

Part 1 General

1.1 REFERENCES

- .1 ASTM A53- 20, Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- .2 ASTM A105/A105M-21, Forgings, Carbon Steel, for Piping Components.
- .3 ASTM A106/A106M-19a, Seamless Carbon Steel Pipe for High Temperature Service.
- .4 ASTM A108-18, Steel Bars, Carbon, Cold-Finished, Standard Quality.
- .5 ASTM A181/A181M-14(2020), Forgings, Carbon Steel, for General-Purpose Piping.
- .6 ASTM A193/A193M-20, Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
- .7 ASTM A194/A194M- 20a, Carbon and Alloy Steel Nuts for High-Pressure and High Temperature Service.
- .8 ASTM A216/A216M-18, Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.
- .9 ASTM A234/A234M-19, Piping Fittings of Wrought Carbon and Alloy Steel for Moderate and Elevated Temperatures.
- .10 ASTM A278/A278M-01(2020), Gray Iron Castings for Pressure-Containing Parts for Temperatures Up To 345°C.
- .11 ASTM A307-14e1, Carbon Steel Bolts and Studs, 60,000 psi Tensile.
- .12 ANSI/ASME B1.20.1-2013(R2018), Pipe Threads, General Purpose.
- .13 ANSI/ASME B31.1-2020, Power Piping.
- .14 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.
- .15 MSS SP-58-2018, Pipe Hangers and Supports - Materials, Design and Manufacture.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit six (6) copies of shop drawings for review.
- .2 Cross-reference to contract documents.
- .3 Include plans, elevations, sections and construction details, including:
 - .1 Prefabricated sections with field connection joints.
 - .2 Expansion loops (where indicated) anchors and guides.
 - .3 Pipeline identification data.
- .4 Scale of plans, elevations, and sections:
 - .1 To be minimum 1:50.

- .2 Show piping using double lines.
- .5 Shop drawings for leak detection system: manufacturer to include pull port locations on shop drawing submittal(s).
- .6 Shop drawings for alternative systems for expansion loops: include calculations based on minimum fluid temperature of 7.2°C, local ground temperature and maximum operating hot water heating fluid temperature of 93.3°C. Obtain Departmental Representative's approval before fabrication.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into Operation and Maintenance Manuals.

1.4 RECORD DRAWINGS

- .1 Provide as specified in Section 21 05 01 - Common Work Results for Mechanical.
- .2 Include following:
 - .1 Information relating to elevations, inverts and location of piping, anchors, expansion loops.
 - .2 Existing services uncovered during installation.
 - .3 Existing services known to exist within 3 meters of installation.

1.5 WELDING

- .1 Refer to Section 23 05 17 – Pipe Welding.

1.6 DELIVERY AND STORAGE

- .1 Be responsible for shipping, delivery, unloading, and storage of all materials.
- .2 Handle and store in manner to ensure that all materials and coatings are not damaged.

Part 2 Products

2.1 PIPING

- .1 District energy heating piping: pre-manufactured, pre-insulated, schedule 40 carbon steel carrier pipe to ASTM A53/A53M, Grade A, welded.
- .2 Acceptable Materials:
 - .1 PERMA-PIPE
 - .2 Urecon
 - .3 Thermacor Process Inc.
 - .4 Power Pipe
 - .5 Logstor

2.2 UNDERGROUND (BURIED) STEEL PIPE

.1 General

- .1 All straight sections, fittings, anchors and other accessories shall be factory prefabricated to job dimensions.
- .2 Each system layout shall be computer analyzed by the piping system manufacturer, to determine stresses and movement of the service pipe.
- .3 The system design shall be in strict conformance with ANSI B31.1, latest edition, and stamped by a Registered Professional Engineer.
- .4 Factory trained field technical assistance shall be provided for the critical periods of the installation (i.e., unloading, field joint instruction and testing).
- .5 The system shall be designed based on 100% water, maximum operating temperature of 95°C and maximum operating pressure of 690 kPa.

.2 Service Pipe

- .1 All piping shall be schedule 40 steel piping. Pipe shall be butt welded. Where possible, straight sections shall be supplied in 12-metre random lengths with 150 mm of piping exposed at each end for field joint fabrication.

