

## PART 1 - GENERAL

## 1.01 SUMMARY

## A. Section Includes: Pipe and pipe fittings for the following systems:

1. Heating water piping.
2. Glycol piping.
3. Chilled water piping.
4. Equipment drains and over flows.
5. Low pressure steam piping.
6. Low pressure steam condensate piping.
7. Unions and flanges.
8. Underground pipe markers.
9. Bedding and cover materials.

## B. Related Sections:

1. Division 08 - Access Doors and Frames: Product requirements for access doors for placement by this section.
2. Division 09 - Painting and Coating: Product and execution requirements for painting specified by this section.
3. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping Piping Expansion Compensation: Product requirements for piping expansion compensation devices for placement by this section.
4. Section 23 05 23 - General-Duty Valves for HVAC Piping: Product requirements for valves for placement by this section.
5. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
6. Section 23 05 48 - Noise and Vibration Controls for HVAC Piping and Equipment: Product requirements for Noise and Vibration Isolation for placement by this section.
7. Section 23 07 00 - HVAC Insulation: Product requirements for piping insulation for placement by this section.

8. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
9. Section 23 22 16 - Steam and Condensate Piping Specialties: Product requirements for steam and condensate piping specialties for placement by this section.
10. Division 31 - Aggregates for Earthwork: Aggregate for backfill in trenches.
11. Division 31 - Excavation: Product and execution requirements for excavation and backfill required by this section.
12. Division 31 - Trenching: Execution requirements for trenching for underground piping systems.
13. Division 31 - Fill: Execution requirements for backfilling required by this section.

## 1.02 REFERENCES

### A. American Society of Mechanical Engineers:

1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Gray Iron Threaded Fittings.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
6. ASME B31.1 - Power Piping.
7. ASME B31.9 - Building Services Piping.
8. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
9. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
10. Con Edison Steam Service Rules.

### B. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM B32 - Standard Specification for Solder Metal.
6. ASTM B68 - Standard Specification for Seamless Copper Tube, Bright Annealed.
7. ASTM B68M - Standard Specification for Seamless Copper Tube, Bright Annealed (Metric).
8. ASTM B75 - Standard Specification for Seamless Copper Tube.
9. ASTM B75M - Standard Specification for Seamless Copper Tube (Metric).
10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
11. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
12. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
13. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
14. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.

C. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:

1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
2. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

### 1.03 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

- B. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes for approval, prior to fabrication or installation.
- C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.
- D. Welder certifications and welding procedures.
- E. Underground Piping Systems
  - 1. General
    - a. Pipe manufacturer shall furnish a detailed layout for the direct-buried piping. The layout shall include the following:
      - 1) Layout drawing at  $\frac{1}{4}"=1'-0"$  scale, showing size, type and location of each component used in the system including anchors, guides, building entrance and exits.
      - 2) Transition point to aboveground system and building entrance details.
      - 3) Anchor details.
      - 4) Grade and pipe elevations. Sections shall be shown on the same sheets as plan views.
    - b. Submit calculations provided by the manufacturer and sealed by a NYS registered Professional Engineer for the following:
      - 1) Heat loss calculations for the interface temperature between the foam and steel conduit.
      - 2) Pipe stress analysis in accordance with ASME B31.1.
  - 2. Specific Submittals include the following:
    - a. Piping
    - b. Fittings
    - c. Insulation
    - d. Field Joint Assemblies
    - e. Anchors
    - f. Quality Assurance Procedures for Insulation Installation

#### 1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Perform Work in accordance with IBC-NJ requirements.

## 1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three (3) years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum ten 10 years documented experience.
- C. Underground Piping
  - 1. Qualifications: The manufacturer shall have a minimum of five years' experience in the fabrication of direct-buried jacket and conduit piping systems as specified herein. The manufacturer must provide references for a minimum of 10 similar installations. The references shall include location, contact name, contact telephone number, project cost, and description of the project including direct-buried products used.
    - a. Manufacturer's Field Advisor:
      - 1) The direct-buried pipe manufacturer shall assign to the project a factory trained Field Advisor with expertise in the installation of direct-buried piping. The Field Advisor must be a full time employee of the direct-buried pipe manufacturer. A sales representative is not acceptable.
      - 2) The Field Advisor shall also be experienced in the use and installation of the product.
      - 3) The Field Advisor shall be required to:
        - a) Demonstrate the proper technique for installing a field joint assembly to the Contractor's employees. The demonstration shall include the creation of a mock-up assembly by the Field Advisor.
        - b) Attend a pre-installation conference.
        - c) Instruct the Contractor at the job site in the proper handling and installation procedures of the direct-buried piping prior to commencement of the Work.
        - d) Pre-qualify the Contractor's employees on field joint assemblies.
        - e) Immediately visit the job site if requested, to inspect the Work or to resolve questions or problems which may arise during the Work.
        - f) Make a minimum of four (4) one-day visits in addition to the pre-installation conference and creation of the mock-up assembly. Site visits shall be scheduled at the beginning of the project (completion of first field joint assembly), 5%, 20% and 50% completion to inspect the ongoing contract work.
        - g) Submit all recommendations in writing.

b. Installation:

- 1) The installer of the direct-buried piping shall have a minimum experience of three similar projects. Provide written proof of experience with the submittals, including project location, value, description of products used, contact person, and phone number. Failure to provide sufficient documentation and proof of experience shall be grounds for rejection of the Contractor's qualifications.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install underground piping when bedding is wet or frozen.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 COORDINATION

- A. Division 01 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of buried piping with trenching.
- C. Reference Section 230500 for additional requirements.

