 Section on project closeout or operation and maintenance data for procedures and requirements for preparation and submittal of maintenance manuals.
 - B. In addition to the information required by Division 1 for Maintenance Data, include the following information:
 - 1. Complete list of parts and wiring diagrams.
 - 2. Names, addresses and telephone numbers of the Contractor, Sub-contractors and local company responsible for maintenance of each system or piece of equipment.
 - 3. All information shall be permanently bound in a 3-ring binder. The job name and address and contractor's name and address shall be placed on the cover and spine of each binder in a permanent manner. Dymo-tape is not acceptable.
 - 4. Copies of all test reports shall be included in the manuals.
 - 5. Provide manuals with dividers for major sections and special equipment. Mark neatly in ink the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.
 - C. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, is provided and the manual is reviewed by the Architect/Engineer.

1.16 TESTING:

- A. Submit test reports as outlined in Division 1 Sections on Quality Control Services and other sections of this Division.
- B. Testing as required by these specifications shall pertain to all equipment, wiring, devices, etc. installed under this contract and being reused.
- C. General Scope:
 - 1. The Contractor shall hire an independent testing agent to conduct operating and acceptance tests on new electrical system components and all existing devices which are impacted by the project.
 - 2. The Testing agent shall furnish all equipment, instruments and personnel required to conduct tests.

1.17 DEMOLITION/REMODEL WORK:

- A. Refer to Division 1 Section on Summary of work for requirements on working in Owner-occupied areas of the existing building and Division 2 section on selective demolition. The following are additions and modifications.
- B. The project involves renovation and remodel of the existing building. On the drawings, work may be denoted by showing items as bold or light line weight and certain renovation symbols are used. These indications and symbols are amplified as follows:

- 1. Bold Print (when used): Work included in this contract is denoted in bold print or line weight.
- 2. Light Print (when used): Work shown lightly indicates existing conditions to remain.

R = Existing items to be removed. Contractor shall remove the existing item and the associated existing wiring. Where the raceway serving the equipment is accessible (via removal of suspended ceiling, crawl space, etc.) the raceway shall also be removed. Where the removal of a raceway leaves visible evidence on an existing surface which is not being repaired or replaced by the General Contractor, this contractor shall repair the surface. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank coverplate installed. Where the concealed raceway is uncovered by demolition performed by the General Contractor, the raceway shall be removed (or extended to new location if appropriate).

E = Existing item to remain in place. Contractor shall perform the following function based upon the item to remain:

- Luminaires - Leave in place.
- Switches - Maintain circuit continuity.
- Receptacle - Remove devices if required for new work and reinstall.
- Clock - Clean and reinstall.

ER = Existing item to remain in place; replace device. Contractor shall perform the following function based upon the item to remain:

- Luminaires - Clean and install new lamps.
- Switches - Remove and replace with new in existing box.
- Receptacles - Remove and replace with new in existing box.

Clock - Clean and replace.

RL =Existing item to be relocated. Contractor shall remove the existing item, and store in a safe place. The existing item shall be relocated to the new position as called for on the drawings. At Contractor's option, the existing wiring may be extended, or new wiring may be run from the source. Based upon the item to be relocated, the Contractor shall perform the following function:

Luminaires - Clean and install new lamps.
Switches - Replace.
Receptacles - Replace.
Clocks - Clean and relocate.

- C. Existing equipment that is removed and not scheduled to be reused shall remain the property of the Owner and be delivered for disposition unless specifically indicated otherwise and shall be stored in a location designated by the Owner. Items which are removed and not wanted by the Owner shall become the property of the Contractor and shall be removed from the site.
- D. Existing equipment that is removed and is to be reused shall be cleaned, serviced and operable before being reinstalled.
- E. Where remodeling interferes with existing circuits and equipment which are not to be removed, such circuits and equipment shall be reworked and relocated as required to complete the project.
- F. The Contractor shall remove all distribution equipment, conductors, etc., which are indicated to be removed or which must be removed to accommodate demolition. Equipment to be removed may require reworking conduit and wiring in order to maintain service to other equipment.
- G. Where remodeling interferes with circuits serving areas outside of the project or phase limits or which are remodeled in later phases of the project, circuits shall be reworked or temporary circuits provided as required.
- H. Existing equipment and circuiting shown are based on field surveys and/or Owner furnished drawings. The Contractor shall verify conditions as they exist with necessary adjustments being made to the drawing information.
- I. Coordinate the routing of all conduits with the existing mechanical and plumbing systems in order to avoid conflicts with ducts, pipes, etc. Where existing electrical boxes, conduit, or equipment interfere with installation of new ducts, plumbing, walls, soffits, luminaires, outlets, etc., the Contractor shall resolve the conflict with the appropriate trade.
- J. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated on the drawings or allowed under the appropriate section of the specifications.
- K. Electrical Outages: Electrical outages must be held to a minimum. The Contractor shall submit a Method of Procedure (MOP) for each outage to the Owner detailing the reasons for the outage, areas affected, sequence of procedures to accomplish work, estimated maximum length of time, the date and time of day outage will occur. The Contractor shall meet with the Owner to set a schedule and date for the outage based on the MOP. Due to the critical implications of power outages, the Owner may direct the Contractor as to the time of day or night and date an outage may take place.