.3 Subassemblies

- .1 End seals, gland seals and anchors shall be designed and factory prefabricated to prevent the ingress of moisture into the system. All subassemblies shall be designed to allow for complete draining and drying of the conduit system.

.4 Service Pipe Insulation

- .1 Service pipe insulation shall be two (2) layers of 10 mm thick aerogel blanket insulation with a K-factor of 23 mW/m-K at 100°C and a density of 0.20 g/cc.
- .2 The insulation shall be hydrophobic with a compressive resistance of 20.7 kPa at 10% deformation and water vapour sorption of <5% by weight. 25mm of applied polyurethane foam insulation on the conduit insulation as indicated.

.5 Outer Conduit

- .1 The steel conduit casing shall be smooth wall, welded steel conduit of the thicknesses equivalent to 10 Gauge. Changes in casing size, as required at oversized casing to allow for service pipe expansion, shall be accomplished by eccentric and/or concentric fittings and shall provide for continuous drainage.

.6 Pipe Supports

- .1 All pipes within the outer casing shall be supported at not more than 3 metre intervals. These supports shall be designed to allow for continuous airflow and drainage of the conduit in place.
- .2 The straight supports shall be designed to occupy not more than 10% of the annular air space.
- .3 Supports shall be of the type where insulation thermally isolates the service pipe from the outer conduit.

- .4 The surface of the insulation shall be protected at the support by a sleeve not less than 300 mm long, fitted with traverse and where required, rotational arresters.
- .7 Outer Conduit Insulation and Jacket
 - .1 Outer conduit insulation shall be 10 mm thick aerogel blanket insulation with a K-factor of 23 mW/m-K at 100°C and a density of 0.20 g/cc. The insulation shall be hydrophobic with a compressive resistance of 20.7 kPa at 10% deformation and water vapour sorption of <5% by weight. Quality assurance procedures for the insulation shall include a visual check prior to jacketing, an infrared inspection and an x-ray inspection of the entire length to insure there are no insulation voids. The urethane foam shall meet ASTM C591. The outer jacket shall be fiberglass (FRP) and shall be filament wound, directly on to the aerogel blanket insulation. No PVC or HDPE jackets shall be allowed. All straights and fittings shall be factory jacketed.

2.3 LEAK DETECTION SYSTEM

- .1 The secondary containment system manufacturer shall furnish a PAL-AT cable type leak detection system. The piping shall be designed to allow pulling of the leak detection cable into the conduit, both during and after piping installation. Containment pull ports shall be located at a maximum of 500 feet apart for straight runs and reduced by 150 feet for every 90-degree change in direction.
- .2 The leak detection and location system shall consist of a microprocessor based panel capable of continuous monitoring of a sensor string for leaks and faults. The unit shall have a sensing range of 2,000 feet per cable with up to eight (8) cables per panel.
- .3 The alarm unit(s) shall operate on the principle of pulsed energy reflection and be capable of mapping the entire length of the sensor cable and storing the digitized system map in non-volatile memory. The alarm units shall provide continuous indication that the sensor cable is being monitored.
- .4 After proper acknowledgement of a minor leak, the leak detection system shall be capable of monitoring the entire sensing string for additional leaks, even if they are smaller than the leak previously acknowledged.
- .5 The system shall be capable of accounting for minor installation irregularities, static moisture and puddles (such as condensation) with no loss in accuracy or sensitivity.
- .6 The system shall locate the point of origin of the first leak or fault within $\pm 0.1\%$ of the distance from the last calibration point to the leak, or ± 1 metre, whichever is greater. The monitoring unit shall report and record, to non-volatile memory, the type of fault, distance, date and time of an alarm.
- .7 The alarm unit(s) shall be enclosed in a modified NEMA 12 enclosure and have a two (2) line by forty character display providing status and alarm data.
- .8 The monitoring units shall have a factory mounted alarm horn. The monitoring shall be UL-Listed and FM-approved to provide connections for intrinsically safe sensor

circuits for use in a Class 1, Division 1, Group C and D hazardous location. The system shall provide alarm, break, short, status and distance outputs to the building automation system through a terminal strip within the controller.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PREPARATION

- .1 Lay out work in accordance with lines and grades as indicated. Refer to both mechanical and civil drawings for requirements.
- .2 Verify ground profiles, grades, lines, levels, dimensions as indicated against established benchmarks. Report discrepancies to the Departmental Representative and obtain written instruction.

