PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this Section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. Provide all labor, materials and equipment required to complete the mechanical site utility work of the Contract Documents. Verify all existing utilities and exact locations prior to installation of new piping and provide all necessary trim and fittings for required connections. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing the following:
1. Chilled water piping.
2. Steam supply piping.
3. Steam condensate return piping.
4. Piping accessories.
5. Valves and valve boxes.
6. Expansion compensation.
7. Thrust blocks.
8. Excavation, trenching and backfill.
9. Cathodic protection for buried carbon steel piping.
10. Cleaning and testing of piping.
11. Connection of site utility services to building piping system of buildings, to existing site utilities and to site utilities specified under other divisions.

B. Provide complete design, hardware, installation, maintenance, and repair requirements for the direct bury piping system.

C. A complete, underground piping system including carrier piping, pipe supports, insulation, air/water-tight outer protective casing, anchors, corrosion protection, casing drain-connections, casing vent connections, and accessories to a point at least 6 inches inside the buildings

D. Performance of each piping systems shall be based on heat transfer calculation for the longest underground path at full design capacity. Heat transfer calculations shall be provided by pipe system manufacturer for each service starting with the point of supply where the pipe enters the underground system to the most remote location where the pipes transitions into a building. Calculations shall be based on fluid flows at full design capacity. Heat transfer calculations for above grade piping are not included in the section. Insulation thickness shall be based on maximum allowable heat transfer. Return water insulation thickness shall match supply water thickness. For each system the maximum allowable temperature rise or drop shall be limited to the following:
1. Chilled water supply: 2°F rise from design based on 70°F ground temperature.
2. Steam supply: 5°F drop from design based on 55°F ground temperature.
3. Steam condensate: 2°F drop from design based on 55°F ground temperature.

1.3 RELATED WORK IN OTHER SECTIONS

A. Coordinate with site work and civil engineering design for trench excavation and backfill, paving and cast-in-place concrete.

B. Section 230500: Basic HVAC Materials and Methods

C. Section 232113: HVAC Piping, Valves and Specialties

D. Section 230700: Mechanical Insulation

E. Section 232123: Pumps and Hydronic Specialties

F. Section 264200: Cathodic Protection

1.4 TRENCHING, BACKFILLING, AND COMPACTION

A. Provide trenching, backfilling, and compaction for the Work of this Section.

B. Trenching, backfilling, and compaction shall comply with requirements referenced in Section 230500 and relevant Architectural specifications, in addition to requirements specified in this Section.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of piping system, boxes and accessories.

B. Shop Drawings: Submit shop drawings indicating underground piping installation showing all fittings with inverts. Indicate all footings and grade beams
   1. Complete descriptions and drawings of design of system and materials of construction including sizes, types, locations, component parts, assembly, carrier pipes, casing, anchors, pipe guides, pipe supports, expansion loops, and building wall and floor penetrations, end seals, leak plates, field installation instructions, design of the transition points to aboveground systems.
   2. Manufacturer’s data sheets on coatings, carrier pipe and insulation.
   3. Expansion Bends:
      a. Locations, sizes, types, movements.
      b. Anchor locations, design, forces and moments.
   4. Calculations approved and stamped by Professional Engineer demonstrating that allowable stress of piping will not be exceeded due to thermal expansion and that anchor forces and moments are not excessive. Calculations shall be performed by a finite-element, three-dimensional analysis computer program.
   5. Calculations and drawings for thrust blocks.
   6. Drawings and calculations shall have professional engineer's stamp.
   7. Heat transfer calculations to validate insulation thickness per system.
   8. Type and details of the cathodic protection system including dielectric gaskets. Design life calculations for cathodic protection system. Coordinate with Div 26.

