

## SECTION #2553 - HOT WATER UNDERGROUND (DIRECT BURIED) PIPING

PART 1 GENERAL

## 1.1 SUMMARY

- A. University of Rochester owns and operates an underground hot water piping system and leak detection system manufactured by Logstor A/S. This section provides for the installation of new underground hot water piping and connections to the University's existing system. All new piping and leak detection equipment shall be as manufactured by Logstor A/S or University of Rochester Central Utilities approved equal and compatible.
- B. This section provides for designing, furnishing, installing, and testing of pre-insulated European standard thin wall direct buried water piping system including isolation valves, integrated pipe supports, expansion joints, leak detection wiring, pipe fittings, and appurtenances for hot water service.
- C. All pre-insulated piping systems shall be jacketed suitable for direct bury, and they shall be capable of allowing sufficient movement for thermal expansion and contraction. Each assembly shall be factory-designed for the specific project. Expansion loops, expansion joints, anchors, and guides shall be furnished and installed to provide a trouble-free system and avoid stress on any equipment and building structure.
- D. The leak detection system shall be integral to the pipe section, furnished, and tested by the manufacturer.

## 1.2 REFERENCE STANDARDS

- A. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
  - 1. American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME)
    - a. B16.5 Pipe Flanges and Flanged Fittings
    - b. B16.9 Factory-made Wrought Steel Butt Welding Fittings
    - c. B16.11 Forged Steel Fittings, Socket-Welding and Threaded
    - d. B16.34 Valves-Flanged, Threaded, and Welding End
    - e. B1.20.1 Pipe Threads, General Purpose, inch
    - f. B31.1 Power Piping
  - 2. American Society for Testing and Materials (ASTM)
    - a. A53/A53M, Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
    - b. A105/A105M, Carbon Steel Forgings for Piping Applications.
    - c. A106/A106M, Seamless Carbon Steel Pipe for High Temperature Service.
    - d. A108, Steel Bar, Carbon & Alloy, Cold-Finished.
    - e. A181/A181M, Carbon Steel Forgings for General-Purpose Piping.
    - f. A193/A193M, Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
    - g. A194/A194M, Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High Temperature Service, or both.
    - h. A216/A216M, Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
    - i. A234/A234M, Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
    - j. A307, Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
  - 3. ASNT SNT TC-1A, Radiographic Inspector Qualification.
  - 4. AWS B3.0, Welding Procedures and Performance Qualifications

5. AWS C1.1, Recommended Practices for Resistance Welding
6. AWS W1, Welding Inspection
7. European Standards
  - a. European Standard EN253 Pre-insulated Bonded Piping Systems
  - b. European Standard EN448 Pre-insulated Fitting Assemblies
  - c. European Standard EN488 Pre-insulated Steel Valve Assemblies
  - d. European Standard EN489 Joint Assemblies on Pre-insulated Pipes
  - e. European Standard EN14419 Networks – Surveillance systems
  - f. European Standard EN 13941 Design and installation of pre-insulated bonded pipe system for district heating
  - g. DIN 1626, Steel Quality St 37.0 (ASME-A53 Grade B Equal)
8. ISO 9001 Quality Systems
9. ISO 14001 Environmental Management System

### 1.3 QUALITY ASSURANCE

- A. The Contractor shall provide a field representative from the piping system manufacturer to be present for several milestone events:
  1. Prior to delivery to train and certify Contractor personnel on unloading, handling installation of the insulated piping.
  2. Prior to installation training shall address bedding preparation, welding, insulation of joints, joining and testing of leak detection wiring and backfilling of piping.
  3. Periodic visit to observe installation
    - a. The manufacturer's representative shall make a minimum of two visits once installation has begun and shall submit a written report through the Contractor to University of Rochester describing observations including condition of piping at the job site, damage to the insulation and jacket, recommendations for correction to any improperly installed piping and the progress of the installation.
- B. On completion of the installation, the Contractor shall deliver to the University of Rochester Project Manager a certificate from the manufacturer that the installation is in compliance with all installation recommendations and warranty requirements of the manufacturer.
- C. The Contractor shall prepare Weld Procedure Specifications (WPS) and Weld Procedure Qualification Records (PQR) to cover all combinations of pipe diameters, pipe thicknesses, materials and configurations necessary to complete this piping installation. Each WPS and PQR shall be prepared in accordance with the current edition of ANSI B31.1 and Section IX, ASME Boiler and pressure vessel code. Each PQR shall be signed and certified by the Contractor. The corresponding testing laboratory report shall be attached as supporting documentation.
- D. Welders employed by the Contractor shall be qualified in accordance with the current edition of ANSI B31.1 and Section IX, ASME Boiler and pressure vessel code. Qualification welds shall be made at the job site or project lay-down area. The Contractor shall notify the University of Rochester Project Manager a minimum of 2 days prior to conducting qualification tests. Welder qualifications tests done for previous projects or trade unions will not be accepted. Welder Performance Qualifications (WPQ) shall be signed and certified by the Contractor, with the corresponding testing laboratory report shall be attached as supporting documentation. Welders shall be qualified for the pipe diameters, pipe thicknesses, materials specified and positions of welds required during fabrication of the piping. Submit the Welder Performance Qualification (WPQ) certifications and pictorial identification of each welder to the University of Rochester Project Manager for review prior to commencing piping fabrication.
- E. All welds shall be identified by the welder's mark and a sequence number. University of Rochester will employ a Certified Welding Inspector (CWI), certified as Level 2 minimum in the NDE methods utilized, independent of the contractor fabricating or installing the piping, to visually examine all welds in accordance with inspection and examination requirements of ANSI B 31.1. Any welds

