SECTION 33 61 02

UNDERGROUND HOT WATER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Design Standards for District Heating Systems FDG
B. Section 31 00 00: Earthwork
C. Section 31 10 00: Site Preparation
D. Section 31 23 00: Excavation and Fill
E. Section 32 00 01: Site Restoration and Rehabilitation

1.2 SUMMARY

A. Stanford University owns and operates an underground hot water piping system and leak detection system manufactured by Logstor A/S in conformance with the European standards referenced in paragraph 1.3 below. This section provides for the installing new underground hot water piping and connecting it to Stanford’s existing Logstor A/S system. All new piping and leak detection equipment shall be compatible with the existing piping and leak detection systems and shall be manufactured by Logstor A/S or Stanford Approved equal.

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 in conformance with ASME/ANSI B31.1, latest edition.

C. All pre-insulated piping systems shall be completely sealed and waterproof to protect the steel pipe, insulation, and leak detection wiring from moisture, and they shall be capable of allowing sufficient movement for thermal expansion and contraction. Each assembly shall be fabricated as 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. Provide leak detection system designed, furnished, installed and tested per contract drawings and manufacturer instructions.
1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ANSI/ASME B31.1, Power Piping

2. ANSI/ASME Boiler and Pressure Vessel Code:
   a. Section I: Power Boilers
   b. Section V: Nondestructive Examination
   c. Section IX: Welding and Brazing Qualifications

3. ASTM D 2240 Shore Hardness of Materials

4. ASTM E 1003, Standard Practice for Hydrostatic Leak Detection

5. AWS B3.0, Welding Procedures and Performance Qualifications

6. AWS C1.1, Recommended Practices for Resistance Welding

7. AWS W1, Welding Inspection

8. 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)
   h. ISO 9001 Quality Systems
   i. ISO 14001 Environmental Management System
1.4 QUALITY ASSURANCE

A. The Contractor shall provide a field representative from the piping system manufacturer to be present prior to the initial installation period to train and certify Contractor personnel on unloading, handling and installation of the insulated piping. Training shall address bedding preparation, welding, insulation of joints, joining and testing of leak detection wiring and backfilling of piping.

B. On completion of the installation, the Contractor shall deliver to the Stanford 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 Stanford 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 Stanford Project Manager for review prior to commencing piping fabrication.

E. All welds shall be identified by the welder’s mark and a sequence number. Stanford 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 joint connections, and names of personnel making/testing each wiring connection.

1.5 SUBMITTALS

A. Wet Weather Plan. The Contractor shall submit a written plan to include procedures for protecting exposed pipe, insulation, leak detection wiring, welding operations and joint kit installation operations and hydrostatic test inspections from damage due to rain and mud.

B. Submit shop drawings, to scale, of the piping layout of the pre-insulated direct buried piping system.

C. Shop drawings shall indicate all offsets, elevation changes and existing utility crossings.

D. Product data on all materials, including piping, fittings, valves, pipe supports, expansion joints, storage instructions, and installation procedures.

E. Weld Procedure Specifications (WPS), Procedure Qualification Records (PQR), and Welder Performance Qualifications (WPQ). Prior to production welds.

F. Quality Control Manual shall provide procedure to track manufacturer’s 3.1 Certificate Production documentation and identify material pieces cut from certified pipe.

G. Manufacturer production certification.

H. Stress analysis report and manufacture’s approval for final as-built installation of each piping segment.

I. 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

J. 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.

1.6 RECORD DRAWINGS

A. Provide as specified in Section 01770 – Closeout and Turnover Procedures.

B. Include the following:

1. Record (as-built) drawings of all buried and concealed piping, indicating exact locations, sizes, pipe materials, and service media. Record drawing shall be submitted maximum one month after installation.
2. Record drawings shall be annotated to show any deviations in plan or profile from the design and/or shop drawings.

3. Record drawings shall be annotated to show the GPS coordinates of all weld joints and/or leak detection wiring joints.

1.7 DELIVERY, STORAGE AND HANDLING

A. Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacture.

B. Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

C. End caps, whether 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 be removed only when necessary for fit-up or welding of the pipe.

D. Pre-insulated pipes are to be handled per the manufacturer’s recommendations or instructions.

E. Contractor shall be responsible for shipping, delivery, unloading, and storage of all materials.

1.8 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.