1. The Contractor will be responsible for providing temporary power required for the duration of the outages. The required outages to connect and disconnect the temporary power will require a MOP as described above.
- L. PCB type ballasts may be present in existing luminaires. If PCB ballasts are discovered by the Contractor, report such occurrence to the Architect and the Electrical Engineer immediately. The Contractor shall remove and dispose of PCB type ballasts at an E.P.A. (Environmental Protection Agency) approved site in the prescribed manner acceptable to the EPA. The Contractor shall pay all fees associated with this work.
- M. If other suspected hazardous material, in any form, is discovered by this Contractor in the process of his work, he shall report such occurrence to the Architect immediately. The Engineer will determine the action to be taken. Hazardous material removed is not a part of the work to be done under this Division.
- N. Contractor is responsible for sending removed lamps to be recycled. The Contractor should ensure the recycling agency meets RCRA and CERCLA regulations. Provide certificate of compliance in O&M Manuals.

1.18 WARRANTIES:

- A. Refer to the Division 1 Section on Warranties and Bonds for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In no case shall the warranty for the total electrical system be less than one year from date of acceptance by the Owner.
- B. Compile and assemble the warranties specified in Division 26, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item. Information to include product or equipment description, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.19 CLEANING:

- A. Refer to the Division 1 Section on project closeout or final cleaning for general requirements for final cleaning.
- B. Clean all luminaires, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

1.20 PROJECT CLOSEOUT:

- A. The contractor shall be responsible for providing the items listed on the checklist prior to final observation. Required test reports shall be included in the O & M manuals. (Checklist is located at the end of this section.)
- B. Punch Lists:
 1. Final payment will not be authorized until all items on the final punch list have been completed, and routine maintenance procedure and spare parts have been received.
- C. Operation and Maintenance Manuals:

1. Compile a complete list of product data and shop drawings, acceptance tests, warranties, certificates, sub-contractor and supplier information (i.e. name, address, and phone no.).

D. Guarantees and Warranties:

1. Furnish to the Owner a formal warranty covering the electrical system installed under this contract, to be free from defective materials and workmanship for a period of one year after date of acceptance of installation by Owner. During this period provide all labor and new materials required to repair or replace all defects to the satisfaction of the Owner at no cost to Owner.

1.21 SPECIAL ELECTRICAL PROVISIONS:

A. Bidding Requirements:

1. The bidder shall give evidence of being able to be bonded to (1-1/2 times job value). A letter shall be provided by the bonding agency assuring capability of bonding this level and associated rates.
2. The successful firm shall be capable of starting work immediately upon receipt of contract award and have the resources to complete the total project in accordance with the general contractor's construction schedule. (Allowance will be made for material delays caused by problems outside of contractor's control, with proper documentation.)

B. Qualification Requirements:

1. Contractors bidding this project must complete AIA Document A305-1986 "Contractor's Qualification Statement" and submit it with their proposal for information purposes.
2. In addition to the information requested in Item 1, the Contractor must provide a statement(s) indicating they meet the following minimum requirements.
 - a. List a minimum of two projects completed in the last five years which were similar in size (or larger), complexity and type. For each project list:
 - 1) Name and location of project.
 - 2) Name, address and phone number of client/owner and owner's representative.
 - 3) Contract type (prime or subcontract) and contract value (or subcontract value).
 - 4) Year in which work was performed.
 - b. If required, list two projects on which the contractor as the prime Contractor (may be the same projects listed in paragraph (a), if applicable).
 - c. The firm and its operating officers (above the level of Project Manager) shall have been involved in Electrical Contracting for at least five years.
 - d. List project values (or subcontract values, if applicable) which total at least five times job value of electrical work in the last five years completed by the firm or its operating officers.