failing the visual inspection shall be ground out, re-welded and tested at the expense of the Contractor. The CWI shall submit a written report of his examination of each weld to the Engineer.

- F. The Contractor shall maintain a log of the installation and testing of the leak detection system wiring. The log shall include pre-installation resistances for each length of pipe, precise lengths of alarm wiring, continuity measurements as work progresses, GPS coordinates of field joint connections, and names of personnel making/testing each wiring connection.

#### 1.4 SUBMITTALS

- A. Submit NYSPE certified shop drawings, to scale, of the piping layout of the pre-insulated direct buried piping system.
- B. Shop drawings shall indicate all offsets, elevation changes and existing utility crossings.
- C. Product data on all materials, including piping, fittings, valves, pipe supports, expansion joints, storage instructions, and installation procedures.
- D. Weld Procedure Specifications (WPS), Procedure Qualification Records (PQR), and Welder Performance Qualifications (WPQ). Prior to production welds.
- E. Quality Control Manual shall provide procedure to track manufacturer's 3.1 Certificate Production documentation and identify material pieces cut from certified pipe.
- F. Manufacturer pipe production certification.
- G. Contractor shall provide stress analysis report for each segment of piping certified by a NYS PE. Contractor shall use the manufacturer's stress analysis program or an equivalent stress analysis program validated to be an equal. The manufacturer shall acknowledge in writing that the stress analysis is being performed by contractor is accurate. Any construction changes shall be modeled in a final stress analysis report with manufacture's acceptance of the installed conditions.
- H. Alarm Wiring Connection Log. Submit log for approval of format prior to start of work. Log shall be maintained at the job-site and completed log shall be submitted upon completion of
- I. Hydrostatic Test Plan. Contractor shall submit a written plan and drawings for the hydrostatic test. The plan shall include all procedures and shutdowns necessary for the hydrostatic test. Plans shall identify temporary and permanent fill points, vents, bypasses, valves, gauges and other appurtenances needed.

#### 1.5 RECORD DRAWINGS

- A. Include the following:
  - 1. Record drawing shall be submitted maximum one month after installation in paper and AutoCAD .DWG format.
    - a. NYSPE certified drawings showing all inverts and location of piping, branches, fittings, isolation valves, vents, drains, anchors, expansion loops and adjacent buildings, structures significant surface features to an accuracy of 0.1 feet horizontal and vertical.
  - 2. NYSPE certified leak detection alarm wiring schematic with accurately measured lengths of alarm wire runs, and locations of termination boxes.
  - 3. Details of permanent instrumentation.
  - 4. Drainage provisions at low points and venting provision at high points.

5. Existing buried services or intersecting piping uncovered during excavation.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacture.
- B. End caps weather supplied by the piping manufacturer or fabricated by the contractor are to be kept on the ends of the piping sections to keep debris from entering the pipe while it is in storage or handling. End caps shall only be removed when necessary for fit-up or welding of the pipe.
- C. Pre-insulated pipe are to be handled per the manufacturer's recommendations or instructions.
- D. Contractor shall be responsible for shipping, delivery, unloading, and storage of all materials.

#### 1.7 WARRANTY

- A. Manufacturer's warranty form in which manufacturer agrees to repair or replace components which fail in materials or workmanship within specified warranty period.