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.

2.2 WELDING MATERIALS

A. Filler Materials

1. Electrodes shall be AWS E6010 for root passes and fill passes unless otherwise submitted to and approved by the SU Energy Operations Thermal Systems Engineer.

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. All piping, fittings, valves, strainers, and other equipment on the primary side shall be designed and installed for:
   a. Operating Pressure: 150 psig
   b. Hydro Test pressure: 225 psig
   c. Operating Temperature: 200ºF maximum

3. Quality Control Manual shall provide procedure to track manufacturer’s Certificate Production documentation and identify material pieces cut from certified pipe.

4. The Contractor shall install the piping as shown on the engineered contract drawings. If deviations from the contract drawings are necessary due to field conditions, the Contractor shall coordinate with the SU Project Manager to have the changes reviewed and approved by the Engineer of Record for the piping design.

B. Exterior Distribution Piping System – Direct Buried

1. Buried Piping – European Pre-insulated.
   a. EN253 European Standard, Steel 37.0 (ASTM A53 Grade B equal).
   b. Acceptable materials: Logstor or approved equal. The Contractor shall notify the Stanford Project Manager of any proposed substitutions prior to the bid date.

2. Service pipe shall be steel with polyurethane foam insulation, polyethylene outer casing, two 1.5 mm copper surveillance wires and an unique pipe identification label. Copper surveillance wires shall have one bare wire and one tinned finish to facilitate installation. Pipe pressure rating shall be 362 psi. Pipe temperature rating shall be 284°F for continuous operation and 302°F for maximum short term operation.
3. 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.

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

5. Expansion Bends Expansion Loops and Expansion Joints
   a. Provide expansion loops and bends, fittings, and foam cushions as required by the engineered contract drawings.
   b. Expansion joints shall not be used without prior approval by the Stanford Project Manager.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Install piping in accordance with the specifications, pipe manufacturer's published installation instructions and as shown on the drawings.

C. Field Supervision. Factory trained field supervision shall be provided for all critical periods of pre-insulated pipe installation including but not limited to: unloading, field joint construction, field insulation of joints and fittings, and testing.

D. Field Joints. Field joint kits shall be installed only after the hydrostatic testing has been successfully completed. Joint areas shall be backfilled only after installation of the joint kit in accordance with manufacturer's recommendation and approval by the SU Sustainability Department Inspector.

E. Install pre-formed heat shrink seals on all field cuts of pre-insulated piping shall be in accordance with manufacturer’s published recommendations:

F. Backfill shall be per referenced specification. Place pipe system on an 8-inch tamped bed of granular material. Evenly fill trench width with 8 inch layers of backfill material compacting each layer to a minimum compaction of 95% of Standard Density as indicated in Division 2.
3.2 WELDING

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

B. Installation Requirements
   1. Identify each weld with welder’s identification stamp.
   2. Fittings:
      a. DN 50 / NPS 2” and smaller for air vents/drains: install welding type sockets. Contractor submit pipe/weldolet combinations for approval to ensure compatibility with metric piping. Contractor may need to machine standard schedule 40 weldolets to match metric equivalent pipe.
      b. Branch connections: install welding tees or forged branch outlet fittings.

C. Quality Assurance (Q.A.)
   1. Submit Company’s Q.A. Manual for all work performed under this Contract. This Manual shall be submitted as part of the Bid submission documents.
   2. Maintain a Q.A. Program for defect prevention and is service reliability.
   3. Maintain on site Q.A. Program and Quality Control Plan, wet weather procedures, 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.