C. Maintenance Data: Submit maintenance data and replacement material lists. Include this data in maintenance manual.

D. Product Samples: Provide one 12" long sample of each proposed type of pipe.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components - remove from project site.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
2. Replacement parts shall be readily available and stocked in the USA.
3. For all Grade B (ASTM A53 carbon steel piping specified below grade provide a mill report with production identification numbers for piping submitted to permit tracking of pipe by mill and production lot.
4. The pre-engineered direct-buried systems shall conform to specification requirements and shall be manufactured by a company which specializes in these systems, and which has been in the business in excess of five years.
5. The installation of each direct-buried systems shall performed by a contracting firm with documented experience in excess of five years.
6. Manufacturers of assemblies of products, which include components made by others, shall assume complete responsibility for final assembled unit.
7. Certification that system manufacturer regularly and currently manufactures direct-buried systems, and that the designs of the system and equipment to be provided for this project conform to specification requirements. This certification shall be an original signed by a principal officer of the manufacturer.
8. Manufacturer’s quality assurance plan for fabrication, delivery, storage, installation and testing of system. Certificate of Qualification from system manufacturer that his field representative regularly performs the specified duties in relation to monitoring the installation of the system, that he is technically qualified and experienced in the installation of the system and is authorized by the supplier to make and sign the daily reports specified herein.
9. A proposed schedule of activities indicating when various items of work and tests are to be carried out and when quality control inspectors of the supplier will be present at the job site.
10. A written report from the manufacturer’s representative, at the job site, during critical stages of material delivery and construction.
11. Upon completion of the work, Certificate of Compliance, signed by the manufacturer and the contractor, certifying that the system has been installed in accordance with contract requirements.

B. Codes and Standards:
1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.

2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
3. Perform all tests required by governing authorities and as required under all Division 23 Sections. Provide written reports on all tests.
4. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

C. Product Delivery, Storage and Handling
1. Deliver products to the site in containers with manufacturer's stamp or label affixed.
2. Protection: Use all means necessary to protect materials before, during, and after installation and to protect the installed work and materials of all other trades.
3. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components - remove from project site.
4. The general arrangement and locations of piping are shown on the Drawings. Changes may be necessary to accommodate work. Should it be necessary to deviate from arrangement or location indicated in order to meet existing conditions or due to interference with work of other trades, such deviations as offsets, rises and drops in piping that may be necessary, whether shown or not, shall be made without extra expense. Accuracy of data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for assistance and guidance, and exact locations, distances, and elevations will be governed by actual site conditions.
5. All work shall be in accordance with the applicable codes listed in Division 01. No extra charge will be paid for furnishing items required by the regulations but not specified herein or shown on the Drawings. Should there be any direct conflict between the Drawings and/or Specifications and the above rules and regulations, the rules and regulations shall take precedence.
6. All work shall be completely coordinated, and all lines, grades, slopes and vertical and horizontal locations of pipes shall be exactly determined in the field and cleared with the Owner's Representative before the installation of these items is begun. No extra compensation shall be made for failure to observe this clause.
7. The Drawings and Specifications do not undertake to list every item that will be installed. When an item is necessary for the satisfactory operation of the system, it shall be furnished without extra cost. Work called for in the Specifications, but not on the Drawings, or vice versa, shall be done as though required by both. Lack of specific mention of any work necessary for proper completion of the work in the Specifications and/or Drawings, shall not lessen the Contractor's responsibility.
8. Pipe spaces provided in the design shall be utilized and the work shall be kept within the spaces established on the Drawings.
9. Manufacturers' directions shall be followed in all cases where manufacturers of articles used in this Contract furnish directions covering points not shown on the Drawings or specified herein. Manufacturers' directions do not take precedence over the Drawings and Specifications. Where manufacturers' directions are in conflict with the Drawings and Specifications, submit these conflicts to the Engineer and receive clarification before installing the work.
10. Do not permit or cause any work to be covered or enclosed until it has been inspected, tested, and approved. Should any of the work be enclosed or

covered before inspection and test, Contractor shall, at his/her own expense, uncover the work; and, after it has been inspected, tested and approved, make all repairs with such materials as may be required. Restore all work to its original and proper condition.

11. Be responsible for damage to any of this work before acceptance. Securely cover all openings, both before and after setting into place, to prevent obstructions in the pipes and breakage.
12. Repair all damage to the premises occasioned by the work. All damage to any part of the premises caused by leaks or breaks in the pipe installed under this Section of the work for a period of one (1) year after date of final acceptance of the work, shall be repaired
13. Obtain Owner's Representative's approval prior to rerouting of existing services. Refer to Division 01 sections for alterations, shutdown and temporary construction for existing services.

D. Qualifications of Welders: Welders performing work under this Contract shall be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators". Installation shall conform to ANSI 31.1 "Power Piping". Welders shall be tested and certified for all positions.