C. General Requirements:

1. The successful firm shall provide a project supervisor of proven experience, and be willing to leave him (or her) on the project for the duration of the project, unless acceptable alternative arrangements are made with the University.
2. The successful firm must have a business office which is staffed during normal working hours (8:00-5:00 Monday through Friday).
3. The project manager of the successful firm shall have paging capability during normal working hours.

D. Craftsman Regulations:

1. Contractors shall include no more than one indentured apprentice per journeyman electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.
2. Helpers may be assigned to the project as required to do laboring type tasks, but may not do any installation type electrical work.

1.22 CONSTRUCTION REQUIREMENTS:

A. The contractor shall maintain and have available at the jobsite current information on the following at all times:

1. Construction Plans and Specifications
2. Addenda
3. Change Orders
4. Submittals
5. Inspection Reports
6. Test Results
7. Outage Information and Requests
8. Record Drawings (showing all changes)

Division 26

SPEC SECTION	ITEM	REQUIREMENTS						
		REPORT/ DATA		TEST/ REPORT	FACTORY REP SUPER-VISION AT SITE	TRAINING REQD AT SITE	EXTRA MATERIAL	O&M'S
		SHOP DWG.	LISTING PROD. DATA					
26 05 00	CONTRACTOR/EQUIPMENT WARRANTIES							X
	O&M MANUALS	X	X				X	X

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 SUBMITTALS:

- A. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- B. Shop drawings indicating details of fabricated products and materials.
- C. Engineered Design consisting of details and engineering analysis for supports for the following items:
 - 1. Suspended transformers
 - 2. Cable trays
 - 3. Trapeze hangers for multiple conduit runs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit
 - b. B-Line Systems, Inc.
 - c. GS Metals Corp.
 - d. Unistrut Diversified Products
 - 2. Conduit Sealing Bushings:
 - a. O-Z/Gedney
 - b. Cooper Industries, Inc.
 - c. GS Metals Corp.
 - d. Killark Electric Mfg. Co.
 - e. Madison Equipment Co.
 - f. Raco, Inc.
 - g. Spring City Electrical Mfg. Co.
 - h. Thomas & Betts Corp.

2.2 COATINGS:

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES:

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
 - 3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 12-gage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.
- F. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
 - 1. One-Hole Conduit Straps: For supporting 3/4" and smaller rigid metal conduit; galvanized steel.
 - 2. Two-Hole Conduit Straps: For supporting 1" and larger rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.

2.4 FABRICATED SUPPORTING DEVICES:

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
 - 3-inch and smaller: 20-gage.
 - 4-inch to 6-inch: 16-gage.
 - over 6-inch: 14-gage.

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. EMT, IMC, or Rigid Conduit.

2.5 FIRE SEALS:

- A. Material: Firestopping material shall be asbestos free, 100% intumescent, have code approval under BOCA, ICBO, SSBC, NFPA 101, NFPA 70, and be capable of maintaining an effective barrier against flame and gases in compliance with the following requirements.
- B. Flame Spread: 25 or less, ASTM E84
- C. Fire Resistance and Hose Stream Tests: Firestopping materials shall be rated "F" and "T" in accordance with ASTM E 814 or UL 1479. Rating periods shall conform to the following:

(F)	3	(T)	3	Time-rated floor or wall assemblies.
(F)	3	(T)	3	Openings between floor slabs and curtain wall.
- D. Manufacturers: Subject to compliance with requirements, provide fire seals of the following:
 1. 3M Company
 2. Tremco

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
 1. Conform to manufacturer's recommendations for selection and installation of supports.
 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 4. Support parallel runs of horizontal raceways together on trapeze-type hangers. Use 3/8" diameter or larger threaded steel rods for support.
 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing. For hanger rods supporting 1-1/2" or larger conduits provide 3/8" minimum threaded steel rods with pipe hangers.

6. Space supports for raceways in accordance with NEC. When there are 4 or more 2" conduits in a trapeze, supports shall be spaced 5' O.C.
 7. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
 8. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom nut.
- D. Miscellaneous Supports: Support miscellaneous electrical components separately and as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- E. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- F. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws, where authorized by the Owner and structural engineer. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 - a. Anchoring methods as follows:
 - 1) Solid Masonry: Lead expansion anchors or preset inserts.
 - 2) Concrete Surfaces: Lead expansion or self-drilling anchors.
- 3.2 PERSONNEL PROTECTION:
- A. Where U-channel systems, angles, brackets or other standard structural metal shapes are readily accessible and exposed to personnel, provide plastic or rubber end caps.
 - B. Where threaded rod supports are readily accessible and exposed to personnel, provide plastic or rubber end caps.
- 3.3 FIRESTOPPING LOCATIONS:
- A. Preparation:
1. Coordination: Coordinate the work with other trades. Firestopping materials at penetrations of insulated pipes and ducts can be applied after insulation is in place. If insulation is composed of combustible material, the thickness of firestopping materials must be equivalent to that of the insulation. If the insulation is composed of non-combustible material, it may be considered as part of the penetrating item.