PART 2 - PRODUCTS

2.01 HEATING WATER AND GLYCOL PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 seamless, black.
  1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.

2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.
- B. Copper Tubing: ASTM B88 (ASTM B88M), Type L hard drawn for sizes 3" and smaller.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
  2. Joints: Soldered for 125 psig, brazing for operating pressure above 125 psig.

## 2.02 CHILLED WATER PIPING, BURIED

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 steel, seamless, black, insulated and enclosed with AWWA C105 10 mil polyethylene jacket.
1. Fittings: ASTM A234/A234M forged steel welding type with double layer, half-lapped 10 mil (0.25 mm) polyethylene tape.
  2. Joints: Welded.
  3. Insulation: 2" polyurethane foam.

## 2.03 CHILLED WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 steel, seamless, black.
1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
  2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.
- B. Copper Tubing: ASTM B8, Type L, hard drawn for sizes 3" and smaller.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
  2. Joints: Soldering for operating pressure 125 psig or less. Brazing for operating pressure above 125 psig.

## 2.04 COLD WATER

- A. Copper Tubing: ASTM B88, Type L, hard drawn for sizes 3" and smaller.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
  2. Joints: Lead free 95-5 Soldering.

## 2.05 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized.
1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.

2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; flanged for pipe 2-1/2 inches (65 mm) and larger.
- B. Copper Tubing: ASTM B88 (ASTM B88M), Type L, hard drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
  2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver.
- 2.06 LOW PRESSURE STEAM PIPING, BELOW GROUND (15 PSIG (103 kPa) MAXIMUM)
- A. Factory fabricated conduit type system with insulated carrier pipe, air space and outer containment pipe.
- B. Steel Carrier Pipe: ASTM A53/A53M, Schedule 40 steel, seamless, black.
1. Fittings: ASME B16.3 malleable iron Class 125, or ASTM A234/A234M forged steel Class 125.
  2. Joints: Welded.
  3. Insulation: 2" mineral wool.
- C. Steel Containment Pipe: 10 gauge black steel with 20 mil epoxy coating.
- 2.07 LOW PRESSURE STEAM CONDENSATE PIPING, BELOW GROUND
- A. Factory fabricated conduit type system with insulated carrier pipe, air space and outer containment pipe.
- B. Steel Carrier Pipe: ASTM A53/A53M, Schedule 80 seamless, black.
1. Fittings: ASME B16.3 malleable iron Class 125, or ASTM A234/A234M forged steel Class 125.
  2. Joints: Welded
  3. Insulation: 2" Mineral Wool
- C. Steel Containment Pipe: 10 gauge black steel with 20 mil epoxy coating.
- 2.08 LOW PRESSURE STEAM PIPING, ABOVE GROUND (15 PSIG (103 kPa) MAXIMUM)
- A. Steel Pipe: ASTM A53/A53M, Schedule 40 seamless, black.
1. Fittings: ASME B16.3 malleable iron Class 125, or ASTM A234/A234M forged steel Class 125.
  2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.



2.09 LOW PRESSURE STEAM HUMIDIFICATION PIPING, ABOVE GROUND (15 PSIG (103 kPa) MAXIMUM)

- A. Steel Pipe: ASTM A-312, Schedule 40, 304 stainless steel.
  - 1. Fittings: ASME A403 stainless steel Class 150.
  - 2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.

2.10 LOW PRESSURE STEAM CONDENSATE PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M, Schedule 80 seamless, black.
  - 1. Fittings: ASME B16.3 malleable iron Class 125, or ASTM A234/A234M forged steel Class 125.
  - 2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.

2.11 COMPRESSED AIR PIPING

- A. Suitable for 150 psig working pressure.
- B. Piping shall be Type "L" drawn copper tubing or ASTM B-88-66A.
- C. Fittings shall be wrought sweat fittings with 95/5 tin/antimony solder.
- D. Valves shall be 200 lb brass or bronze ball valves.

2.12 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches (50 mm) and Smaller:
  - 1. Ferrous Piping: Class 250, malleable iron, threaded.
  - 2. Copper Piping: Class 150, bronze unions with brazed joints.
  - 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches (65 mm) and Larger:
  - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
  - 2. Copper Piping: Class 150, slip-on bronze flanges.
  - 3. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene gaskets.
- C. Flanges shall be of same weight as the fittings and valves in each service category. Welding neck flanges shall be used with flanged valves, equipment, etc., on welded lines. Galvanized screwed flanges shall be used on galvanized screwed lines. Flanges shall be drilled in conformance with 150 lbs. or 300 lbs. standard and shall be faced and spot-faced. Screwed and loose flanges on brass piping shall be brass.

Laps shall be machined on front, back and edge. Screwed flanges shall have faces perpendicular to adjoining pipe.

## 2.13 PIPE FITTINGS

- A. Each pipe fitting shall have cast, stamped, or indelibly marked on it the marker's name or mark, weight, and quality of the product when such marking is required by the approved standard.
- B. Welding fittings shall be of same material and schedule as pipe to which they are welded. Welding fittings including laterals shall be approved factory reinforced to develop full working pressure of connecting piping main. Welding elbows shall be long radius pattern. Welding fittings shall be used exclusively, except as otherwise specified. Weldolets may be used for branches only where branch is two (2) or more nominal pipe sizes smaller than main or riser. All welding "lateral" fittings shall have pressure ratings equal to the pipe with which they are to be used. Welding fittings shall be of Tube-Turn or Walworth manufacture or approved equal, to conform to ASTM-A-234 specifications.
- C. Nipples shall be extra heavy shoulder type of same material as pipe, close nipples are not acceptable.