PART 2 - PRODUCTS

2.1 DIRECT BURIED PIPING

A. Chilled Water Piping

a. Carrier pipe: Pipe shall be manufactured from a high density polyethylene (HDPE) conforming to ASTM D3350 and D2837 with SDR wall thickness based on design temperature and pressure requirements. Select wall thickness and diameters for minimum pressure drop and maximize service life based on manufacturer selection criteria.
b. Fittings and joints using butt-fusion as applicable for the fitting or joint type. Fusion-weld tooling, welding machines, and electrofusion devices shall be specified by the pipe and fittings manufacturer.
c. Insulation: Polyurethane foam with K-factor=0.13, density=2 pcf, closed cell, filling space between carrier pipe and jacketing (minimum). Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.
d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248 and D3350, Type III, Category 5, Class C and Grade P23/P34. Minimum thickness of 100 mils.
e. Warranty: Minimum 10 years.

2. Plastic (Polypropylene) Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Rovanco or approved equal.

a. Carrier pipe: Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. All pipes shall be made in a three layer extrusion process. Piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipes shall comply with the rated pressure

requirements of ASTM F 2389 or CSA B137.11. Select wall thickness and diameters for minimum pressure drop and maximize service life based on manufacturer selection criteria. Carrier pipe manufactured by Aquatherm Greenpipe/Climatherm, or approved equal.

b. Fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. Fusion-weld tooling, welding machines, and electrofusion devices shall be specified by the pipe and fittings manufacturer.

c. Insulation: Polyurethane foam with K-factor=0.13, density=2 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.

d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248 and D3350, Type III, Category 5, Class C and Grade P23/P34. Minimum thickness of 100 mils. No FRP overwrap or sprayed jacketing will be allowed.

e. Fittings and joint closures shall consist of polyurethane foam with PE cover or sleeve and pressure sensitive tape.

f. Warranty: Minimum 10 years.

3. Copper Pipe: Preinsulated pipe with jacket. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative.Pipe system shall be manufactured by Thermacor Copper-Therm, Perma-Pipe, Rovanco or equal.

a. Carrier pipe. Copper ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure.

b. Fittings: Factory fabricated and insulated with polyurethane foam and one piece molded Polyethylene cover.

c. Insulation: Polyurethane foam with K-factor=0.13, density=2 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.

d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils. No FRP overwrap or sprayed jacketing will be allowed.

e. Joint closures shall consist of polyurethane foam, HDPE sleeve and heat shrink sleeve.

4. Fiberglass Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Fiber-Therm 250, Perma-Pipe, Rovanco, or equal.

a. Fiberglass pipe: conforming to MIL-SPEC P28584A and P22245A. Minimum wall thickness 0.180 inches. Series 2000 Bondstrand, Smith Red Thread II filament wound fiberglass or approved equal.

b. Fittings: Bell and spigot type joined by thermosetting epoxy resin. Connection to steel pipe with flanged fittings.

c. Casing: Polyurethane insulation with jacket and heat shrink sleeves.

d. Insulation: Polyurethane foam with K-factor=0.13, density=2 pcf, closed cell, filling space between carrier pipe and jacketing.

Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.

e. Jacketing Material: Seamless polyvinylchloride (PVC) conforming to ASTM 1784 or high density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 100 mils. No FRP overwrap or sprayed jacketing will be allowed.

f. Joint closures shall consist of polyurethane foam and heat shrink sleeve.

5. Stainless Steel Pipe: Preinsulated pipe with jacket. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Ferro-Therm, Perma-Pipe, Rovanco, or equal.

a. Carrier pipe: Stainless steel 316/316L Alloy, ASTM A312, Schedule 40 or Schedule 80. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.

b. Fittings: ASTM A403. Shall be factory preinsulated.

c. Joints: Butt-weld for sizes 2-1/2” and larger. Socket-welded or butt-welded for 2” and smaller. Comply with Power Piping Code ASME/ANSI B31.1.

d. Casing: Polyurethane insulation with jacket and heat shrink sleeves.

e. Insulation: Polyurethane foam with K-factor=0.13, density=2 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inches, or larger as required to minimize heat loss in distribution system.

f. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.

g. Joint closures shall consist of polyurethane foam and heat shrink sleeve.