2. Surface Preparation: Surface Preparation to be in contact with firestopping materials shall be free of dirt, grease, oil, loose material or other substances that may affect proper fitting or the required fire resistance.
- B. Cleaning: After completion of firestopping work in any area, equipment shall be reviewed and walls, ceilings and all other surfaces not to receive firestopping shall be cleaned of deposits of firestop materials.
- C. Inspection: The architect may select and the Owner will pay an independent testing laboratory to examine firestopped areas to ensure proper installation prior to concealing or enclosing the firestopped areas.

END OF SECTION 26 05 29

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section and all subsequent Division 26 sections.

1.2 SUMMARY:

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in sections of Division 1 through 23.

1.3 ACCESSIBILITY:

- A. Install equipment and materials to provide required code clearances and access for servicing and maintenance. Coordinate the final location with piping, ducts, and equipment of other trades to insure proper access for all trades. Coordinate locations of concealed equipment, disconnects, and boxes with access panels and doors. Allow ample space for removal of parts, fuses, lamps, etc. that require replacement or servicing.
- B. Extend all conduits so that junction and pull boxes are in accessible locations.
- C. Install access panel or doors where equipment or boxes are concealed behind finished surfaces.

1.4 ROUGH-IN:

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 23 for rough-in requirements.

1.5 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Electrical installations, inspections, and testing shall meet, at a minimum, the versions of the following in effect at the date of these contract documents except where otherwise specified:

1. Underwriters Laboratories (UL)
2. Federal and State Regulations
3. OSHA
4. NFPA
5. NEMA
6. IEEE
7. ANSI
8. NESG
9. CBM
10. NECA
11. ICEA
12. NETA

- B. All material used on this project shall be UL listed and labeled and be acceptable to the authority having jurisdiction as suitable for the use intended.

- C. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.
- 1.6 PERMITS AND FEES:
- A. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.
- 1.7 ELECTRICAL INSTALLATIONS:
- A. Drawings are diagrammatic in character and do not necessarily indicate every required conduit, box, fitting, etc.
 - B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both.
 - C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.
 - D. Before any work is begun, determine that equipment will properly fit the space and that conduit can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.
 - E. Verify all dimensions by field measurements.
 - F. Arrange for chases, slots, and openings in other building components to accommodate electrical installations.
 - G. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - H. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring an access path for positioning prior to closing-in the building or space.
 - I. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
 - J. Where mounting heights are not detailed or dimensioned, install electrical conduits, boxes, and overhead equipment to provide the maximum headroom possible. In general, keep installations tight to structure.
 - K. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting and removal with minimum of interference with other installations.
- 1.8 CUTTING AND PATCHING:
- A. This Article specifies the cutting and patching of electrical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.
 - B. Refer to the Division 1 Section covering cutting and patching for general requirements.

- C. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
 - D. When coring is required or identified, an x-ray of the area is to be taken prior to the performance of the work operation. X-ray work requires an MOP and protection.
 - E. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.
 - F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
 - G. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work;
 - 2. Remove and replace defective Work;
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents;
 - 4. Remove samples of installed Work as specified for testing;
 - 5. Install equipment and materials in existing structures;
 - 6. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
 - H. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to removal of conductors, conduit, luminaires, boxes, devices and other electrical items made obsolete by the new Work.
 - I. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 - J. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 - K. Locate identify, and protect mechanical and electrical services passing through remodel or demolition area and serving other areas required to be maintained operational.
- 1.9 TEMPORARY FACILITIES:
- A. Light, Heat, Power, Etc.
 - 1. Responsibility for providing temporary electricity, heat and other facilities shall be as identified in these specifications, as shown on the drawings and as specified in Division 1.
 - B. Building distribution equipment and devices (existing or new) shall not be used without written permission of the Owner. If used for temporary power, the equipment shall be properly maintained and any damage resulting from use shall be repaired by the Contractor. The guarantee period for new equipment shall not begin until the equipment is turned over to the Owner.

