SECTION 23 21 13 - PRE-INSULATED PIPING

PART 1 - GENERAL

1.1 QUALIFICATIONS

A. The system supplier for preinsulated piping systems shall have fabricated systems of the composition defined herein for at least five years.

B. Acceptable Manufacturers:
   1. Perma-Pipe/Ricwil
   2. Thermacor Process Incorporated

PART 2 - PRODUCTS

2.1 PREINSULATED PIPING SYSTEM – CHILLED WATER SUPPLY AND RETURN

A. General Description:
   1. Preinsulated piping systems shall be provided for all underground chilled water piping.
   2. A preinsulated piping system consists of carrier pipe, insulation, protective jacket, connectors, supports, and appropriate fittings.
   3. All underground chilled water pipes with fluid temperatures up to 60 degrees shall utilize polyurethane foam insulation with HDPE jacketing.
   4. All straight sections, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. One square cut, plain end for field cutting and beveling is allowed per straight run of pipe. Other ends shall be factory square cut and factory beveled such that the field welds have the capability of being welded to pass x-ray testing.
   5. Each system layout shall be computer analyzed by the piping system manufacturer to determine stresses, anchor forces, heat losses, and anticipated movements of the service pipe along the entire length of pipe. The conditions for analysis are as follows: installation temperature of 0ºF, ambient temperature of 50ºF, depth of soil cover is 10 feet, soil conductivity of 10.00 btu-in/sq.ft H-F, and a service line operating temperature of 48ºF. Friction between the ground and the jacketing material must be taken into account for the anchor force and stress calculations.
   6. The system design shall be in strict conformance with ASME/ANSI B31.1, latest edition, and stamped by a registered professional engineer.

B. Service Pipe:
   1. Internal piping shall be ASTM A-53, Grade B, ERW carbon steal. Schedule 40 for sizes through 10 inch, 0.375-inch wall thickness for sizes 12 inch and over (standard). Domestically produced pipe is required.
   2. All joints shall be butt-welded for sizes 2-1/2 inches and larger, and socket welded for 2 inches and smaller.
   3. Where possible, straight sections shall be supplied in35+foot double random lengths with sufficient piping exposed at each end for field joint welding and fabrication.

C. Accessories:
   1. End seals, fittings and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system during shipping, outdoor storage, installation, and operation. End caps on the ends of the service pipe are required to prevent debris from entering the pipe for the period of time up until installation.

D. Insulation:

1. Service pipe insulation (polyurethane foam) for straight sections shall be spray applied or injected such that the final foam product has a nominal 2-3 pound per cubic foot density, 90% minimum closed cell content, conforms to ASTM C-591, and has an initial K factor less than or equal to 0.16. Performed polyurethane foam for fittings is acceptable.
2. To ensure no voids are present, all insulation shall be inspected by one of the following two methods: visually checked prior to application of the protective jacket, infrared inspection of the entire length during the foaming process. After successful completion of testing, all test report documents shall be submitted to the university for records.
3. The insulation shall be applied to the minimum thickness specified below. The insulation thickness shall not be less than indicated in these specifications.

Nominal Pipe Size	Insulation Thickness
<14”	1”
14”+	1-1/2”

E. Protective Jacket:
1. All straight sections of the factory preinsulated piping system shall be jacketed with a High Density Polyethylene jacket conforming to ASTM D1248. PVC jackets shall not be allowed.
2. All HDPE jacketing material shall have minimum wall thickness as specified below. The wall thickness shall not be less than indicated in these specifications.

Jacket O.D.	Jacket Thickness
O.D. < 12”	0.125”
12”, O.D.< 24”	0.150”
O.D.>24”	0.175”

3. All fittings of the factory preinsulated piping system shall be jacketed with the same material used for the straight sections of pipe and prefabricated to minimize field joints. Fittings shall be jacketed using a molded HDPE cover over polyurethane foam. Fittings shall be waterproof from the factory without the use of any type of tape, cellophane (or other non-HDPE plastic) wrap, mastic, glue, or hot air welds.