B. Steam Piping

1. Carbon steel pipe: Preinsulated Class “A” steel pipe system with fusion bond epoxy on outer drainable conduit with air gap and insulated jacket. The preinsulated piping manufacturer shall provide a pre-engineered and prefabricated piping system. System shall be provided with engineered cathodic protection system by manufacturer. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Class “A”, Perma-Pipe, Rovanco or equal.

a. Pipe and Fitting Material: ASTM A53 Grade B, Schedule 40 or Schedule 80 black steel. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.

b. Joints: Butt-weld for sizes 2-1/2” and larger. Socket-welded or butt-welded for 2” and smaller. Comply with Power Piping Code ASME/ANSI B31.1.

c. Conduit: 10-gauge, welded, smooth-wall black steel conforming to ASTM A-211, A-139, A-134, and A-135. Conduit shall be tested at the factory to insure air and watertight welds prior to any fabrication. Conduit closure shall be 10-gauge steel.

d. Carrier Pipe Insulation: Mineral wool or calcium silicate. Minimum thickness 1-1/2".
e. Conduit Insulation: Polyurethane foam with K-factor=0.16, density=2 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1" or larger as required to minimize heat loss in distribution system.
f. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.
g. Joint closures shall consist of polyurethane foam, HDPE sleeve and heat shrink sleeve.
h. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.

2. Carbon steel pipe: Preinsulated steel pipe system with fusion bond epoxy on outer drainable conduit with air gap and insulated jacket. The preinsulated piping manufacturer shall provide a pre-engineered and prefabricated piping system. System shall be provided with engineered cathodic protection system by manufacturer. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Duo-Therm 505, Perma-Pipe Multi Therm 500, or approved equal.
   a. Pipe and Fitting Material: ASTM A53 Grade B, Schedule 40 or Schedule 80 black steel. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.
   b. Joints: Butt-weld for sizes 2-1/2" and larger. Socket-welded or butt-welded for 2" and smaller. Comply with Power Piping Code ASME/ANSI B31.1.
   c. Conduit: 10-gauge, welded, smooth-wall black steel conforming to ASTM A-211, A-139, A-134, and A-135. Conduit shall be tested at the factory to insure air and watertight welds prior to any fabrication. Conduit closure shall be 10-gauge steel.
   d. Carrier Pipe Insulation: Mineral wool or calcium silicate. Minimum thickness 1-1/2".
   e. Conduit Insulation: Polyurethane foam with K-factor=0.16, density=2 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1" or larger as required to minimize heat loss in distribution system.
   f. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.
   g. Joint closures shall consist of polyurethane foam, HDPE sleeve and heat shrink sleeve.
   h. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.
3. Carbon steel pipe (Maximum 150 psig, 366°F): Preinsulated pipe with jacket and internal water stops. The preinsulated piping manufacturer shall provide a pre-engineered and prefabricated piping system. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the

installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative.Pipe system shall be Thermacor HT-406 or approved equal.

a. Pipe and Fitting Material: ASTM A53 Grade B, Schedule 40 or Schedule 80 black steel. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.
b. Joints: Butt-weld for sizes 2-1/2” and larger. Socket-welded or butt-welded for 2” and smaller. Comply with Power Piping Code ASME/ANSI B31.1.
c. Insulation: Polyisocyanurate foam with K-factor=0.17, density=2.4 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inch, or larger as required to minimize heat loss in distribution system.
d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.
e. Joint closures shall consist of polyurethane foam and heat shrink sleeve.
f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.

C. Steam Condensate Pressure Piping (maximum 50 psig, 210°F)

1. Carbon steel pipe: Preinsulated pipe in drainable conduit with air gap and insulated jacket. The preinsulated piping manufacturer shall provide a pre-engineered and prefabricated piping system. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative. Pipe system shall be manufactured by Thermacor Duo-Therm 505, Perma-Pipe Multi Therm 500, or equal.

a. Pipe and Fitting Material: ASTM A53 Grade B, Schedule 40 or Schedule 80 black steel. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.
b. Joints: Butt-weld for sizes 2-1/2” and larger. Socket-welded or butt-welded for 2” and smaller. Comply with Power Piping Code ASME/ANSI B31.1.
c. Conduit: 10-gauge, welded, smooth-wall black steel conforming to ASTM A-211, A-139, A-134, and A-135. Conduit shall be tested at the factory to insure air and watertight welds prior to any fabrication. Conduit closure shall be 10-gauge steel.
d. Carrier Pipe Insulation: Mineral wool or calcium silicate. Minimum thickness 1-1/2”.
e. Conduit Insulation: Polyurethane foam with K-factor=0.16, density=2 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1” or larger as required to minimize heat loss in distribution system.
f. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.
g. Joint closures shall consist of polyurethane foam and heat shrink sleeve.

h. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.