## 2.14 UNDERGROUND PIPE MARKERS

- A. Furnish materials in accordance with IBC-NJ.
- B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Specific Service Type" in large letters.

## 2.15 MISCELLANEOUS UNDERGROUND PIPING APPURTENANCES

- A. Miscellaneous Underground Appurtenances:
  - 1. General:
    - a. All miscellaneous appurtenances, including but not limited to anchor plates, end seals, and gland seals shall be designed and factory fabricated, and shall be watertight to a maximum head pressure of 7 ft. of water.
    - b. All miscellaneous appurtenances shall provide zero bubbles when tested with a soap solution during the pneumatic testing of the field joints.
    - c. Manufacturer of underground piping system shall perform and provide thermal expansion, stress calculations and design expansion loops, anchors, supports and certify, submit stamped drawings, details and calculations by a NJ State licensed PE.
  - 2. Anchors:
    - a. Anchors shall be fabricated with ½-inch thick steel plate. Plates shall extend a minimum of 3 inches beyond the outer jacket.

- b. Anchor plates shall have vent and drain holes for free air passage and conduit drainage.
  - c. All anchor plates shall be furnished with an epoxy coating. No uncoated steel shall be in contact with the soil. Each anchor plate shall be furnished with a shrink wrap seal to completely isolate the anchor plate.
  - d. Concrete thrust blocks shall be cast over anchor plates and conduits large enough for firm anchorage into undisturbed trench sidewall and/or bottom. The concrete block shall be a minimum 36 inches in length and extend a minimum 12 inches beyond at top and bottom of anchor plate.
- 3. End Seals:
  - a. All system terminal ends shall be provided with end seals. End seals shall be provided with threaded connections for drains and vents.
  - b. All end seals shall be designed to allow for complete drainage and drying of the conduit.
- 4. Wall Penetrations:
  - a. The manufacturer of the piping system shall provide a hydrostatic seal consisting of mechanical type interlocking rubber links. The links shall seal the annular space between the system jacket and the wall sleeve or core-drill opening.
- B. Pre-fabricated elbows, tees, joints and expansion loops shall be provided by the piping system manufacturer conforming to same specification as straight piping. Expansion loops shall be sized to handle required pipe movements

## 2.16 BEDDING AND COVER MATERIALS

- A. Bedding: Fill Type as specified in Division 31.
- B. Cover: Fill Type as specified in Division 31.
- C. Soil Backfill from Above Pipe to Finish Grade: Soil Type as specified in Division 31. Subsoil with no rocks over 6 inches (150 mm) in diameter, frozen earth or foreign matter.
- D. Bedding, cover and finish fills shall be approved by Architect prior to commencing the work. Submit sample as necessary.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Division 01- Administrative Requirements: Verification of existing conditions before starting work.

B. Verify excavations are to required grade, dry, and not over-excavated.

C. Verify trenches are ready to receive piping.

### 3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Clean pipes, fittings prior to installation. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. All piping shall be new, unused and shall be cleaned throughout prior to installation. Remove all rust, scale and deposits. Protect all open ends of piping from entrance of dust at all times. All exposed, uninsulated piping and accessories shall be painted.

### 3.03 CONNECTIONS

A. Copper with solder or brazing joints shall be cleaned bright and properly fluxed. Flux shall be non-corrosive as approved. Mechanical press joint fittings are not acceptable.

B. Threaded Joints:

1. Make up screw pipe with clean sharp threads and pipe joint cement used on male thread only.
2. Ream ends of pipe and clean out the pipe after cutting.
3. Use graphite paste on threads of cleanout plugs.
4. Provide sufficient number of flanges or unions to disassemble piping without breaking screwed fittings.

C. Teflon paste shall be used on screwed joints and shall be applied to the male thread only.

D. In connection to equipment, the manufacturer's recommendation as to pipe size and arrangement shall be followed. Connection to equipment shall be made to permit ready disconnection of equipment with minimum disturbance to adjoining pipe. Screwed or flanged unions shall be used at all equipment at inlet and outlet ends. Piping shall be flanged, or fitted with unions for all sections immediately adjacent to connection of equipment which may require pipe removal to aid in all large tube pulling, coil removal, cleaning etc.

- E. Assembly of the mechanical joint pipe and fittings shall be complete with a torque wrench. Torque to be applied to each bolt shall be between 60 pounds and 90 pounds. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation will not be permitted.
- F. Flange joints shall be faced true, packed and made up perfectly square and tight. Each flange joint shall be provided with suitable grade steel bolts for the specific service and with hexagon nuts. Bolts and nuts shall be dipped in a mixture of graphite and oil, just before installation.
- G. Gaskets shall have proper thickness and suitable for specific service. All gaskets shall be asbestos free. Gaskets in steam service shall meet the requirement of the utility company.
- H. Where piping is to be installed under related work by other Sections, in connection with work and equipment installed by this Trade, the piping will be installed by other Sections, this Trade shall make the final connections.
- I. Provide di-electric fittings for all connections between ferrous and non-ferrous metals.