1.10 ELECTRICAL SUBMITTALS:

- A. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 Section covering shop drawings, product data, and samples for submittal definitions, requirements, and procedures.
- B. The manufacturer's material or equipment listed first in the specifications or on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the first names, the cost of any changes in construction required by their use shall be borne by this Contractor.
- C. All equipment shall conform to the State and/or local Energy Conservation Standards.
- D. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Each submittal shall be reviewed for general conformance with contract requirements and stamped by the respective contractor prior to submittal to the Architect/Engineer. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed unless written prior approval is obtained by the Contractor.
- E. Before starting work, prepare and submit to the Architect/Engineer four (4) sets of all shop drawings, descriptive product data, and samples required for the project. Continue to submit four (4) sets, after each Architect/Engineer's action, until a "No Exception Taken" or "Make Correction Noted" action is received with the exception of Fire Alarm submittals which must be submitted until a "NO EXCEPTION TAKEN" action is received. The Engineer will complete an initial review and, if required, a single subsequent review of the resubmittal. If the submittal requires a third review or additional reviews, the University may withhold amount(s) necessary from Contractor's final request for Payment to reimburse the Engineer at their standard hourly rates. Submittals shall include the following specified materials and, in addition, any materials not listed below but which are specified in the individual sections of Division 16 which follow.
 - 1. Lamps
 - 2. Supporting devices
- F. Mark submittals with designations as shown on the drawings and identify as required by Specification Sections.
- G. All electrical submittals shall be assembled into a single package.
 - 1. Submittals shall be provided in expandable, three-post, hard back binders.
 - 2. Each submittal shall be tabbed by the electrical specification section it is specified in.
 - 3. An index shall be provided which includes:
 - a. Product
 - b. Plan Code (if applicable)
 - c. Specification Section
 - d. Manufacturer and Model Number
- H. Submittals shall be provided for review within four (4) working weeks from award of contract to successful bidder.

1.11 PRODUCT OPTIONS AND SUBSTITUTIONS:

- A. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.
- B. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture.

1.12 PRODUCT LISTING:

- A. Prepare a list of major electrical equipment and materials for the project. A sample schedule is included at the end of this Section to complete this requirement.
- B. Provide a product listing within one (1) week from award of contract to successful bidder.
- C. Submit this listing as a part of the submittal requirement specified in the Division 1 Section on Products and Substitutions.
- D. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, sheet metal, steel bar stock, welding rods, solder, fasteners and similar items used in Work, except as otherwise indicated.
- E. Conduit and Fittings: All conduits and fittings installed exposed within the same room or immediate area shall be of the same manufacturer.
- F. Provide products which are compatible within systems and other connected items.

1.13 DELIVERY, STORAGE AND HANDLING:

- A. Refer to the Division 1, Sections on Transportation and Handling and Storage and Protection.
- B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage and weather.
- D. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.14 RECORD DOCUMENTS:

- A. Refer to the Division 1 Section on Project Closeout or Project Record Documents for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment,

dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices, and any other relevant deviations from the Contract Documents.

- C. During construction, the contractor shall maintain at the job site a set of updated construction documents for the singular purpose of recording the above information. All record drawings shall be completed in erasable pencil. These changes shall be updated weekly.
 - D. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme.
 - 1. Red shall indicate new items, deviations and routing.
 - 2. Green shall indicated items removed or deleted.
 - 3. Blue shall be used for relevant notes and descriptions.
 - E. The Contractor shall have available at the job site current information on the following at all times:
 - 1. Addenda
 - 2. Change Orders
 - 3. Submittals
 - 4. Inspection Reports
 - 5. Test Results
 - 6. Outage Information and Requests.
 - F. At the completion of the project, submit these documents to the Architect/Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the Architect/Engineer.
- 1.15 OPERATION AND MAINTENANCE DATA:
- A. Refer to the Division 1 Section on project closeout or operation and maintenance data for procedures and requirements for preparation and submittal of maintenance manuals.
 - B. In addition to the information required by Division 1 for Maintenance Data, include the following information:
 - 1. Complete list of parts and wiring diagrams.
 - 2. Names, addresses and telephone numbers of the Contractor, Sub-contractors and local company responsible for maintenance of each system or piece of equipment.
 - 3. All information shall be permanently bound in a 3-ring binder. The job name and address and contractor's name and address shall be placed on the cover and spine of each binder in a permanent manner. Dymo-tape is not acceptable.
 - 4. Copies of all test reports shall be included in the manuals.
 - 5. Provide manuals with dividers for major sections and special equipment. Mark neatly in ink the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.
 - C. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, is provided and the manual is reviewed by the Architect/Engineer.