#### 1.8 MAINTENANCE TOOLS

- A. Furnish all required special tools for maintenance and operation of systems and
- B. 1.9.2 Return all special tools to Owner at successful completion of Work.

### PART 2 – PRODUCTS

#### 2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, manufacturer's installation requirement, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
  1. Design Code: ANSI/ASME B31.1 – POWER PIPING
  2. Service: Pressurized Hot Water
  3. Design Pressure: 232 psig (1600 kPag)
  4. Design Temperature : 248° F (120° C)
  5. Hydro Test pressure: 348 psig

#### 2.2 WELDING MATERIALS

##### A. Filler Materials:

1. Electrodes shall be AWS E6010 for root passes and E7018 for fill passes.
2. All filler materials shall be fully identified by the ASME Specification number and the AES classification number.
3. Filler metal storage and handling procedures shall be required to maintain the material in a clean and dry condition up to the time of use.
4. Low hydrogen electrodes shall be handled and stored in accordance with the manufacturer's recommendations to avoid pickup and to retain the low hydrogen characteristics of the electrode.

5. Contractor shall be responsible for providing electric power to rod ovens at all times.

## 2.3 HOT WATER PIPING SYSTEM MATERIALS

### A. General

1. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
2. Quality Control Manual shall provide procedure to track manufacturer's 3.1 Certificate Production documentation and identify material pieces cut from certified pipe.
3. Service pipe shall be steel with polyurethane foam insulation, polyethylene outer casing, two 1.5 mm copper surveillance wires and a unique pipe identification label. Copper surveillance wires shall have one bare wire and one tinned finish to facilitate installation.
4. Valves shall be ball valves with all welded casing, stainless steel ball, Teflon seat, and stainless steel spindle top complying with the requirements of EN 488. Options include extension spindles, valve covers, and vent/drain kit.

### B. Anchors

1. Provide as required by stress analysis and at penetration to building. If building structure is unable to support anchor, provide exterior buried anchor.

### C. Styrofoam Insulation as Separator:

1. Application: Separation from other utilities and structures: Use 2" (50 mm) thick foam. Install between district energy piping and other utility when clearance is less than 12" (300 mm).
2. Material complies with ASTM C578-10 Type VI
3. Thermal Resistance – 5.0 hr-ft<sup>2</sup>-°F/Btu (0.88 m<sup>2</sup>-C/W).
4. Minimum Compressive Strength – 60 psi (414 kPa).
5. ASTM C518 – Standard Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

### D. Rigid Cellular Plastics

1. Acceptable Products: Dow Styrofoam Highload 60, or equivalent.

### E. Foam Pads as Expansion Cushion:

1. Application: to allow for free expansion of the district heating piping under hot water system design and operating conditions. Install foam pad between district energy piping and sand bedding at changes of horizontal and vertical direction as specified on drawings. Also on direct buried valve stems, branches, etc. Use 1" (40 mm) thick foam pads in layers to achieve specified thickness.
2. Material as supplied by pipe manufacturer.
3. Expansion joints shall not be used without prior approval by the University of Rochester Project Manager.

PART 3 - EXECUTION

## 3.1 INSTALLATION

## 3.2 WELDING

## A. Workmanship

1. Welding shall be in accordance with ANSI/ASME B31.1.

## B. Fittings:

1. DN 50 / NPS 2" and smaller: install welding type sockets. Contractor submit pipe/ socket combinations for approval to ensure compatibility with metric piping.
2. Branch connections: install welding tees or forged branch outlet fittings.

## C. Quality Assurance (Q.A.)

1. Maintain a Q.A. Program for defect prevention and is service reliability.
2. Maintain on site Q.A. Program and Quality Control Plan, hold points, welder certifications, weld procedures, weld maps identifying the location of all welds performed on the piping system together with the identification of the welder performing the weld.

## 3.3 PREPARATION

## A. Lay out work in accordance with lines and grades as indicated.

1. Verify ground profiles, grades, lines, levels, dimensions against the Contractor's Work and established benchmarks. Report discrepancies to Engineer and obtain written instruction.

## B. Handling and Storage

1. Handle and store pipes strictly in accordance with manufacturer's instructions.
2. Protect all pipes from damage during shipping, hauling and handling.
3. Securely cap both ends of all pipe and fittings at all times to keep out foreign matter.
4. Protect insulation at pipe ends by sealing with polythene bags or wrapping to prevent ingress of moisture.
5. During storage, transportation, and laying, carefully protect pipes so that the jacket or insulation is not damaged in any manner. Cushion all saddles or bearings with burlap or other soft material. In handling the pipe a cushioned sling will be acceptable or other devices and methods, as approved. Exclude the use of noncushioned ropes, chains, wedges, or levers in handling the pipe.
6. Protect pipe from being dropped, welded on, rolled, dragged or handled in any manner that might damage the jacket, pipe ends or insulation.