#### 3.04 INSTALLATION - BURIED PIPING SYSTEMS

- A. Establish elevations of buried piping with not less than 4 ft of cover.
- B. Excavate pipe trench in accordance with Division 31.
- C. Install pipe to elevation as indicated on Drawings.
- D. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches (100 mm); compact to 95 percent maximum density.
- E. Install pipe on prepared bedding. Clean piping prior to installation.
- F. Route pipe in straight line.
- G. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- H. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.
- I. Install trace wire continuous over top of pipe buried 6 inches (150 mm) below finish grade, above pipe line; coordinate with Division 31. Refer to Section 23 05 53.
- J. Pipe Cover and Backfilling:
  - 1. Backfill trench in accordance with Division 31.

2. Maintain optimum moisture content of fill material to attain required compaction density.
  3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches 150 mm) compacted layers to 12 inches 300 mm) minimum cover over top of jacket. Compact to 95 percent maximum density.
  4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
  5. Do not use wheeled or tracked vehicles for tamping.
- K. Install Work in accordance with IBC-NJ.
- L. Provide thrust blocks, anchors and expansion loops to permit for expansion of piping system.
- M. The direct-buried piping shall be covered before it is transported to the site.
- N. All off-loaded materials shall be inspected for damage prior to placement in the trench. All damaged jackets and conduits shall be repaired as recommended by the manufacturer. After all repairs have been completed, provide an additional shrink seal around the damaged area independent of the manufacturer's repair. Any repairs that result in the creation of a field joint shall be repaired with a field joint assembly.
- O. The Contractor shall cover all piping with tarps after it is off-loaded. The pipe shall be covered at all times. The Contractor shall cover the pipe in the storage area, as well as any pipe that is moved to the trench locations.
- P. The system shall be installed in accordance with written instructions furnished by the manufacturer and under guidance of the manufacturer's Field Advisor.
- Q. Supply all trenching and shoring, as required to obtain the proper depth and width needed to install the system. All piping shall be placed on a permanent bedding material as specified. No temporary supports are permitted.
- R. All direct-buried piping shall be pitched to ensure all sections drain to either a manhole or a building. Low points between manholes are not permitted.
- S. Backfill the trench as specified in Division 31 and as indicated herein. Furnish and install a 6-inch layer of sand on the bottom of the trench. The sand shall be placed and tamped to provide uniform bedding for the direct-buried pipe. The trench shall be evenly backfilled in 6-inch compacted layers to a minimum height of 12 inches above the top of the gutter jacket/conduit. The remaining trench shall be backfilled in uniform layers with suitable excavated soil.
- T. All pipes in manholes shall be insulated using mineral wool covered with a metal jacket. All insulation work shall conform to the requirements of Section 23 07 00 – HVAC Insulation.

U. Drying of Annular Space:

1. The Contractor shall ensure the annular space between the carrier pipe and conduit is dry before sealing the conduit. The Contractor shall use a dry gas purge method to remove all moisture for the piping system.
2. The Contractor shall furnish all air compressors, desiccant dryers, pressure regulators, flow meters, inlet and outlet dew point meter, piping, valves, etc. as required to dry the piping.
3. The Contractor shall circulate dry, compressed air through the space to absorb any moisture. The compressed air shall have a maximum pressure of 5 psig, and a dew point less than -20°F. The Contractor shall provide dew point meters at the compressed gas inlet and outlet to the piping system.
4. The flow rate shall ensure the velocity of compressed air through the annular space is between 10 and 20 ft/sec.
5. The Contractor shall circulate the compressed air for a minimum of 48 hours. After the initial dry out period, the Contractor shall secure the compressed air for a minimum of four hours to allow the annular space to reach equilibrium. The compressed gas system shall then be started, and the inlet and outlet dew point shall be measured. The dew point at the outlet from the annular space shall 20°F or less. The process shall be repeated if the dew point at the outlet from the annular space exceeds 20°F.
6. Drying the annular space using the carrier pipe is not permitted.

V. Mock-Up Assembly:

1. For the dryable/testable/drainable pre-manufactured direct buried underground piping system; provide a field joint "mock-up assembly" at the site location.
2. Contractor and manufacturers field advisor shall demonstrate the successful completion of a mock-up field joint assembly as specified herein, to the satisfaction of the design team representative prior to receiving approval for use of a piping system. The mock-up shall be comprised of two 4-foot long sections of 13.5-inch diameter conduit complete with a 4-inch diameter welded steel carrier pipe, carrier pipe insulation, four corrugated spacers, air space, welded steel conduit, conduit insulation, and outer jacket. The field joint shall be constructed with the manufacturer's pressure testable field joint assembly finished with sleeve and a second shrink sleeve. The contractor and manufacturers field advisor shall demonstrate the welding together of the steel carrier pipe sections, installation of the carrier pipe insulation, installation of corrugated spacers, welding together of the steel conduit sections, installation of conduit insulation, installation of field joint assembly, air test of steel closure sleeve, air test of field joint assembly, sealing of test holes, and installation of second shrink sleeve.

W. Pipe Route:

1. Install the direct-buried piping as shown on the Contract Drawings.

2. Prior to any excavation work, mark-out all utilities along the installation path as shown on the drawings and be responsible for any repairs to existing utilities that are damaged by the excavation work.
3. Be aware that the stresses on the pipe for the route shown on the Contract Drawings are within allowable limits as specified in ASME B31.1. The pipe shall be installed as indicated on the drawings. Do not deviate from the pipe route for any reason other than unforeseen circumstances. Provide a stress analysis stamped by a New Jersey State Professional Engineer. Any deviations shall be submitted and approved by the Engineer before any piping is installed. Any additional materials, labor or other costs that result from the deviation for any reason other than unforeseen circumstances shall be paid for by the installer.