D. Inspection and Test – General Requirements
   1. Review all weld quality requirements and defect limits of applicable code and standards with Stanford’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 Stanford 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. Stanford will employ a Certified Welding Inspector (CWI) independent of the contractor fabricating or installing the piping to visually examine and perform ultrasonic 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. Hydrostatic Test
   a. Test all piping to 225 psig for 4 hours.
   b. Submit hydrostatic test procedure a minimum of Twenty-one (21) days prior to scheduled test for approval by the Stanford Project Manager.
   c. Contractor shall repair any defects identified during the hydrostatic testing and re-test after the repairs are completed.
   d. All welds shall be accessible by the SU Inspector to conduct a visual inspection of each weld. Bell holes shall allow sufficient clearance for the inspector to view all portions of each weld. Trench shall be dry and free of mud. During wet weather months, the contractor shall conduct hydrostatic testing only on non-rainy days. The contractor shall allow sufficient time to remove water and mud prior to any hydrostatic test.
   e. The contractor shall not insulate or backfill any piping until the hydrostatic testing has been approved by the Stanford Project Manager.
   f. 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.
   g. Prior to the final tie-in welds to the existing live LTHW system, the new piping shall be filled with clean domestic water mixed with an approved fluorescent dye/surface tension reducer additive (American Gas & Chemical Company F-
Trace or approved equal). The additive shall be mixed at the manufacturer’s recommender ratio.

h. All air shall be expelled from the pipe.

i. Provide permanent Logstor air vents at all high points to properly conduct the test with the prior approval of the Contractor/Stanford’s representative.

j. The water shall stand under pressure a sufficient time to allow the escape of air from any air pockets.

k. The pressure should then be increased to the required pressure as per ANSI/ASME B31.1.

l. Hydrostatic Test Pressure
   1). Test Pressure = 225 psig
   2). Continuously monitor, chart and record the pressure during the whole course of the testing operation.
   3). The test pressure shall be maintained for minimum of four (4) hours without any pressure drop or leakage.
   4). At the end of the 4 hour test, the SU Inspector will conduct a 100% visual inspection with UV light. Contractor shall remove trench plates as necessary for the SU inspector to access each weld.
   5). After the hydrostatic test is successfully completed, the Contractor shall add and circulate an approved corrosion inhibitor until the pipe is drained in preparation for the final tie-in welds.

12. Hydrostatic Testing of Final Tie-in Welds
   a. After the new piping has been cleaned and filled (See Section 3.3D Filling and Cleaning) the contractor shall conduct a final hydrostatic test with de-ionized water.
   b. The tie-in welds shall remain uninsulated for the final hydrostatic test.
   c. No dye, surface tension reducer or other chemical shall be added to the de-ionized water.
   d. The SU inspector will conduct a visual inspection at the end of the 4-hour hydrostatic test using a water sensitive color developer (American Gas & Chemical Company WDP-217 or equal).
13. Test results shall be reported on a written report form and will include at least the following data:
   a. Client’s name.
   b. Contractor’s name.
   c. Date of examination.
   d. Test location.
   e. Test section, i.e. station – station.
   f. Fill water source.
   g. Start test time.
   h. End test time.
   i. Start Test Pressure.
   j. End Test Pressure.
   k. Pipe Sizes.
   l. Results of examination.
   m. Signature of Contractor Representative.
   n. Signature of Inspector.

E. DEFECTS CAUSING REJECTION


F. REPAIR OF WELDS WHICH FAILED INSPECTION

1. The Contractor shall repair all welds that fail the visual inspection or hydrostatic test. Repairs shall be in accordance with ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

2. The Contractor shall provide all labor, materials and equipment to re-inspect and re-hydrostatic test all repaired welds.

3. 

G. CLAIMS AGAINST STANFORD FOR DELAYS

1. Claims for delays in completion of project will not be entertained for reasons of failures of welds or test to pass examinations.
H. 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 Stanford’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.

3.3 HOT WATER PIPING SYSTEMS

A. HANDLING AND STORING PRE-INSULATED PIPE.

1. Handling and storage of pipes shall be in accordance with manufacturers’ instructions.

2. Protect all pipe from damage during shipping, hauling and handling.

3. 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. Ropes, wire ropes and slings, chains, wedges, or levers shall not be used in handling or laying the pipe.

4. The pipe shall not be dragged, dropped, welded on, rolled, or handled in any manner that might damage the jacket or insulation. In lowering the pipe into the trench, every care shall be taken to prevent swinging impact or scuffing on the sides of the trench.

5. 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, it shall be walked by crane, loaded on a truck and moved, or moved by other acceptable means.

6. Both ends of the pipe shall be securely capped at all times to keep out foreign matter.

7. During wet weather, the Contractor shall at all times protect the exposed pipe insulation with Visqueen securely fastened over the pipe ends. Trenches shall be kept free of standing water to prevent the pipe ends from being submerged.