## C. Installation of Hot Water Piping – General

1. The Contractor shall verify that the heating pipes are installed to the correct location and orientation shown in the Contract drawings. Where possible the buried piping, supply pipe shall be on the right hand side of the trench when your back is towards the University District Heating Plant.
2. Maintain clearances between pipes and structures for O&M as indicated and/or as directed.
3. Provide manual air vents, drains, drip legs, dirt pockets as specified and as indicated.
4. Seal piping passing through walls as indicated with water tight mechanical seals.
5. Provide for pipe movement as required and in accordance with installation instructions.
6. Use eccentric reducers in horizontal piping to prevent accumulation of pockets of air and or to prevent the drain down of water.
7. Weld couplings for drains into carbon steel piping to ANSI/ASME B31.1.
8. Cap open ends of piping during installation. Remove all foreign material from inside piping.
9. Remove all burrs from piping. Clean scale and dirt, inside and out before and after assembly.
10. Grade nominally horizontal piping at 0.5% slope generally in direction of flow unless otherwise specified.
11. Removal of a portion of pipe to facilitate welding of the joint and then replacing the cut out section, sometimes called "fish mouth" or "window" welding, will not be permitted on any pipe.
12. After the welding is completed on each section of pipe and the welds have been radiographically tested and approved, the piping is subject to hydrostatic pressure testing. Hydrostatic pressure testing to be carried out in accordance with this Section.
13. All Revisions to routing/location of piping require written approval of Engineer.

#### D. JOINT FIT-UP

1. The geometry of pipe weld joints (i.e. joint preparation and root opening) shall be in accordance with the tolerance specified by the weld joint sketches contained in the welding procedures submitted to the University of Rochester's representative.
2. In cases where the internal misalignment exceeds 1/16 inch, the component with the wall extending internally shall be trimmed internally so that the adjoining internal surfaces are approximately flush. This trimming shall not result in a piping component wall thickness less than the minimum design thickness and the change in contour shall not exceed 30 degrees.
3. Miters shall not exceed 5 degrees.

#### E. Installation of Pre-Insulated Hot water Piping

1. Verify all pipe and components are supplied and ready for installation at the place of storage.
2. Carefully inspect each pipe unit. Damaged units to be rejected or repaired according to manufacturer's recommendations to satisfaction of the Engineer.

3. When lowering the pipe into the trench, take every care to prevent swinging impact scuffing of pipe against the sides of the trench.
4. Place pipe along the side of the trench on cushioned blocks as close as possible to the location where it will be laid. If the pipe is to be moved longitudinally along the trench, walk pipe by crane, load on a truck and move, or move by other acceptable means.
5. Handle each pipe unit into its position in the trench only in such manner and by such means as is acceptable to the Engineer. At all times furnish suitable engineer designed devices, such as spreader bars or beams, to permit satisfactory support of the pipe unit when it is lifted. Install the pipe in trench in maximum 80 ft (24 m) long sections as approved by the Engineer.
6. Keep each pre-insulated piping joint free of moisture at all times until application of joint kit. Take extra precautions, such as wrapping each joint with plastic wrap, if site conditions are wet and/or humid.
7. Install the piping to the alignment and grades indicated on the drawings or as directed by the Engineer. Support each pipe on bedding material as indicated and have firm bearing along its entire length.
8. Use temporary supports, if necessary, to raise the piping or to allow rotation of the pipe to facilitate welding joints. If temporary supports are utilized, they shall consist of 4" x 4" (100 x 100 mm) boards and be placed in the trench with a maximum spacing of 12' (3.6m).
9. Remove all temporary supports prior to backfilling.
10. As necessary and in order to provide clearance for welding and jointing, bedding material shall not initially be put in place in the trench at the pipe joints.
11. Prepare steel pipe with flat ends or properly beveled, aligned and spaced for welding. All welding on pipes, fittings, and valves shall be done in compliance with the Weld Procedure Specifications (WPS) and Weld Procedure Qualification Records (PQR). Gas welding or electric arc welding may be used and the type of rods and filler used shall be selected to match the base metal alloy analysis.
12. Securely cap the ends of the pipe in the trench, which are not being fitted or welded, at all times to prevent the entrance of foreign matter.
13. Make all cuts of the exterior polyethylene jacket as per manufacturer recommendations so that no indications of fracture arise.
14. Remove all polyethylene foam from the steel pipe before welding is started.
15. Keep exposed polyethylene foam at pipe ends dry and covered during installation, and ensure that there is no moisture trapped within.
16. Make branch connections only with fittings supplied by the pipe manufacturer.
17. Check alarm wires for faults before welding in sections of pipe.
18. After the welding is completed on each section of pipe and the welds have been radiographically examined and approved the piping shall be subjected to a hydro-static pressure test. The pressure test shall be carried out in accordance with the "Pressure Test" section below.
19. After acceptance of examination of welds, the piping shall be cleaned as described in Cleaning in this section.