2. Carbon steel pipe: Preinsulated pipe with jacket with internal water stops. The preinsulated piping manufacturer shall provide a pre-engineered and prefabricated piping system. Engineering by the manufacturer shall include a review and recommendation of piping layout, including expansion compensation and anchoring. A stress analysis of the piping system shall be completed at the conclusion of the installation to incorporate any and all changes that may have occurred during the installation. On-site training and inspection of joint closures and installation shall be provided by factory certified representative.Pipe system shall be Thermacor HT-406 or approved equal.

a. Pipe and Fitting Material: ASTM A53 Grade B, Schedule 40 or Schedule 80 black steel. Elbows shall be long radius. Normal pressure application: 150 lb. rating. High pressure application: 300 lb. rating.

b. Joints: Butt-weld for sizes 2-1/2” and larger. Socket-welded or butt-welded for 2” and smaller. Comply with Power Piping Code ASME/ANSI B31.1.

c. Insulation: Polyisocyanurate foam with K-factor=0.17, density=2.4 pcf, closed cell, filling space between carrier pipe and jacketing. Minimum thickness shall be 1-1/2 inch, or larger as required to minimize heat loss in distribution system.

d. Jacketing Material: High density polyethylene (HDPE) conforming to ASTM D1248. Minimum thickness of 80 mils.

e. Joint closures shall consist of polyisocyanurate foam and heat shrink sleeve.

f. Leak detection system shall consist of copper wire embedded in the foam of each piece of pre-insulated pipe and fittings.

2.2 VALVES

A. Refer to Section 230500 for valves.

B. All valves shall be designed for Class 150 pipe systems, and shall open by turning the stem counterclockwise.

C. Buried Butterfly Valves: Valves shall be mechanical joint, rubber-seated butterfly valves conforming to AWWA Standard C504 Class 150B. Buried valves shall be equipped with a 2” square operating nut and shall be Henry Pratt Co. "Groundhog,” BIF "Model 56,” ITT Grinnell, or equal. Buried valves shall be bituminous coated and shall be provided with an extension stem equipped with a 2” square operating nut. Extension stem shall extend to within 18” of top of valve box.

2.3 TAPPING SLEEVE AND TAPPING VALVE

A. Cast iron mechanical joint type sleeve, sized specifically for actual O.D. and piping material, Koppel, Mueller, or Clow.

2.4 VALVE BOXES

A. Cast iron valve boxes for shutoff valves buried in ground shall be complete with bell bottoms, extension piece, top and cover. Boxes shall be suitable for the types of

valves with which they are used. All valve boxes shall have a concrete collar flush with grade.

B. Lids shall have the applicable letters embossed upon the top surface. Tagging shall match existing lids.

C. Manufacturer: Tyler, ITT Grinnell, Mueller or Kennedy.

2.5 PIPE LOCATING WIRE AND MARKER

A. Pipe Locating Wire: Bare AWG No. 10, soft drawn, single strand copper wire.

B. Provide at least six mil PVC electrical tape insulation around wire where adjacent to metal pipe, valves, and in all valve boxes.

C. Pipe marker shall be internal with locating wire color coded for use with different utility pipe systems, and marked with the utility tape every 24 inches. Provide 4 mil thick, 4"inch wide polyethylene marker.

2.6 THRUST BLOCKS

A. Provide 2,000 psi concrete thrust blocks at changes in pipe direction, changes in pipe sizes, dead-end stops and at valves.

B. Calculate area of undisturbed earth of thrust block based on 2000 psi soil and 150 psi water test pressure.

C. Concrete and reinforcing steel shall be as specified in Divisions 03 and 05. All concrete shall be Class A, unless specified otherwise.

D. Miscellaneous nuts and bolts shall be stainless steel.

2.7 ANCHORS

A. Pre-fabricated anchors shall be furnished and installed in pipe systems as required by piping system manufacturer. Anchors shall consist of steel pipe welded to pipe and conduit. The steel anchor plate shall be 1/2” thick and extend a minimum of 1-1/2” beyond the outside jacket.

2.8 RODS AND CLAMPS

A. Socket clamps shall be stainless steel, four bolt type, equipped with stainless steel socket clamp washers and nuts. Anvil Fig. 595 and 594, B-Line B3134, or equal.

B. Rods shall be stainless steel.

2.9 MECHANICAL SLEEVE SEALS

A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

B. Sleeve: To be furnished by same manufacturer of seals; schedule 40 galvanized steel pipe or Century line sleeves, with integral anchor and waterstop collar.