X. Welding:

1. Welding of all carrier pipes shall conform to the requirements as specified herein.
2. All welding of pipe joints and procedures shall be in accordance with the following:
  - a. Section IX - Welding and brazing qualifications of the ASME Boiler and Pressure Vessel Code.
  - b. American Welding Society B2.1 - Specification for Welding Procedure and Performance Qualifications.
  - c. ASME B31.1 Power Piping.
3. Prepare Certification of Welder Performance Qualification Test containing the information detailed in form QW-484 and QB-484, of ASME Section IX for all welders to be employed for fabrication. These documents shall be provided to the Engineer for approval of each welder, and shall be kept on file. Only Engineer-approved welders may weld any pipe on the project.
4. The Owner reserves the right to remove any welder from the project for any reason.
5. Parts that are to be joined by welding may be held in alignment during the welding process by the use of bars, jacks and clamps.
6. Socket weld couplings shall be used for welded line joints, where specified, in nominal pipe sizes 1-1/2 inches and smaller.
7. Piping:
  - a. Weld end preparations for field joints and for joining to supplied items shall be in accordance with Chapter V of ASME B31.1. All weld ends preparation dimensions shall be in accordance with ASME B16.25.
  - b. Base pipe material shall be prepared in accordance with the following:



- 1) The edges or surfaces of the parts to be joined by welding shall be machined and cleaned of all oil, grease, scale, rust, or other deleterious materials.
- 2) Maximum joint gap distance shall be 3/16 inch for 2 1/2 NPS pipe and larger and 1/8 inch for 2" NPS and smaller.

8. Welding Processes:

- a. Welding shall be performed by one or more of the following processes. Other processes may be permitted when the technical adequacy has been demonstrated to the satisfaction of the Owner and Engineer.
  - 1) Shielded Metal Arc (SMAW) - Only low hydrogen electrodes shall be permitted.
  - 2) Gas-Tungsten Arc (GTAW) – Non-consumable tungsten electrodes shall be AWS A5.12 Class EWTh-2. Filler metal addition shall be used with the gas-tungsten arc process.
  - 3) Gas-Metal Arc (GMAW) - The short circuiting arc deposition transfer mode shall not be used to join materials greater than 1/4" thickness. This practice may be used to deposit the root pass and additional weld passes in the root region of butt joints up to a deposited weld metal thickness of 1/4 inch.
  - 4) Flux-Cored Arc (FCAW) - Cored wire designed for operation without the use of externally supplied shielding gas (i.e., self-shielded typed) is not allowed.
- b. The following shall establish, at a minimum the quality controls that shall be incorporated with any of the above mentioned welding processes:
  - 1) Initiation points of all weld passes and weld layers shall be staggered.
  - 2) When using the shielded metal arc process, the depth of weld metal deposited in each layer shall not exceed 3/16 inch.
  - 3) Vertical position welding shall proceed uphill.
  - 4) Complete penetration and fusion shall be achieved in all regions of the weld zone.
  - 5) All slag, flux or foreign materials remaining on any bead of welding shall be removed by grinding, chipping or wire brushing before depositing the next or successive bead.
  - 6) Any cracks, slag incursions, incomplete fusion or blow holes that appear on the surface of any bead of welding shall be removed by chipping or grinding before depositing the next successive bead of welding.

9. Filler Materials:

- a. All welding filler materials, including any consumable inserts, shall comply with the requirements of ASME or AWS filler material specifications.
- b. All welding filler materials shall be stored in a clean, dry location protected from contamination.
- c. After opening of new sealed electrode containers or removal of electrodes from drying ovens, all electrodes, which are not immediately issued for use, shall be stored in holding ovens at a minimum temperature of 200°F.

Y. Visual Examination of Welds:

- 1. Visual examinations will be performed by the Contractor on 100% of all field welds to detect surface discontinuities in the completed welds. Visual examination will be performed on the final pass only. All welds, including all off-site welds will be visually inspected for cracks, contour and finish, bead reinforcement, undercutting, overlap and size of fillet welds. The Contractor will retain the services of a qualified commercial inspection or testing agency to examine the welds. Provide access to all welds for testing, and provide full cooperation with the testing agency. Include all labor and materials as required to permit the visual examination.
- 2. The visual examination will examine each weld for any defect. The visual examination will be performed in accordance with ASME B31.1, Section 136.4.2. Repair any defects noted in the visual examination at no additional cost to the Owner. All repairs will be re-examined. Welds that are shown by visual examination to have any of the following types defects are unacceptable:
  - a. Cracks - external surface.
  - b. Undercut on surface, which is greater than 1/32 deep.
  - c. Weld reinforcement greater than 5/32 inch.
  - d. Lack of fusion of surface.
  - e. Incomplete penetration (applies only when inside surface is readily accessible).
  - f. Any other linear indications greater than 3/16" long.
  - g. Surface porosity with rounded indications having dimensions greater than 3/16" or four or more rounded indications separated by 1/16" or less edge to edge in any direction. Rounded indications are indications which are circular or elliptical with their length less than three times their width.