20. Install expansion foam cushions at bends and changes in direction strictly as indicated on drawings.
21. Ensure that the piping is isolated from any concrete structures. In the event that the piping is to be installed in close proximity to a concrete structure, install a Styrofoam (SM) divider between the pipe outer casing and the concrete as directed by the Engineer.
22. Ensure the pre-insulated pipe is properly protected before insertion into steel or PVC buried casings. Submit procedure for protection of pipe to Engineer prior to commencement of operation.

F. Alarm Wiring:

1. Provide installation and test procedure for Alarm Wiring for review by Engineer, prior to start of Work.
2. The alarm wires that are embedded in the polyurethane insulation of the pipe and consist of two copper wires, one clean and one tinned.
3. Verify alarm wires are installed and operating in each pipe and component correctly prior to performing any work on that piece (test upon receipt of material).
4. When placing the pipes in the trench, ensure that the alarm wires are located as per pipe manufacturer's instructions and as indicated on alarm wire drawing, if available, or as directed by the Engineer.
5. Connect both end wires in all joints and piping ends by certified electrician.
6. Solder each joint and use jointing clamps as supplied by the piping Supplier and AWG 14 (2 mm<sup>2</sup>) copper wire.
7. Ensure continuity of system as the Work progresses by means of high voltage tester (Megger).
8. Check the resistance of the connections and the resistance between the wire and steel pipe.
9. The alarm system shall be complete. All alarm wires shall be terminated inside building wall penetrations within terminal boxes (provided by piping Supplier) as indicated on Contract drawings. The new alarm wiring system under this Work shall be connected to the Owner's existing alarm wire system at piping tie-in, for monitoring by existing central leak detector panel.
10. Do not weld any piping when leak detection units are connected to the system.

G. Application of Pre-Insulated Piping Joint Kits – Insulation & Shrink Sleeves

1. Install the shrink sleeves to the heating pipelines after pressure testing is complete, strictly in accordance with the manufacturer specifications and after receiving training and certification from the pre-insulated piping manufacturer.
2. Jointing:
  - a. Place the shrink sleeve on one of the pipes to be welded. Weld the steel pipes. (Joint can be pressure tested at this point if in Contractor's procedure).
  - b. Cut away expanded insulation foam from the pipe ends.

- c. Cut the insulation half shells to make them fit tightly between the jacket pipes.
  - d. Fit the insulation shells tightly between the jacket pipes. The pipe ends must be clean and dry.
  - e. Clean the jacket pipes at least 6" (150mm) from both pipe ends. The surface must be clean and dry.
  - f. Crimp and solder alarm wires, lay them along outside of the insulation half shells.
  - g. Activate the jacket pipes with a "tiger" torch at least 6" (150mm) from both sides of the pipe ends, until the surface has a matte, silky appearance.
  - h. Place the shrink film so that the marking line goes around the pipe. Pull the paper off and take the film loosely around the pipe.
  - i. Heat the whole film from the center outwards just to the point that the mastic becomes visible at the edges and that the shrink film is tightly fitted.
  - j. Remove packing from main shrink sleeve and ensure sleeve is clean and dry inside and out. Center shrink sleeve on the joint. Heat shrink from the middle outwards towards one end then from the middle to the other end.
3. Training:
- a. The piping manufacturer shall train the Contractor's personnel in the correct procedures for installation of all components of the heating pipes prior to installation of the first piece of piping.
  - b. Training shall include Contractor's installation personnel performing actual test joint examples for all reasonably anticipated pipe joint and alarm wire configurations that the Contractor's forces may encounter in the course of performing the Work.
  - c. No workers shall be allowed to perform pre-insulated piping joint installation unless they have been certified by the piping manufacturer for pre-insulated piping joint installation within one year of performing the Work.