C. Manufacturer: Thunderline Link Seal, Metraflex Metraseal, or equal.

2.10 TEST CONNECTIONS

A. Saddles shall be of malleable or ductile iron, with neoprene gasket and ¾" N.P.T. female pipe connection, Smith Blair No. 311, Rockwell International No. 331.

B. Valves shall be 3/4” - 300# bronze globe with composition disc. NOTE: When all tests have been completed, valve and pipe nipple shall be removed from the saddle and a forged steel pipe plug shall be inserted.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Have on hand all installation manuals, brochures, and procedures for the equipment and materials concerned.
1. Follow manufacturer's instructions, where such are provided, in all cases that cover points not shown on the Drawings or specified herein.
2. Manufacturer's instructions do not take precedence over the Drawings and Specifications.
3. Where manufacturer's instructions are in conflict with the Drawings and Specifications; submit the conflicting instructions to the Owner's Representative for clarification before performing the work.
4. Use fittings to make all changes in direction and size unless otherwise shown on the Drawings.
5. Maintain factory plastic end covers on the pipe during storage. Caps shall be removed upon installation of pipe to insure cleanliness.
6. Manufacturer piping drawings for expansion and contraction.

B. Representative of System Manufacturer: This shall be a person who regularly performs the duties listed below, is certified in writing by the system manufacturer to be technically qualified and experienced in the installation of the system, and shall be authorized by the manufacturer to make and sign the daily reports specified herein. The representative shall be responsible for training and supervision of the installing workers. This is to include the following services and/or training.
1. Inspection of material delivered to site.
2. Inspection of concrete anchors.
3. Field joint closure work.
4. Repair of any coatings.
5. Holiday test of steel piping systems.
6. Installation and testing of cathodic protection systems. Coordinate with Div 26 installer and Section 264200 Cathodic Protection.
7. The slope of the system. Elevation readings shall be witnessed and recorded.

C. Protect casing coating from damage during rigging, storage and installation. Protect casing and carrier pipe ends from water intrusion during rigging and installation. Protect casing coatings from ultraviolet light (sunlight).

D. Defective Material: The Representative shall take prompt action to return to the factory damaged or defective material and shall order prompt replacement of such material.

E. Cleaning of Piping: Remove dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe “pig” before connecting pipe sections.

F. Wet Insulation: Sections of system, which have been fully or partially submerged in water, must be replaced. Moisture content of insulation shall not exceed five percent by weight.

G. Vents and Drains at Ends of System: At each casing termination (end plate) in building, plug the casing drain openings with brass plugs and extend one inch pipe size vent pipes from the casing vents to one foot above the conduit in buildings.

~~3.2 CATHODIC PROTECTION OF METAL PIPE~~

~~A. Cathodic Protection: Provide cathodic protection for steel piping/casing systems and buried exposed metal. Assume that 25 percent of the exterior of the steel casing is exposed metal. Cathodic protection systems shall have a minimum design life of 25 years and shall be designed in accordance with recommendations of NACE SP0169 (latest edition). Provide all anodes, wiring, dielectric pipe flange kits, and any additional required isolation devices, at points necessary within vaults or at building terminations. Provide test stations at grade on each section of the piping system. Isolation flanges and unions shall be rated for the carrier pipe service temperature and pressure. Coordinate with Section 264200 Cathodic Protection.~~

~~3.3~~**3.2** MECHANICAL SLEEVE SEALS

A. Install mechanical link seal(s) where piping penetrates an exterior walls or floors. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.

~~3.4~~**3.3** TRENCH, EXCAVATION AND BACKFILL

A. Conform to requirements of Division 02.

B. Install all utilities with a minimum 36” cover over the crown of the pipe.

C. Provide all necessary shoring, sheeting, pumping as part of work of this division.

D. Dig trenches straight, true to line and grade with bottoms smoothed of any rock points. Excavate 3” below grade of pipe, fittings, hubs, couplings, etc., using templates to fit outside periphery of lower third of piping.

E. Excavations for trench may be by machine or by hand with special care used around buried utilities and trees shown on Contract Drawings.

F. All excavations shall be carefully done to avoid "over-digging" and backfilling the bottom of trench before pipe is installed in the trench.

G. Before placement of pipe, a sand bed shall be prepared in the following manner:

1. Trench shall be backfilled with sand to a minimum depth of 6”.
2. Sand shall be compacted sufficiently to prevent settlement of pipe.
3. Loose sand shall be removed at mechanical joints so that the barrel of the pipe will be firmly supported on compacted sand.