3. The following additional visual quality examinations shall be performed:
  - a. Arc strikes shall be removed by grinding and the area examined for freedom from defects by liquid penetrate. Any crack or linear indications are unacceptable.
  - b. Grinding shall not result in a reduction in wall thickness below the minimum required by the applicable code, material specification, or design calculation.
  - c. Each weld shall be uniform in width and size throughout its full length.
  - d. Wash pass welding (re-melting cover pass to smooth weld contour) is prohibited.
  - e. Butt welds shall be full penetration.
  - f. Socket welds, depth of insertion of pipe or tube within the socket or sleeve shall be 3/8 inch minimum.
  - g. Attachment Welds: All temporary welded attachments used for erection purposes shall be removed by mechanical cutting or air-arc cutting the attachment a distance from the supporting metal surface sufficient to preclude damage, but in no case less than 1/8 inch. The remainder of the attachment shall be ground flush with the base metal surface. The ground area shall then be examined visually to ensure freedom from defects. Under no conditions are temporary attachments to be removed by hammer blows.
4. Written reports for each visual examination performed by the Contractor's testing agency will be available for review. The Owner's testing agency shall have the final word in determining the acceptability of any welds.

Z. Testing:

1. Hydrostatic Testing of Carrier Pipe:
  - a. Hydrostatically test all new piping. Tests for all new piping shall be performed in accordance with part C2.270 of Section VII of the ASME Boiler and Pressure Vessel Code, and the requirements noted in this Section of this Specification. All materials and equipment required to perform the hydrostatic test shall be furnished. All tests shall be performed successfully prior to insulation, completion of the field joint assembly and backfilling.
  - b. Sanitary water of a potable quality shall be used for hydrostatic testing. Test pressures shall be maintained in the systems for at least 30 minutes with no visible leaks or loss of pressure.
  - c. Unless otherwise specified, all piping shall be subjected to a minimum pressure of 1.5 times the system design pressure.
  - d. All tests shall be witnessed, certified and documented by the Owner's Site Representative.

- e. Any defective joints shall be repaired; their welds re-examined, and re-tested. Successfully complete a hydrostatic test of the carrier pipe prior to insulation, completion of the field joint assembly and backfilling the trench.

2. Pneumatic Testing of Conduit:

- a. The Contractor shall test all conduit field joints with 15 psig air pressure held continuously as the field joints are tested with a soap solution. Acceptable joints shall have zero bubbles.
- b. The Contractor shall successfully complete the 15 psig air test before backfilling the trench.

3. Pneumatic Testing of Outer Jacket:

- a. Test all field joints on the system with 5 psig air pressure held continuously as the field joints are tested with a soap solution. Acceptable joints shall have zero bubbles.
- b. The Contractor shall test the nearest factory joints on both sides of the field joints with a soap solution while applying 5 psig to the field joints. No factory joints shall leak during the testing of the field joints. The manufacturer shall repair any leaking factory joint as required to pass the pneumatic test.
- c. Successfully complete the 5 psig air test before backfilling the trench.

AA. Pre-Qualifying Personnel:

- 1. Pre-qualify all employees that will be installing the field joint assemblies. Pre-qualification shall be accomplished by the employee attending the Field Advisor's demonstration at the mock-up assembly, and by successfully completing three field joint assemblies. Successful completion shall be demonstrated by testing the joint per the testing criteria contained in this specification.
- 2. All qualifying tests shall be witnessed by the Owner's Site Representative and the manufacturer's Field Advisor. The field advisor shall provide written verification of acceptance for each employee. After successfully completing the three field joint assemblies, the employee will be permitted to perform the field joint assemblies for the system. Any field joint assembly installed by a non-qualified employee shall be rejected, and replaced at no additional cost to the owner.
- 3. Include all labor and materials as required for each qualifying employee to perform the three field joint assemblies necessary to qualify the employee.

BB. Cleaning:

- 1. Piping shall be clean inside and outside at time of shipment. All waste, such as metal chips and filings, welding rods and stubs, waste, rags, debris, shall be removed from the interior of each piping unit. All mill scale, rust, oil, grease, chalk, crayon, paint marks, sand and other deleterious material shall be removed from interior and exterior surfaces.

2. Thoroughly clean all new piping of all contaminants such as oil, grease, welding slag and spatter, loose mill scale, dirt, corrosion product, or any other foreign substances. Install temporary vents and drains with isolation valves on all new carrier piping to permit flushing of the pipe.
  3. Fill and flush the system a minimum of two times using potable water. Supply all labor and materials to flush the system. Potable water will be available from the facility.
- CC. The direct-buried piping system shall include all miscellaneous piping materials, including but not limited to, piping, fittings, outer jacket, conduit, insulation, field joint assemblies, pipe supports, anchors, guides, end seals, expansion loops and other components as required for the proper installation of the system.
- DD. The Contractor shall furnish all supervision, labor and materials required to accomplish the work associated with the installation of the equipment specified herein and indicated on the Contract Drawings.
- EE. Field Joint Assemblies:
1. All field joint assemblies shall be factory-supplied assemblies, and shall be air-pressure testable to ensure the integrity of the system.
  2. No field joint assembly shall be installed until the carrier pipe has completed a successful weld examination and hydrostatic test, and insulation has been installed at the joint.
  3. Field joint assemblies shall be finished with an HDPE sleeve. The field joint assembly shall be air testable.
  4. Field Joint interface temperature between the foam and conduit shall not exceed 190°F. Foam to conduit interface temperatures up to 245°F are permitted if the foam provided has a continuous operating temperature of 300°F (minimum). Documentation shall be provided showing the foam temperature rating and the heat loss calculation of the interface temperature. All calculations shall be based on a ground temperature of 40°F, and a soil conductivity of 15 Btu-in/hr-ft<sup>2</sup> -°F.
  5. After the manufacturer's field joint assembly has successfully completed a 5-psig air pressure test, the test holes shall be sealed.
  6. A second heat shrink wrap seal and/or sleeve independent of the manufacturer's field joint assembly shall be installed around the joint to completely encase the entire joint area. Overlap the manufacturer's field joint assembly by 6 inches on each end.
  7. All chemicals shall be stored at a temperature between 60°F and 85°F

### 3.05 INSTALLATION - ABOVE GROUND PIPING

- A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.

- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 00.
- G. Provide access door where valves and fittings are concealed in inaccessible spaces. Coordinate size and location of access doors with Division 08.
- H. Install non-conducting dielectric connections wherever jointing dissimilar metals. Insulate pipe joints or valves between dissimilar metals, to prevent dielectric action; use isolating flanges. Dielectric couplings are unacceptable
- I. Cap pipe and equipment outlets during construction; keep lines and inside of equipment free of foreign materials.
  - 1. Provide for expansion without warping lines, or dislocating or straining connected equipment beyond allowable stress limits.
  - 2. Install piping to clear building construction and to avoid interference with other work.
  - 3. Conceal piping.
- J. Pipe base drains from pumps to open drains; use plugged tees at 90 degree turns.
- K. Provide drain with gate valve for equipment containing water. Pipe to an open drain where such drain is within 50 feet of equipment.
- L. Water Lines:
  - 1. At each low point, provide drain nipple and a 3/4" hose bibb drain with cap or a 3/4" drain valve piped to an open drain.
  - 2. Provide air vents at high points in chilled water, process condenser water, pumped condensate and hot water heating lines.
  - 3. Pitch chilled water and hot water piping upward in direction of flow or install piping with top of pipes at same level, using eccentric reducers.
- M. Place valves and specialties so as to permit easy operation and access; pack all valves at the completion of the work before final inspection.
- N. Water coils: Provide air venting at top of coil and drainage at bottom of coil with 1/2" gate valves.
- O. Provide cold-water make-up piping between the outlets provided under the Plumbing Work and point of equipment under HVAC Work requiring same. Each

connection to be provided with a globe valve, check valve and vacuum breaker. An anti-siphon check valve, similar to that made by Bidoro Company, may be substituted for the check valve and vacuum breaker.

- P. Provide a cold water makeup tank, pump and piping for each expansion tank, fill stations and other equipment requiring same. Each connection shall be provided with a gate valve, check valve and a backflow preventer.
- Q. Vents for water systems shall be appropriately valved, 3/4" minimum, and piped over to indirect drains or to locations accessible for draining.
- R. Provide a capped hose bibb and valve at the base of all water risers to accept a hose for drainage.
- S. Provide drain piping from plenums, cooling coils with drain traps and extend drain piping to nearest floor drain or roof drain. For drain piping for gravity flow, pitch pipe down in direction of flow. Provide minimum 2-inch drain pipe from each air handling unit and air intake plenum casings.
- T. Miscellaneous drains and overflow from tanks, equipment, piping, relief valves, pumps, etc., shall be run to the nearest indirect drain and terminate in an elbow over the drain. Provide drain valves wherever required for complete drainage of piping, including the system side of all pump check valves. Drain lines shall pitch not less than 1" in 40' in direction of flow.
  - 1. Screwed couplings and shoulder nipples not exceeding 6" in length shall be of same material as pipe but of dimensions conforming to Schedule 80. Close nipples are prohibited.
- U. Vertical sections of main risers in shafts shall be constructed of pipe lengths welded together; do not use mechanical couplings or screwed fittings.
- V. Drawings indicate generally the sizes and locations of pipe lines, but the Construction Manager reserves the right to direct changes in run and details of pipe work as necessitated by site conditions. Piping to be of sizes indicated on the Drawings; size any pipe diameter not shown on the Drawings to be in proportion to the load carried at the same resistance as similar piping, or of sizes as directed by Construction Manager.
- W. Cut piping accurately to measurements established at the Construction Site and work into place without springing or forcing, properly clearing all openings, structural members and other equipment. Overhead piping to run as high as possible under structural members.
- X. Establish invert elevations, slopes for drainage to 1/4 inch minimum. Maintain gradients.
- Y. Provide glycol solution. Provide storage for solution, for drain down of system and refill.
- Z. Slope piping and arrange systems to drain at low points.
- AA. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

- BB. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- CC. Install valves in accordance with Section 23 05 23.
- DD. Install hydronic piping specialties in accordance with Section 23 21 16.
- EE. Install steam and condensate piping specialties in accordance with Section 23 22 16.
- FF. Insulate piping. Refer to Section 23 07 00.
- GG. Install pipe identification in accordance with Section 23 05 53.