B. INSTALLATION OF PRE-INSULATED BURIED PIPING

1. Verify all pipe and components are supplied and in place 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 Stanford’s Site Representative.

3. Handle each pipe unit into its position in the trench only in accordance with the pipe manufacturer’s published installation procedures. Furnish suitable devices such as spreader bars, to permit satisfactory support of the pipe unit along its length when it is lifted. No more than twenty-four meters length of pipe shall be joined, lifted and laid in the trench at any time or as approved by the Stanford. Pipe shall not be rolled into trench. Joints shall be secured and supported during lifting and installation. See Specification on Excavation, Trenching, and Backfilling.

4. Alarm Wiring
   a. Installation and test procedure for alarm wiring to be reviewed by Stanford and manufacturer prior to start of work
   b. Use qualified personnel in the installation, testing and commissioning of alarm system.
   c. The alarm wires that are embedded in the polyurethane insulation consist of two copper wires, one clean and one tinned wire. Resistance test each pipe at storage prior to installation.
   d. Verify alarm wires are installed and operating in each pipe and component correctly prior to performing any work on that piece.
   e. When placing the pipes in the trench, ensure that the alarm wires are located as per pipe supplier’s recommendations and as indicated on alarm wiring drawing or as directed by the Stanford.
   f. Connect both end wires in all joints and piping ends by qualified personnel.
   g. Join each connection with jointing clamps as supplied by the manufacturer and solder each joint.
   h. Check each pipe and joint connections for continuity, with and ohm meter. Verify that additional resistance is within 5% of calculated increase in wire resistance.
   i. Ensure continuity of system as work progresses by means of high voltage tester (Megger).
   j. Check the resistance of the connections and the resistance between the wire and steel pipe. Record readings.
k. Make accurate record drawings of alarm wire system for Supply and Return Pipes with GPS location for each weld. Record precise lengths of alarm wiring in system on record drawing. Note wiring take offs to branches and buildings.

l. The alarm system shall be complete. Provide alarm panels and termination boxes. Follow manufacturer’s instruction and provide 120 V power supply to alarm panels and to central alarm panel.

m. Do not weld any piping when leak detection units are connected to the system.

5. Install the piping to the alignment and grades indicated on the drawings. Support each pipe on bedding and insulation material as indicated on drawings and have firm bearing along its entire length. Bedding shall be thoroughly compacted to specification and completely surrounding the pipes. The sand bedding and surround is designed to act as a friction anchor for the system and it shall be the responsibility of the contractor to instruct his labor in the proper backfilling procedures accordingly.

6. Temporary supports may be used to raise the piping or to allow rotation the pipe to facilitate welding joints. If temporary supports are utilized, they shall consist of sandbags or cushioned boards spaced at 12 feet maximum.

7. Provide all temporary supports and remove prior to backfilling.

8. Prior to welding the steel pipe ensure that shrink sleeves and collars are in place on the straight pipes for each joint. Protect shrink sleeves from undue heat caused by sun.

9. Steel pipe ends shall be properly beveled and aligned and spaced for welding in accordance with the Contractor’s Weld Procedure Specification. All welding on pipes, fittings, and valves to be done by personnel who have passed and approved competence test and have been certified.

10. The ends of the pipe in the trench not being fitted or welded shall be securely capped at all times to prevent the entrance of foreign matter.

11. All cuts of the exterior polyethylene jacket to be made as per manufacturers’ recommendations so that no indications of fracture arise.

12. All polyurethane foam must be removed from the steel pipe, in the region or the weld, before welding is started.

13. Pipes required to be cut to length shall be cut and thoroughly cleaned from pipes leaving 11 inch free steel pipe end left for joining.


15. Only pipes conforming to EN253 to be included in the buried sections of the system.
16. Make branch connections only with fittings supplied by the pipe manufacturer or approved by the Stanford Project Manager.

17. Provide all temporary devices such as pressure pumps, gauges, valves, bypasses, caps and pipes, necessary for the conduction of the pressure testing and cleaning operations.

18. After acceptance of hydraulic tests, clean piping as described in Pipe Cleaning section. Provide for all pumps, bends, fittings, valves, strainers and cross over connections for the execution of the flushing of the system.