3.3 PIPING

- .1 Installation: The contractor shall handle the system in accordance with the directions furnished by the manufacturer and as otherwise directed by the departmental representative. The casing shall be air tested at 104 kPa and the service piping shall be hydrostatically tested to 1,035 kPa or 1.5 times the operating pressure. The test pressure shall be held for not less than four (4) hours. Refer to both mechanical and civil drawings for additional pressure testing requirements. Slope piping for drainage. Make provision for thermal expansion.
- .2 Backfill: As a minimum, a 100 mm layer of sand or fine gravel shall be placed and tamped in the trench to provide uniform bedding for the system. The entire trench shall be evenly backfilled with similar material as the bedding in 150 mm compacted layers to a minimum height of 150 mm above the top of the insulated piping system. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable soil. Refer to both mechanical and civil drawings for requirements.
- .3 Leak Detection System: The system manufacturer shall provide a factory trained representative for two (2) site visits / meetings for pre-construction and sensor installation/commissioning.
- .4 Refer to Section 21 05 01 – Common Work Results for Mechanical for warranty and training requirements.

3.4 FABRICATION OF PIPING

- .1 Codes:
 - .1 Do all work in accordance with ANSI/ASME B31.1.
- .2 Joints:

- .1 Welded to match piping specification.
- .2 Elsewhere: welded throughout, except at flanged components.

3.5 INSTALLATION OF PIPING

- .1 Maintain clearances between pipes as indicated.
- .2 Maintain clearance between pipes and structures for O & M as indicated, as directed and to manufacturer's recommendations.
- .3 Seal piping passing through walls as indicated.
- .4 Provide for pipe movement as indicated and in accordance with manufacturer's installation instructions.
- .5 Use eccentric reducers in horizontal piping to prevent accumulation of pockets of air or condensate.
- .6 Weld couplings for drains into piping to ANSI/ASME B31.1.
- .7 Cap open ends of piping during installation. Remove all foreign material from inside piping.
- .8 Remove all burrs from piping.
- .9 Grade nominally horizontal piping at 0.4% slope to high point for air removal.
- .10 Flanges: Tighten bolts evenly with torque wrench. Re-tighten bolts with torque wrench after system is in operation.
- .11 Revisions to location of piping require written approval of the Departmental Representative.

3.6 INSTALLATION OF LEAK DETECTION SYSTEM PULL PORTS

- .1 Install Armaflex insulation on vertical pull port risers, wrapped with Blueskin for entire length, ensuring Blueskin is installed over top of the jacket on the PermaPipe.
- .2 Install waterproof removable insulation bags on pull port flanges.

3.7 PRESSURE TESTS

- .1 Pressure test all piping in stages after installation and before concealing in any way, in accordance with Section 21 05 01 - Common Work Results – Mechanical, 23 05 05 - Installation of Pipework, as noted above, and in accordance with civil and mechanical drawings.

3.8 CLEANING

- .1 To Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.9 INSPECTIONS

- .1 Leave all joints in piping systems uncovered until all tests are completed and system inspected and approved by the Departmental Representative.

3.10 IDENTIFICATION

- .1 Refer to Section 23 05 53 - Mechanical Identification.

3.11 START-UP

- .1 Provide continuous supervision during start-up.
- .2 Upon start-up, bring all mains up to temperature and pressure slowly over a 24 hr period.
- .3 After system is in operation and under maximum temperatures and pressures:
 - .1 Tighten all bolts on flanges, using torque wrench. Repeat several times during commissioning.
 - .2 Check operation of drain valves.
- .4 Full scale tests:
 - .1 Upon completion, conduct full scale tests at maximum design flow rates, operating temperatures and pressures for continuous consecutive period of 48 h to demonstrate full compliance with design requirements.

END OF SECTION