#### H. Pre-Insulated Piping Alarm Wires Testing – Removal from Storage

1. In all components the alarm sensor wires are placed at 2:00 o'clock and 10:00 o'clock positions. The two wires are distinguished by one being plain copper wiring and the other being a tinned color. The two wires are colored differently so that the correct connection is made during installation.
2. All straight pipes and bends are joined by welding in such a way that the clean copper wires are always opposite each other. Likewise for the tinned wires. They should be oriented so that the tinned wires are on the right with your back towards the routing back to the Cogen District Heating Plant (with the exception of branch fittings, for which drawings and piping pipe manufacturer's instructions must be very carefully followed). NEVER CROSS WIRES OVER ONE ANOTHER! Also, never route wires along the bottom of the insulation joint.
3. Check each piping component carefully for continuity because the wires could have been damaged in transit. You must ensure the wires are not in contact with the steel pipe.
4. Short-circuit the wires at one end of bends and straight components and at both ends of the main for a Tee. Check there is good contact between the wires and that there is no contact between wires and

steel pipe.

5. Using an ohmmeter, connect the two measuring cables to the wires that are not joined together. Check there is good contact and that the wires do not touch each other or the steel pipe. Check that the resistance in the wires does not exceed 0.015 ohms per meter of wire.
  6. Then clean off a spot on the steel pipe and move one measuring cable to this spot. Check that there is good contact. Check by means of a high voltage (Megger) that the resistance is higher than 20 Mohm at a test voltage of 500 V. If the resistance is smaller, there is contact between wire and pipe or excessive moisture in the insulation.
- I. Pre-Insulated Piping Alarm Wires Testing-- Installed in the Field:
1. After the pipe is welded, and before the protective joint covering is installed, clean, crimp and solder alarm wires together. Perform the following test procedure:
    - a. Connect measuring cables to the two wires in the same pipe. Use a Megger to verify that resistance is higher than 20 Mohm at test voltage of 500 V. If the resistance is lower, there is contact between the two wires or moisture in the insulation. Locate and fix the faulty wire connection.
    - b. Clean a spot on the steel pipe. Connect one measuring cable to this spot and the other to one of the wires in the same pipe. Ensure resistance is higher than 20 Mohm at a test voltage of 500 V. If the resistance is lower there is contact between the wire and the steel pipe or moisture in the insulation. Locate and fix the faulty joint connection. Check the other wire in the pipe in the same way.
    - c. At far end of the pipe connect tin plated wire in one pipe to the tinned wire in the adjacent pipe. Similarly connect the clean copper wires together. Ensure good contact at wire connections and that no contact between alarm wires and pipe wall exists.
    - d. Connect the measuring cables to the tinned wire at the free end. Ensure wire resistance does not exceed 1.5 Ohm per 330 ft (100 m) of wire (165 ft (50 m) of pipe). If resistance reading exceeds 1.5 Ohm per 330 ft (100 m) of wire, locate and fix the faulty wire connection. Repeat the inspection on the copper wires.
    - e. When the measurements have been completed, checked and approved, the alarm wires must be joined in accordance with the instructions for the joining method specified. Proceed to check the next assembly in the same way. This is an ongoing procedure and failure to check each pipe and each assembled joint as piping proceeds can lead to costly delays to the project. The Contractor shall be responsible for verifying that the alarm wires are installed correctly and by a competent person.
- J. Hot Tapping of Branch Connections
1. Hot tapping of branch connections to in-service mains shall be done with hot tap valves provided by pre-insulated piping Supplier and piping Supplier-approved hot tapping tool set designed for use with hot tapping valve provided by piping Supplier.
  2. Hot tapping shall be executed in accordance with pre-insulated piping Supplier's installation instructions, and also in accordance with Contract drawings. In case of conflict between Contract drawings or the following and the piping Supplier's installation instructions, consult the Engineer:
    - a. Remove insulation from around existing piping main, being careful not to damage leak detection wiring of existing piping main. Do not tap at an existing insulation joint kit location.

- b. Weld weldolet on to existing main, at a 45° angle.
- c. Weld hot tapping ball valve to weldolet.
- d. Attach hot tapping tool to tapping valve, open valve, pressure test hot tapping valve assembly.
- e. Attach drill to hot tapping tool, drill/saw thru existing pipe wall in stages in accordance with supplier instructions, retract drill shaft/chuck, close hot tapping valve, and remove drill and hot tapping tool.
- f. Weld 45° elbow to hot tapping valve and branch piping to 45° elbow.
- g. After branch piping is completed and pressure tested, open hot tapping valve, weld valve plug, and install T2S-type insulation joint kit.