1.16 TESTING:

- A. Submit test reports as outlined in Division 1 Sections on Quality Control Services and other sections of this Division.
- B. Testing as required by these specifications shall pertain to all equipment, wiring, devices, etc. installed under this contract and being reused.
- C. General Scope:
 - 1. The Contractor shall hire an independent testing agent to conduct operating and acceptance tests on new electrical system components and all existing devices which are impacted by the project.
 - 2. The Testing agent shall furnish all equipment, instruments and personnel required to conduct tests.

1.17 DEMOLITION/REMODEL WORK:

- A. Refer to Division 1 Section on Summary of work for requirements on working in Owner-occupied areas of the existing building and Division 2 section on selective demolition. The following are additions and modifications.
- B. The project involves renovation and remodel of the existing building. On the drawings, work may be denoted by showing items as bold or light line weight and certain renovation symbols are used. These indications and symbols are amplified as follows:

- 1. Bold Print (when used): Work included in this contract is denoted in bold print or line weight.
- 2. Light Print (when used): Work shown lightly indicates existing conditions to remain.

R = Existing items to be removed. Contractor shall remove the existing item and the associated existing wiring. Where the raceway serving the equipment is accessible (via removal of suspended ceiling, crawl space, etc.) the raceway shall also be removed. Where the removal of a raceway leaves visible evidence on an existing surface which is not being repaired or replaced by the General Contractor, this contractor shall repair the surface. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank coverplate installed. Where the concealed raceway is uncovered by demolition performed by the General Contractor, the raceway shall be removed (or extended to new location if appropriate).

E = Existing item to remain in place. Contractor shall perform the following function based upon the item to remain:

- Luminaires - Leave in place.
- Switches - Maintain circuit continuity.
- Receptacle - Remove devices if required for new work and reinstall.
- Clock - Clean and reinstall.

ER = Existing item to remain in place; replace device. Contractor shall perform the following function based upon the item to remain:

- Luminaires - Clean and install new lamps.
- Switches - Remove and replace with new in existing box.
- Receptacles - Remove and replace with new in existing box.

Clock - Clean and replace.

RL =Existing item to be relocated. Contractor shall remove the existing item, and store in a safe place. The existing item shall be relocated to the new position as called for on the drawings. At Contractor's option, the existing wiring may be extended, or new wiring may be run from the source. Based upon the item to be relocated, the Contractor shall perform the following function:

Luminaires - Clean and install new lamps.
Switches - Replace.
Receptacles - Replace.
Clocks - Clean and relocate.

- C. Existing equipment that is removed and not scheduled to be reused shall remain the property of the Owner and be delivered for disposition unless specifically indicated otherwise and shall be stored in a location designated by the Owner. Items which are removed and not wanted by the Owner shall become the property of the Contractor and shall be removed from the site.
- D. Existing equipment that is removed and is to be reused shall be cleaned, serviced and operable before being reinstalled.
- E. Where remodeling interferes with existing circuits and equipment which are not to be removed, such circuits and equipment shall be reworked and relocated as required to complete the project.
- F. The Contractor shall remove all distribution equipment, conductors, etc., which are indicated to be removed or which must be removed to accommodate demolition. Equipment to be removed may require reworking conduit and wiring in order to maintain service to other equipment.
- G. Where remodeling interferes with circuits serving areas outside of the project or phase limits or which are remodeled in later phases of the project, circuits shall be reworked or temporary circuits provided as required.
- H. Existing equipment and circuiting shown are based on field surveys and/or Owner furnished drawings. The Contractor shall verify conditions as they exist with necessary adjustments being made to the drawing information.
- I. Coordinate the routing of all conduits with the existing mechanical and plumbing systems in order to avoid conflicts with ducts, pipes, etc. Where existing electrical boxes, conduit, or equipment interfere with installation of new ducts, plumbing, walls, soffits, luminaires, outlets, etc., the Contractor shall resolve the conflict with the appropriate trade.
- J. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated on the drawings or allowed under the appropriate section of the specifications.
- K. Electrical Outages: Electrical outages must be held to a minimum. The Contractor shall submit a Method of Procedure (MOP) for each outage to the Owner detailing the reasons for the outage, areas affected, sequence of procedures to accomplish work, estimated maximum length of time, the date and time of day outage will occur. The Contractor shall meet with the Owner to set a schedule and date for the outage based on the MOP. Due to the critical implications of power outages, the Owner may direct the Contractor as to the time of day or night and date an outage may take place.