H. Trench width and special instructions necessary to correctly install pipe and fittings shall be as recommended by the pipe manufacturer.

I. Special preparation shall be taken to keep the inside of the piping clean of all debris, especially sand and dirt, during installation and testing. Maintain factory covers on open ends of pipe until lowered into trench.

J. After testing and acceptance, the trench shall be backfilled with native backfill for the first 10” depth, then wetted and hand tamped, refilled with the native backfill to approximately 12” over top of pipe, wetted again and hand tamped firm. Mechanical tamping of rock-free soil shall be carefully done to achieve a minimum of 90% compaction at depth of 12” and below, and to 95% for top 12” depth.

K. Provide precast monument set flush with surface in paved area to locate branch connection.

~~3.5~~**3.4** CONCRETE

A. Conform to requirements of Division 03.

B. Install thrust blocks and anchors as per pipe manufacturer's recommendations.

C. Provide concrete thrust blocks for piping. Concrete thrust blocks shall be poured and set before pressure testing.

D. Concrete thrust blocks shall be installed at all fittings and at all changes of direction whether shown on drawing or not.

E. Thrust blocks shall be formed on the sides to establish a definite shape and limit on height and width subject to approval before ordering concrete. Make-shift and ill-fitting forms will not be accepted. Forms shall be removed before backfilling.

F. Thrust blocks shall be allowed to cure a minimum of 3 days before water pressure is applied to any part of the system and before forms are removed.

~~3.6~~**3.5** WELDED PIPING

A. Conform to welding procedures per recommendations of American Welding Society.

~~3.7~~**3.6** UNDERGROUND PIPING INSTALLATION

A. Lay piping on a bed of the specified sand, at least 6” thick, or firm undisturbed earth. Remove loose rock, clods, and debris from the trench before placing bedding sand, and before laying any pipe.
1. The pipe shall be made up with the pipe barrel bearing evenly along its full length on the sand bed on the bottom of the trench.
2. In the case of steel or other rigid joint piping, excavate holes under joints and connections for access for making up, welding, testing, and wrapping joints.

B. Thoroughly cleanout each section of pipe and fitting before lowering into the trench. Clean each pipe or fitting by swabbing-out, brushing-out, blowing-out with compressed air, washing-out with water, or by any combination of these methods necessary to remove all foreign matter.

C. If cleaned pipe sections and fittings cannot be placed in the trench without getting dirt into the open ends, tie tightly woven canvas or other type of approved cover over the ends of the pipes and fittings until they have been lowered into position in the trench. After removal of the covers in the trench, completely remove foreign matter from the pipe ends and fittings.

D. Do not lower any pipe or fitting into a trench that contains water.
   1. Pump water from wet trenches, and keep the trenches dry until the joints have been completed and the open ends of the pipes have been closed with watertight plugs or bulkheads.
   2. Whenever pipe installation is discontinued on any job for short periods or whenever work is stopped at the end of the day, close the open ends of the pipe with watertight plugs or bulkheads. Do not remove the plug or bulkhead unless the trench is dry.
   3. Keep the trench dry at all times.

E. Assemble lengths of pipe such that centerline of two pipes being joined do not form an angle exceeding 2 degrees in any plane. In addition, the angle formed in the vertical plane shall not exceed 1-1/2 degrees.

~~3.8~~**3.7** SLOPING, AIR VENTING, AND DRAINING:

A. Chilled water:
   1. Slope all piping mains to allow for drainage at low points. Slope shall not exceed 1%. Provide drain valves and hose adapters at all low points in piping inside the building or exterior concrete vaults.
   2. Connect all water branch piping to the top or side of their respective mains. All branch piping shall slope upwards towards the building riser at a maximum slope not exceeding 1%.
   3. Provide manual or automatic vents at all high points in water piping as specified elsewhere in the specifications.

B. Steam:
   1. Slope steam piping as specified and as indicated, true to line and grade, and free of traps and air pockets downward a minimum of 1”per 40 feet of run in the direction of flow and maximum 1% slope.
   2. Where horizontal piping must be reduced in size, use eccentric reducers that allow continuing a uniform pitch along the bottom of the piping (in downward pitched systems). Avoid concentric reducers in horizontal piping to avoid potential water hammer.
   3. Takeoffs from steam mains are to be taken from the top of the main preferably at a 45 degree angle.
   4. Where branch takeoffs are less than 10 feet in length, the branch line is to be pitched back 1/2 inch per 10 feet providing drip legs.