F. Field Joints:
1. All field joints shall be made in straight sections of pipe. Field joints other than at straight sections shall not be acceptable.
2. The method of field joint closure is as follows:
    1) The field joints are pressure tested and inspected for leaks.
    2) A split sleeve with holes in the top is placed around the joint area and secured with straps and sealed to the jacket with tape.
    3) Two-part polyurethane foam is mixed properly and poured into the holes on the top of the split sleeve.
    4) After the foam insulation has expanded and cured, any excess foam shall be removed.
    5) An adhesive backed heat shrinkable sleeve is then placed around the field joint area making sure to overlap the sleeve onto the HDPE jacketing by at least 3” on each side. This 3” overlap is to be completely on the HDPE and does not include the length of overlap of the split sleeve or tape.
    6) Heat is applied using a rosebud torch to the heat shrinkable sleeve slowly and evenly across the length of the sleeve until the sleeve has drawn tight.
    7) Any spots that pucker up during the shrinking process shall be covered with a thick-bodied asphaltic mastic (black roofing compound).
    8) Backfilling of the trench shall not begin until the area has cooled to the touch.
3. The piping systems manufacturer shall furnish all the foam insulation, split sleeves, and heat shrinkable jacketing materials for making the field joints. The contractor shall furnish the straps, tape, knives, saws, torch, gas, and mastic materials.

2.2 PREINSULATED PIPING SYSTEMS – STEAM CONDENSATE RETURN

A. General Description:

1. Preinsulated piping system shall be provided for all underground steam condensate piping.
2. A preinsulated piping system consists of carrier pipe, insulation, protective jacket, connectors, supports, and appropriate fittings.
3. All underground steam condensate return pipes with fluid temperatures up to 200 degrees shall utilize polyurethane foam insulation with HDPE jacketing.
4. All straight sections, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. One square cut, plain end for field cutting and believing is allowed per straight run of pipe. Other ends shall be factory square cut and factory beveled such that the field welds have the capability of being welded to pass x-ray testing.
5. Each system layout shall be computer analyzed by the piping systems manufacturer to determine stresses, anchor forces, heat losses, and anticipated movements of the service pipe along the entire length of pipe. The conditions for analysis are as follows: installation temperature of 0ºF, ambient temperature of 50ºF, depth of soil cover is 10 feet, soil conductivity of 10.00 btu-in/sq.ft H-F, and a service line operating temperature of 200ºF. Friction between the ground and the jacketing material must be taken into account for the anchor force and stress calculations.
6. The system design shall be in strict conformance with ASME/ANSI B31.1, latest edition, and stamped by a registered professional engineer.

B. Service Pipe:
1. Internal piping shall be ASTM A-53, Grade B, ERW seamless carbon steel. Schedule 80 for sizes through 8 inch, 0.500-inch wall thickness for sizes 10 inches and over (extra strong). Domestically produced pipe is required.
2. All joints shall be butt-welded for sizes 2-1/2 inches and larger, and socket welded for 2 inches and smaller.
3. Where possible, straight sections shall be supplied in 35+ foot double random lengths with sufficient piping exposed at each end for field joint welding and fabrication.

C. Accessories:
1. End seals, fittings and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system during shipping, outdoor storage, installation and operation. End caps on the ends of the service pipe are required to prevent debris from entering the pipe for the period of time up until installation.

D. Insulation:
1. Service pipe insulation (polyurethane foam) for straight sections shall be spray applied or injected such that the final foam product has a nominal 2-3 pound per cubic foot density, 90% minimum closed cell content, conforms to ASTM C-591, and has an initial K factor less than or equal to 0.16. Preformed polyurethane foam for fittings is acceptable.
2. To ensure no voids are present, all insulation shall be inspected by one of the following two methods: visually checked prior to application of the protective jacket, infrared inspection of the entire length during the foaming process. After successful completion of testing, all test report documents shall be submitted to the university for records.
3. The insulation shall be applied to the minimum thickness specified below. The insulation thickness shall not be less than indicated in these specifications.

Nominal Pipe Size	Insulation Thickness
< 8”	1-1/2”
10”+	2”

E. Protective Jacket:
1. All straight sections of the factory preinsulated piping system shall be jacketed with a High Density Polyethylene jacket conforming to ASTM D1248. PVC jackets shall not be allowed.
2. All HDPE jacketing material shall have minimum wall thickness as specified below. The wall thickness shall not be less than indicated in these specifications.

Jacket O.D.	Jacket Thickness
O.D. < 12”	0.125”

12”<O.D.<24”	0.150”
O.D.>24”	0.175”

3. All fittings of the factory preinsulated piping system shall be jacketed with the same material used for the straight sections of pipe and prefabricated to minimize field joints. Fittings shall be jacketed using a molded HDPE cover over polyurethane foam. Fittings shall be waterproof from the factory without the use of any type of tape, cellophane (or other non-HDPE plastic) wrap, mastic, glue or hot air welds.