### 3.06 ROUTES AND GRADES

- A. Piping shown on the drawings shall be considered as diagrammatic for clearness and may or may not, in all parts, be shown in its true position. This fact does not, in any way, relieve the Contractor from full responsibility for the proper erection of a system of piping in every aspect suitable for the work intended.
- B. Drawings indicate generally sizes and locations of pipelines, but the right is reserved to direct changes in details of pipe work as necessitated by actual conditions. Piping shall be of sizes indicated on drawings. Any pipe size not shown shall be in proportion to the load carried at the same resistance as similar piping, or of size as directed.
- C. Piping shall be accurately cut to measurement established at the construction site and shall be worked into place without springing or forcing, properly clearing openings, structural members and other equipment. Overhead piping shall be run as high as possible under structural members.
- D. Exposed piping shall be run perpendicular and/or parallel to floors, walls, etc. Piping and valves shall be grouped neatly and shall be run so as to avoid reducing headroom or passage clearance.
- E. Piping shall be concealed. Piping shall be installed so that same can be drained of all water.
- F. Water mains shall pitch upward in direction of flow.
- G. Fittings of the eccentric reducing type shall be used where change of size occurs in horizontal piping for proper drainage or venting.
- H. Steel pipe bends shall be made of open hearth, low carbon steel, leaving a smooth uniform exterior and interior finish. Pipe bends shall be made with seamless steel pipe, having a minimum radius of not less than 5 pipe diameters.
- I. Long-turn fittings shall be used wherever conditions permit.
- J. Piping above grade shall be installed so as to be readily accessible for operation, maintenance, repair or replacement.



- K. Extra heavy nipples for short shoulder type only. Close nipples are prohibited.
- L. Under all conditions, and unless otherwise shown or directed, branches from any steam main shall be taken from the top of the pipe, and all valve stems shall stand upright or at an angle above the center line of the pipe and not handle down.
- M. No piping or work of any kind shall be concealed or covered until all required tests have been satisfactorily completed and the work has been approved by the Architect and all authorities having jurisdiction.
- N. Steam condensate return piping and cooling condensate drain piping shall pitch continuously down in direction of flow.

### 3.07 INSTALLATION - HEATING AND COOLING PIPING SYSTEMS

- A. Install engine exhaust piping per ASME B31.9.
- B. Install heating water, chilled water and glycol water piping in accordance with ASME B31.9.
- C. Install steam supply and steam condensate return piping in accordance with ASME B31.9.

### 3.08 FIELD QUALITY CONTROL

- A. Division 01 - Quality Requirements and Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test heating water piping system, glycol piping system, chilled water piping system and condenser water piping system in accordance with ASME B31.9.
- C. Test low pressure steam supply piping, low pressure steam condensate piping, medium and high pressure steam supply piping and medium and high pressure steam condensate piping in accordance with ASME B31.9.

### 3.09 CLEANING

- A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.
- B. After completion, fill, clean, and treat heating water piping system, glycol piping system, chilled water piping system, condenser water piping system. Refer to Section 23 25 00.
- C. After completion, clean, and treat low pressure steam supply piping, low pressure steam condensate piping, medium and high pressure steam supply piping, medium and high pressure steam condensate piping. Refer to Section 23 25 00.

### 3.10 TESTING OF PIPING SYSTEMS

- A. Pay fees for tests and inspections; furnish labor, materials, equipment and any instruments required for the tests.
- B. Perform tests and comply with requirements of the inspecting agency to obtain approval for Owner's use of systems and equipment, as a part of the Contract Work.
- C. Replace or repair equipment damaged during testing.
- D. Give advance notice of tests to Authorities Having Jurisdiction.
- E. Replace any materials which fail under testing and replace or satisfactorily repair any other materials or work damaged by the testing or failures.
- F. Do not conceal or insulate any section of piping until testing on that section has been satisfactorily completed and approved.
- G. The Contractor shall provide all temporary valves, blanks and accessories for all piping tests, as part of the Work.
- H. Test Criteria: Make all piping systems tight under the following test conditions:
  - 1. Perform hydrostatic test as specified in "Examination, Inspection and Testing" of ANSI B31.9 code, except that duration of test shall be two hours without pressure drop and that no system shall be tested at less than indicated in Item 3 below.
  - 2. If outside temperature is expected to be at or below freezing temperature, the Owner has the option to require that the Contractor test piping by the use of non-corrosive glycol/water mixture.
  - 3. Unless otherwise noted or specified, screwed piping shall be tested under a hydrostatic pressure of 200 psig for a period of 2 hours without fall in pressure gauge reading. Welded and brazed piping shall be subjected to 150 psig air pressure test and welds inspected by applying soap suds. During the air pressure tests, pinholes shall be rewelded at the direction of the Architect/Engineer. Following the air pressure test, piping shall be subjected to hydrostatic test for a period of 2 hours without fall in the pressure gauge reading.
- I. Hydrostatic test at 1-1/2 times operating pressure. Operating pressure of water systems, unless noted otherwise, shall be determined by adding pump shutoff head to building static height, with consistent units.
- J. Miscellaneous Drain Piping:
  - 1. Perform same tests as specified for water piping above, except that minimum test pressure shall be 50 psig and test duration shall be a minimum of 10 minutes (unless directed by Owner to be of longer duration).

- K. Heat exchangers, valves, strainers and piping accessories shall be treated as part of the piping system for testing purposes, except for the following items:
  - 1. Pressure gauges or other sensitive instruments which might be damaged during testing - remove during test and replace after test.
- L. Underground Piping Tests: same as piping above ground.
- M. Provide pipe flanges, caps, temporary valves, cut and cap piping for testing. Test pipes in sections if required or directed by the Owner or Construction Manager. Coordinate sequencing of installation and testing.
- N. Any weld deemed defective, in the opinion of certified welding inspection and testing agency, shall be ground out for full depth and re-welded to the full satisfaction of the testing agency at no additional cost to the Owner.

### 3.11 SYSTEM REQUIREMENTS

- A. All piping systems and components shall be rated for a minimum design working pressure of 150 psig, unless otherwise noted.

END OF SECTION