K. Inspection and Test – General Requirements

- 1. Review all weld quality requirements and defect limits of applicable code and standards with University of Rochester’s Representative before any work is started.
- 2. Formulate “Inspection and Test Plan” and submit for review.
- 3. Each welder shall be tested on site prior to commencing work on. Welders shall be tested for the 6G position on coupons fabricated from DN standard sized piping.
- 4. The Contractor shall select weld test coupon diameter(s) to ensure the contractor’s procedure and each welder is qualified for the range of pipe diameters and thicknesses to be welded on this project. Coupons diameters shall be selected in accordance with the thickness limitations specified in ANSI B31.1 sections QW-451 and QW-452.
- 5. Coupons shall be examined in accordance with the ANSI/ASME Boiler and Pressure Vessel Code Section IX. Tests and examinations shall be carried out at the Contractor’s expense.
- 6. Each coupon shall be stamped with the welders’ recognition number.
- 7. The qualification tests shall be conducted the contractor. The University of Rochester Project Manager shall be notified 2 working days prior to each test weld and shall be permitted to have a representative observe the welding.
- 8. Do not conceal any production welds until they have been inspected, tested and approved by inspector.
- 9. Welders shall have experience in welding of similar pipe sizes and materials to those used on this project.
- 10. All welds shall be identified by the welder’s mark and a sequence number. University of Rochester will employ a Certified Welding Inspector (CWI) independent of the contractor fabricating or installing the piping to visually examine and perform ultrasonic or radiographic testing of all welds in accordance with inspection and examination requirements of ANSI B 31.1. Any welds failing the visual inspection shall be ground out, re-welded and radiographed at the expense of the Contractor. The CWI shall submit a written report of his examination of each weld to the Engineer.

11. 100% of all welds shall be examined by on site radiography or phased array ultrasonic non-destructive exam methods in compliance with ASME B31.1 standards. If any of these welds failed, the weld shall be repaired and re-examined until no failures are reported.

L. Hydrostatic Test

1. Submit hydrostatic test procedure a minimum of fourteen (14) days prior to scheduled test for approval by the University of Rochester Project Manager.
2. The contractor shall not insulate or backfill any piping until the hydrostatic test plan has been approved by the University of Rochester Project Manager.
3. Furnish and install suitable temporary testing plugs or caps for the pipeline, all necessary bracing, pressure pumps, pipe connections, bypasses, meters, gauges and other similar equipment, and all labor required.
4. The section of pipe to be tested shall be filled with water of approved quality supplied by the contractor.
5. All air shall be expelled from the pipe.
6. Provide air vents at all high points to properly conduct the test with the prior approval of the Contractor/University of Rochester's representative.
7. All taps shall be properly plugged upon completion of the test.
8. The water shall stand under pressure a sufficient time to allow the escape of air from any air pockets.
9. The pressure should then be increased to the required pressure as per ANSI/ASME B31.1.
10. Hydrostatic Test Pressure
  - a. Test Pressure = 348psig
  - b. Continuously monitor, chart and record the pressure during the whole course of the testing operation.
  - c. The test pressure shall be maintained for minimum of four (4) hours without any pressure drop or leakage.
11. In-Service Test
  - a. Provide an in-service test at normal operating pressures at all tie-in points after final welds have been made.
  - b. Test results shall be reported on a written report form and will include at least the following data:
    - Client's name.
    - Contractor's name.
    - Date of examination.
    - Test location.
    - Test section, i.e. station – station.
    - Fill water source.
    - Start test time.
    - End test time.
    - Start Test Pressure.
    - End Test Pressure.
    - Pipe Sizes.
    - Results of examination.

- Pressure Record Chart
- Signature of Contractor Representative.
- Signature of Inspector.

### 3.4 REPAIR OF WELDS WHICH FAILED INSPECTION

- A. Re-inspect repaired or re-worked welds at own expense as described herein.

### 3.5 CLAIMS AGAINST UNIVERSITY OF ROCHESTER FOR DELAYS

- A. Claims for delays in completion of project will not be entertained for reasons of failures of welds or test to pass examinations.

### 3.6 FILLING AND FLUSHING

- A. Prior to the commissioning of the LTHW system, the system will be flushed.
- B. The project will employ the services of a water treatment subcontractor to provide the necessary chemicals, materials and supervision for a complete cleaning and flushing of all piping up to the point of connection to the building's hot water headers. After satisfactory water quality analysis results have been obtained (according to University of Rochester's water treatment contractor), system start-up and commissioning may occur. A certification from the water treatment contractor will verify that the water quality is acceptable.