~~3.9~~**3.8** LOCATING WIRE AND MARKER TAPE

A. Pipe locating wire shall be provided for the entire length of all pressure pipelines except for metallic piping.

B. Install locating wire by strapping to the pipe or tubing with PVC tape, polyethylene backed tape, or tie locks. Test pipe locating wire with pipe locator equipment prior to final acceptance of pipeline.

C. Stub the locating wire up inside each valve box. Sufficient excess length shall be provided at terminal connections to allow continuation of locating wire to the terminal connection.

D. Wire splices shall be made with compression fittings or soldering; wrapped with Tac-Tape, Aqua-Seal; and wrapped with electrical tape. Prevent bare copper wire from contacting metallic appurtenances including, but not limited to, pipe, buried valves, or fittings.

~~3.10~~**3.9** CONNECTIONS TO EXISTING UTILITY MAINS

A. Install tapping sleeve and tapping valve with flanged designed outlet for existing pipe connection. Follow manufacturer's installation recommendations. The use of pipe freezing technology may be utilized for hot tapping existing line with prior Owner approval.

B. Under no circumstances shall existing lines or utilities be interrupted without prior approval of the Owner's Representative. Submit the request for this approval to the Owner's Representative in accordance with Division 01, and also state the maximum duration of shutdown.

C. Schedule all outages for utility tie-in work well in advance, and give written notice to the Owner's Representative in accordance with Division 01.

D. In preparation for tie-ins to existing on-site utility systems, the Owner will drain and/or blow the existing piping prior to start of tie-in work by the Contractor. In all cases, the Owner will close the appropriate valves to isolate the area of work. The Contractor shall be responsible for refilling the system including all approved chemical treatment. The Contractor shall be responsible for venting the isolated portion of the existing chilled water mains affected by the work of this project.

~~3.11~~**3.10** FLUSHING

A. The entire new piping system shall be thoroughly flushed out until reasonably clean in the opinion of the Owner's Representative.

B. All tests shall be conducted at such times as directed by and in the presence of the Owner's Representative.

~~3.12~~**3.11** PIPE TESTING

A. Chilled water, condenser water, heating water, steam and condensate piping shall be hydrostatically tested to prove watertight prior to backfilling. Provide all instruments, facilities, and labor to conduct testing and placing in operation. In addition, piping

systems with integral airtight external casings shall have the casing air tested to 15 psig with no leaks for two hours.

B. Piping shall be tested in whole or in sections. Testing under this section of the work shall be done before final connections to building piping and existing utility piping is made, with the provision that subsequent leaks, if developed, at these conditions shall be corrected under this section of the work.

C. Any part of any piping system, including all accessories, that shows failure during testing shall immediately be repaired or replaced with new materials. The system shall be completely retested after repair or replacement. This procedure shall be repeated, if necessary, until all parts of all systems withstand the specified tests. All retesting costs shall be part of the Contract.

D. Holiday testing of direct-buried steel piping and casing systems: Test entire surface of piping and casings for faults in coating, after installation in trench, and prior to backfilling. Use test method and voltage recommended by coating manufacturer. Repair any holidays found and retest. System shall not be backfilled until holidays are eliminated.

E. Pressure tests shall be witnessed by the Owner's Representative. Provide minimum 48 hour notice prior to start to each test. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. "Tolerance" shall be no pressure drop, except that due to temperature change. Inspect and test all work prior to burying or concealing. Test pressure shall be one and one-half times (1.5x) the system operating pressure or the listed test pressure below, whichever is greater. Do not exceed the maximum pressure rating of the piping.

SYSTEM	TEST MEDIUM	TEST PRESSURE	TOLERANCE – TEST PERIOD
Chilled Water	Water	100 psig	None - 8 hours
Steam	Air	200 psig	None – 8 hours
Condensate	Water	150 psig	None – 8 hours

~~3.13~~**3.12** CLOSING OF UNINSPECTED WORK

A. No work shall be covered up or enclosed until the opportunity to inspect and test same has been afforded to the Owner's Representative and the Owner's Representative has authorized the Contractor to cover or enclose the work.

B. Any work enclosed or covered in the absence of the Owner's Representative's authorization shall be uncovered. All expense to comply shall be borne by the Contractor.

END OF SECTION