C. APPLICATION OF SHRINK SLEEVES TO BURIED PIPING

1. Provide shrink sleeves to the heating pipelines strictly in accordance with the manufacturers’ specifications. The sand bedding and surround is critical for anchoring the hot water pipe system. Proper compaction is required to maintain the friction forces between pipe jacket and sand.

2. Joint shall consist of:
   a. Follow all manufacturers’ recommended procedures.
   b. Contractor’s work force shall be trained by Manufacturer’s Representative in the correct procedures for installation of all components of the heating pipes.

D. FILLING AND CLEANING

1. General
   a. Notify the Stanford a minimum of 14 days in advance of the flushing and cleaning operation.
   b. Submit filling and cleaning procedure for review a minimum of 21 days prior to commencement of the operation. Flushing procedure shall identify all temporary and permanent fill points, air vents, bypasses, valves, pumps filters and other appurtenances necessary.
   c. Piping installed under this Contract shall be filled with de-ionized water and filtered for a minimum of 48 hours flushed to remove all foreign material from the inside of all piping to the Stanford Instructor’s approval.
   d. Provide for all pipes, pumps, bag filters, connections, bypasses and fittings necessary in order to achieve the proper filling and filtering of the pipe system.
   e. Piping system shall be filled with de-ionized water having a conductivity of less than 2 micro–mhos.
f. After initial fill, the de-ionized water shall be pumped to achieve a minimum flow of 5 feet per second in all piping segments. The de-ionized water shall be filtered through a 5 micron bag filter for a minimum of 48 hours.

g. Take all necessary precautions to prevent damage to the pipe, insulation, or structures from the cleaning operation and remove water from excavations.

h. Take all necessary precautions to ensure that no oil or other lubricant comes into contact with either the inside walls or outside jacketing of the pipe. Remove all oil residues by chemical flush at no cost to Stanford.

i. After the initial 48 hour filtering, Stanford will test for total suspended solids (TSS). Target level for TSS is < 10 ppm. If this level is not met, filtering shall continue with re-testing by Stanford at 48 hour intervals. Filtering shall continue until TSS < 10 ppm.

j. Upon completion of filtering Stanford will test the conductivity of the de-ionized water to verify that the conductivity remains <2 micro-mhos. If the conductivity is above 2 micro-mhos, the contractor shall circulate the water through de-ionizing resin tanks to polish it until the conductivity is below 2 micro-mhos.

k. When filtering and polishing is complete, remove all temporary piping and fittings and complete all final connections.

E. INSPECTIONS

1. 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 Stanford’s representative.

F. START-UP

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

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

   b. After system is in operation and under maximum temperatures and pressure:

      1). Tighten all bolts on flanges, using torque wrench. Repeat as required, several times, during commissioning.

      2). Check operation of drain valves.

      3). Bleed air from system air vents as required.
4). Check clearances of vents, valves and drains in manholes. Adjust casings in valve pits to ensure ease of operation of assemblies as necessary.

   c. Anchors, guides, supports:

   1). Monitor at all times during start-up and commissioning to ensure operation as designed.

   2). Adjust pipe supports, hangers, and anchors.

   END
Special Inspector Scopes of Work

Welding Inspector:
- NDT Services
  - 100% Visual Weld Inspection
  - Sign off each inspection on pipe jacket
  - Provide daily weld test reports

Joint Kit Inspector
- Joint Kit Inspections
  - Test alarm wires for continuity and resistance prior to foam installation
  - Foam halves cut to correct length and installed properly
  - Alarm wires crimped and soldered correctly
  - Alarm wires tested at next joint prior to covering wires
  - Shrink film installed correctly and free of air bubble
  - Outer sleeve installed correctly and shrunk to water tight fit
  - Sign off each joint inspection on pipe jacket and daily joint kit inspection reports.
- Additional Inspections
  - Check alarm wires are placed at 10 & 2 and copper wire is on correct side prior to welding
  - Check that outer sleeve is on pipe prior to welding

Geotechnical Inspector
- 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

- Additional Inspections
  - Check that tracer wire is being placed on return pipe prior to backfill
  - Check that warning tape is being installed over each pipe on top of the sand backfill
  - Check that foam expansion compensators are being installed per plan
  - Verify that each weld and crossing has been surveyed prior to backfill
  - Verify install of protection boards per plan, where required

END OF SECTION