### 3.7 FLUSHING

- A. Prior to hydrostatic testing, pipe system shall be flushed with fresh water until piping is free of dirt and foreign matter. Contractor shall provide all necessary backflow protection, hoses and coupling connections between the domestic water system and the hot water system. Contractor shall be responsible for properly disposing of flush water.
- B. All instrumentation including meters, gauges, transmitters, flow sensors, thermowells, switches, and control valves will be removed and strainer screens temporarily removed from the piping prior to flushing.
- C. Flushing velocity to be not less than 8 fps for 48 hours. Provide flushing screen 20 mesh (0.8 mm perforation size) on flush discharge to monitor material carried by flushing water. Clean screen regularly to ensure circulation.
- D. Upon completion of the flushing process the contractor shall circulate commissioning chemicals in accordance with University of Rochester, Central Utilities as described below. The duration of the circulation shall be a minimum of a 48 hour duration. After acceptance of the pretreatment process the piping systems shall be drained, water used in the treatment process shall be captured and disposed of offsite in accordance with City of Rochester and County of Monroe regulations. A ten working day notification, request to be issued in writing, shall be provided to Central Utilities prior to the commencement of the chemical treatment and filling process. The contractor shall provide a detailed plan outlining the proposed approach to accomplish this work. Central Utilities will have 5 working days to review and accept the plan. Once acceptance is issued the contractor can commence with the work.
- E. Flush Sequence and Products:
1. Fill system with clean domestic water with a pH from 7.0 to 10
  2. Add Nalprep IV alkaline phosphate cleaner at 270 ppm. See chart below:
  3. Circulate for 48 hour
  4. Flush to within 1.0 ppm ortho phosphate and 1.0 ppm iron.

5. Take sample to confirm.
6. Circulate for 8 hours. Retest.
7. Nalprep IV Dosing

System Volume (gal)	Gallons of Nalprep
100	0.23
500	1.14
1,000	2.29
2,000	4.57
5,000	11.4
6,000	13.7
15,000	34.3

3.8 INSPECTIONS

- A. Leave all joints in piping systems uncovered, free from paint and insulation, until all visual inspection, weld testing, and wire resistance testing are completed, system inspected, and approved by University of Rochester’s representative.

3.9 START-UP

- A. Provide services of installation supervisor together with the University of Rochester’s maintenance personnel for continuous supervision during start-up. This will include providing assistance to complete those task listed below.

1. Upon start-up, bring all mains up to temperature and pressure SLOWLY and in set stage.

B. Special Inspector Scopes of Work

1. Welding Inspector:

- a. NDT Services
- b. Visual Weld Inspection
- c. 100% Ultrasonic (or radiographic) Testing
- d. Sign off each inspection on pipe jacket
- e. Provide daily weld test reports
- f. Joint Kit Inspections
- g. Test alarm wires for continuity and resistance prior to foam installation
- h. Foam halves cut to correct length and installed properly
- i. Alarm wires crimped and soldered correctly
- j. Alarm wires tested at next joint prior to covering wires
- k. Shrink film installed correctly and free of air bubble
- l. Outer sleeve installed correctly and shrunk to water tight fit
- m. Sign off each joint inspection on pipe jacket and daily joint kit inspection reports.

2. Additional Inspections

- a. Check alarm wires are placed at 10 & 2 and copper wire is on correct side prior to welding
- b. Check that outer sleeve is on pipe prior to welding
- c. Geotechnical Inspector
- d. Compaction Services
  - Check that proper backfill material is being used
  - Check sand bedding is being compacted to spec
  - Check sand backfill is being compacted to spec

- Check native backfill is being compacted to spec
  - Provide daily compaction reports
- e. Check that warning tape is being installed over each pipe on top of the sand backfill
- f. Check that foam expansion compensators are being installed per plan o Verify that each weld and crossing has been surveyed prior to backfill. Verify install of protection boards per plan, where require
3. Joint Kit Inspections
- a. Test alarm wires for continuity and resistance prior to foam installation
  - b. Foam halves cut to correct length and installed properly
  - c. Alarm wires crimped and soldered correctly
  - d. Alarm wires tested at next joint prior to covering wires
  - e. Shrink film installed correctly and free of air bubble
  - f. Outer sleeve installed correctly and shrunk to water tight fit
  - g. Inspector sign off each joint inspection on pipe jacket and daily joint kit inspection reports.

END OF SECTION