1. The Contractor will be responsible for providing temporary power required for the duration of the outages. The required outages to connect and disconnect the temporary power will require a MOP as described above.
- L. PCB type ballasts may be present in existing luminaires. If PCB ballasts are discovered by the Contractor, report such occurrence to the Architect and the Electrical Engineer immediately. The Contractor shall remove and dispose of PCB type ballasts at an E.P.A. (Environmental Protection Agency) approved site in the prescribed manner acceptable to the EPA. The Contractor shall pay all fees associated with this work.
- M. If other suspected hazardous material, in any form, is discovered by this Contractor in the process of his work, he shall report such occurrence to the Architect immediately. The Engineer will determine the action to be taken. Hazardous material removed is not a part of the work to be done under this Division.
- N. Contractor is responsible for sending removed lamps to be recycled. The Contractor should ensure the recycling agency meets RCRA and CERCLA regulations. Provide certificate of compliance in O&M Manuals.

1.18 WARRANTIES:

- A. Refer to the Division 1 Section on Warranties and Bonds for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In no case shall the warranty for the total electrical system be less than one year from date of acceptance by the Owner.
- B. Compile and assemble the warranties specified in Division 26, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item. Information to include product or equipment description, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.19 CLEANING:

- A. Refer to the Division 1 Section on project closeout or final cleaning for general requirements for final cleaning.
- B. Clean all luminaires, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

1.20 PROJECT CLOSEOUT:

- A. The contractor shall be responsible for providing the items listed on the checklist prior to final observation. Required test reports shall be included in the O & M manuals. (Checklist is located at the end of this section.)
- B. Punch Lists:
 1. Final payment will not be authorized until all items on the final punch list have been completed, and routine maintenance procedure and spare parts have been received.
- C. Operation and Maintenance Manuals:

1. Compile a complete list of product data and shop drawings, acceptance tests, warranties, certificates, sub-contractor and supplier information (i.e. name, address, and phone no.).

D. Guarantees and Warranties:

1. Furnish to the Owner a formal warranty covering the electrical system installed under this contract, to be free from defective materials and workmanship for a period of one year after date of acceptance of installation by Owner. During this period provide all labor and new materials required to repair or replace all defects to the satisfaction of the Owner at no cost to Owner.

1.21 SPECIAL ELECTRICAL PROVISIONS:

A. Bidding Requirements:

1. The bidder shall give evidence of being able to be bonded to (1-1/2 times job value). A letter shall be provided by the bonding agency assuring capability of bonding this level and associated rates.
2. The successful firm shall be capable of starting work immediately upon receipt of contract award and have the resources to complete the total project in accordance with the general contractor's construction schedule. (Allowance will be made for material delays caused by problems outside of contractor's control, with proper documentation.)

B. Qualification Requirements:

1. Contractors bidding this project must complete AIA Document A305-1986 "Contractor's Qualification Statement" and submit it with their proposal for information purposes.
2. In addition to the information requested in Item 1, the Contractor must provide a statement(s) indicating they meet the following minimum requirements.
 - a. List a minimum of two projects completed in the last five years which were similar in size (or larger), complexity and type. For each project list:
 - 1) Name and location of project.
 - 2) Name, address and phone number of client/owner and owner's representative.
 - 3) Contract type (prime or subcontract) and contract value (or subcontract value).
 - 4) Year in which work was performed.
 - b. If required, list two projects on which the contractor as the prime Contractor (may be the same projects listed in paragraph (a), if applicable).
 - c. The firm and its operating officers (above the level of Project Manager) shall have been involved in Electrical Contracting for at least five years.
 - d. List project values (or subcontract values, if applicable) which total at least five times job value of electrical work in the last five years completed by the firm or its operating officers.

C. General Requirements:

1. The successful firm shall provide a project supervisor of proven experience, and be willing to leave him (or her) on the project for the duration of the project, unless acceptable alternative arrangements are made with the University.
2. The successful firm must have a business office which is staffed during normal working hours (8:00-5:00 Monday through Friday).
3. The project manager of the successful firm shall have paging capability during normal working hours.

D. Craftsman Regulations:

1. Contractors shall include no more than one indentured apprentice per journeyman electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.
2. Helpers may be assigned to the project as required to do laboring type tasks, but may not do any installation type electrical work.