F. Field Joints:
1. All field joints shall be made in straight sections of pipe. Field joints other than at straight sections shall not be acceptable.
2. The method of field joint closure is as follows:
   a. The field joints are pressure tested and inspected for leaks.
   b. A split sleeve with holes in the top is placed around the joint area and secured with straps and sealed to the jacket with tape.
   c. Two-part polyurethane foam is mixed properly and poured into holes on the top of the split sleeve.
   d. After the foam insulation has expanded and cured, any excess foam shall be removed.
   e. An adhesive backed heat shrinkable sleeve is then placed around the field joint area making sure to overlap the sleeve onto the HDPE jacketing by at least 3” on each side. This 3” overlap is to be completely on the HDPE and does not include the length of overlap of the split sleeve of tape.
   f. Heat is applied using a rosebud torch to the heat shrinkable sleeve slowly and evenly across the length of the sleeve until the sleeve has drawn tight.
   g. Any spots that pucker up during the shrinking process shall be covered with a thick-bodied asphaltic mastic (black roofing compound).
   h. Backfilling of the trench shall not begin until the area has cooled to the touch.
3. The piping systems manufacturer shall furnish all the foam insulation, split sleeves, and heat shrinkable jacketing materials for making the field joints. The contractor shall furnish the straps, tape, knives, saws, torch, gas, and mastic materials.

2.3 PREINSULATED PIPING SYSTEMS-STEAM

A. General Description:
1. Preinsulated piping systems shall be provided for all underground steam piping.
2. A preinsulated piping system consists of carrier pipe, carrier pipe insulation, steel casing pipe, casing pipe insulation, HDPE casing pipe insulation protective jacket, connectors, supports, internal moment guides, and appropriate fittings.
3. All underground steam distribution pipes with fluid temperatures up to 355ºF shall utilize mineral wool carrier pipe insulation, steel conduit, and polyurethane foam conduit insulation with HDPE jacketing.
4. All straight sections, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. One square cut, plain end for field cutting and beveling is allowed per straight run of pipe. Other ends shall be factory square cut and factory beveled such that the field welds have the capability of being welded to pass x-ray testing.
5. Each system layout shall be computer analyzed by the piping system manufacturer to determine stresses, anchor forces, heat losses, conduit/polyurethane insulation interface temperature, and anticipated movements of the service pipe and conduit along the entire length of pipe. The conditions for analysis are as follows: installation temperature of 0ºF, ambient temperature of 50º F, depth of soil cover is 10 feet, soil conductivity of 10.00 btu-in/sq.ft H-F, and a service line operating temperature of 355ºF. Friction between the ground and the jacketing material must be taken into account for the anchor force and stress calculations.
6. The system design shall be in strict conformance with ASME/ANSI B31.1, latest edition, and stamped by a registered professional engineer.

B. Service Pipe:
1. Internal piping shall be ASTM A-53, Grade B, ERW Carbon steel. Schedule 40 for sizes through 10 inch, 0.375-inch wall thickness for sizes 12 inches and over (standard). Coated pipe is not acceptable. Domestically produced pipe is required.
2. All joints shall be butt-welded for sizes 2-1/2 inches and larger, and socket welded for 2 inches and smaller.
3. Where possible, straight sections shall be supplied in 35+ foot double random lengths with sufficient piping exposed at each end for field joint welding and fabrication.

C. Subassemblies:
1. End seals, gland seals, internal moment guides, fittings (tees and elbows), and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system during shipping, outdoor storage, installation, and operation. End caps on the ends of the service pipe are required to prevent debris from entering the pipe for the period of time up until installation.
2. All subassemblies shall be designed to allow for complete draining and drying of the conduit system.

D. Service Pipe Insulation:
1. Carrier pipe insulation shall be mineral wool in non-supported sections. Split insulation shall be held in place by stainless steel bands installed on 18 inch centers, or two bands per insulation section, whichever is closest together. The insulation shall have passed the most recent boiling tests and other requirements specified in the Federal Agency Guidelines.
2. Support/guide sections shall have calcium silicate of the same thickness as the mineral wool with a protective sheet metal sleeve attached to the calcium silicate with screws.
3. The minimum insulation thickness shall not be less than indicated in these specifications.