1.22 CONSTRUCTION REQUIREMENTS:

A. The contractor shall maintain and have available at the jobsite current information on the following at all times:

1. Construction Plans and Specifications
2. Addenda
3. Change Orders
4. Submittals
5. Inspection Reports
6. Test Results
7. Outage Information and Requests
8. Record Drawings (showing all changes)

Division 26

SPEC SECTION	ITEM	REQUIREMENTS						
		REPORT/ DATA		TEST/ REPORT	FACTORY REP SUPER-VISION AT SITE	TRAINING REQD AT SITE	EXTRA MATERIAL	O&M'S
		SHOP DWG.	LISTING PROD. DATA					
26 05 00	CONTRACTOR/EQUIPMENT WARRANTIES							X
	O&M MANUALS	X	X				X	X

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 SUBMITTALS:

- A. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- B. Shop drawings indicating details of fabricated products and materials.
- C. Engineered Design consisting of details and engineering analysis for supports for the following items:
 - 1. Suspended transformers
 - 2. Cable trays
 - 3. Trapeze hangers for multiple conduit runs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit
 - b. B-Line Systems, Inc.
 - c. GS Metals Corp.
 - d. Unistrut Diversified Products
 - 2. Conduit Sealing Bushings:
 - a. O-Z/Gedney
 - b. Cooper Industries, Inc.
 - c. GS Metals Corp.
 - d. Killark Electric Mfg. Co.
 - e. Madison Equipment Co.
 - f. Raco, Inc.
 - g. Spring City Electrical Mfg. Co.
 - h. Thomas & Betts Corp.

2.2 COATINGS:

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES:

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
 - 3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 12-gage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.
- F. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
 - 1. One-Hole Conduit Straps: For supporting 3/4" and smaller rigid metal conduit; galvanized steel.
 - 2. Two-Hole Conduit Straps: For supporting 1" and larger rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.

2.4 FABRICATED SUPPORTING DEVICES:

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
 - 3-inch and smaller: 20-gage.
 - 4-inch to 6-inch: 16-gage.
 - over 6-inch: 14-gage.

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. EMT, IMC, or Rigid Conduit.

2.5 FIRE SEALS:

- A. Material: Firestopping material shall be asbestos free, 100% intumescent, have code approval under BOCA, ICBO, SSBC, NFPA 101, NFPA 70, and be capable of maintaining an effective barrier against flame and gases in compliance with the following requirements.
- B. Flame Spread: 25 or less, ASTM E84
- C. Fire Resistance and Hose Stream Tests: Firestopping materials shall be rated "F" and "T" in accordance with ASTM E 814 or UL 1479. Rating periods shall conform to the following:

(F)	3	(T)	3	Time-rated floor or wall assemblies.
(F)	3	(T)	3	Openings between floor slabs and curtain wall.
- D. Manufacturers: Subject to compliance with requirements, provide fire seals of the following:
 1. 3M Company
 2. Tremco

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
 1. Conform to manufacturer's recommendations for selection and installation of supports.
 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 4. Support parallel runs of horizontal raceways together on trapeze-type hangers. Use 3/8" diameter or larger threaded steel rods for support.
 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing. For hanger rods supporting 1-1/2" or larger conduits provide 3/8" minimum threaded steel rods with pipe hangers.

6. Space supports for raceways in accordance with NEC. When there are 4 or more 2" conduits in a trapeze, supports shall be spaced 5' O.C.
 7. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
 8. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom nut.
- D. Miscellaneous Supports: Support miscellaneous electrical components separately and as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- E. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- F. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws, where authorized by the Owner and structural engineer. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 - a. Anchoring methods as follows:
 - 1) Solid Masonry: Lead expansion anchors or preset inserts.
 - 2) Concrete Surfaces: Lead expansion or self-drilling anchors.
- 3.2 PERSONNEL PROTECTION:
- A. Where U-channel systems, angles, brackets or other standard structural metal shapes are readily accessible and exposed to personnel, provide plastic or rubber end caps.
 - B. Where threaded rod supports are readily accessible and exposed to personnel, provide plastic or rubber end caps.
- 3.3 FIRESTOPPING LOCATIONS:
- A. Preparation:
1. Coordination: Coordinate the work with other trades. Firestopping materials at penetrations of insulated pipes and ducts can be applied after insulation is in place. If insulation is composed of combustible material, the thickness of firestopping materials must be equivalent to that of the insulation. If the insulation is composed of non-combustible material, it may be considered as part of the penetrating item.

2. Surface Preparation: Surface Preparation to be in contact with firestopping materials shall be free of dirt, grease, oil, loose material or other substances that may affect proper fitting or the required fire resistance.
- B. Cleaning: After completion of firestopping work in any area, equipment shall be reviewed and walls, ceilings and all other surfaces not to receive firestopping shall be cleaned of deposits of firestop materials.
 - C. Inspection: The architect may select and the Owner will pay an independent testing laboratory to examine firestopped areas to ensure proper installation prior to concealing or enclosing the firestopped areas.

END OF SECTION 26 05 29