Nominal Pipe Size	Minimum Insulation Thickness
2”-4”	1.5”
6”-10”	2.0”
12”-14”	2.5”
16”-20”	3.0”

E. Outer Conduit:
1. The steel conduit casing shall be a smooth wall, welded steel conduit of the thick nesses specified below:

Nominal Conduit Size	Minimum Conduit Thickness
6”-26”	10 Gauge (0.1345”)
28”-36”	6 Gauge (0.1943”)
38”-42”	4 Gauge (0.2242”)

2. Changes in casing size, as required to allow for carrier pipe expansion into the conduit, shall be accomplished by eccentric and/or concentric fittings and shall provide for continuous drainage of the conduit along the entire length of pipe.

F. Pipe Supports and Guides:
1. All pipes within the outer casing shall be supported at not more than 10-foot intervals.
2. The supports shall be designed to allow for continuous airflow and drainage of the conduit.
3. The carrier pipe supports in straight runs shall be designed to occupy not more than 10% of the annular air space between the carrier pipe insulation and the steel conduit.
4. Supports shall be of the type where insulation thermally isolates the carrier pipe from the outer conduit. Support/guide sections shall have calcium silicate of the same thickness as the mineral wool with a protective sheet metal sleeve attached to the calcium silicate with screws. This sleeve shall be as long as the corrugated supports, with a minimum length of 12 inches.
5. The corrugated metal supports shall be a minimum of 12” long and of sufficient strength (thickness) to support the pipe without the annular air space being encroached upon.

6. Moment guides and rotational arrestors internal to the outer conduit shall be provided on the locations shown on the drawings and additionally where requires by the manufacturer's analysis.

G. Outer Conduit Insulation:
1. Outer conduit insulation (polyurethane foam) for straight sections shall be spray applied or injected such that the final foam product has a nominal 2-3 pound per cubic foot density, 90% minimum closed sell content, conforms to ASRM C-591, and has an initial K factor less than or equal to 0.16. Preformed polyurethane foam for fittings (elbows and tees) is acceptable.
2. To ensure no voids are present, all insulation shall be inspected by one of the following two methods: visually checked prior to application of the protective jacket, infrared inspection of the entire length during the foaming process. After successful completion of testing, all test report documents shall be submitted to the university for records.
3. The insulation shall be applied to the minimum thickness of 1-1/2 inches. The insulation thickness shall not be less than indicated in these specifications.

H. Protective Jacket
1. All straight sections of the factory preinsulated piping system shall be jacketed with a High Density Polyethylene jacket conforming to ASTM D1248. PVC jackets shall not be allowed.
2. All fittings of the factory preinsulated piping system shall be jacketed with the same material used for the straight sections of pipe and prefabricated to minimize field joints. Fittings shall be jacketed using a molded HDPE cover over polyurethane foam. Fittings shall be waterproof from the factory without the use of any type of tape, cellophane (or other non-HDPE plastic) wrap, mastic, glue, or hot air welds.
3. All HDPE jacketing material shall have minimum wall thickness as specified below. The wall thickness shall not be less than indicated in these specifications.

Jacket O.D.	Jacket Thickness
O.D.<12"	0.125"
12"<O.D.<24"	0.150"
O.D.>24"	0.175"

I. Field Joints
1. All field joints shall be made in straight sections of pipe. Field joints other than at straight sections shall not be acceptable.
2. The method of field joint closure is as follows:
   a. The welds on the carrier pipe field joints are pressure testes and inspected for leaks.
   b. Shipping supports on the ends of the pipe sections are cut off.
   c. Mineral wool insulation (matching the properties of the straight sections) is applied to the joint area and secured in place using stainless steel bands.
   d. A split metal casing is welded to the conduit and each other to form a pressure testable seal around the conduit. This area should allow water to drain freely past the field joint are and not become trapped in a low spot in the conduit.
   e. A split sleeve with holes in the top is placed around the joint area and secured with straps and sealed to the jacket with tape.
   f. Two-part polyurethane foam is mixed properly and poured into the holes on the top of the split sleeve.
   g. After the foam insulation has expanded and cured, any excess foam shall be removed.
   h. An adhesive backed heat shrinkable sleeve is then placed around the field joint area making sure to overlap the sleeve onto the HDPE jacketing by at least 3" on each side. This 3" overlap is to be completely on the HDPE and does not include the length of overlap of the split sleeve or tape.
   i. Heat is applied using a rosebud torch to the heat shrinkable sleeve slowly and evenly across the length of the sleeve until the sleeve has drawn tight.
   j. Any spots that pucker up during the shrinking process shall be covered with a thick-bodied asphaltic mastic (black roofing compound).

k. Backfilling pf the trench shall not begin until the area has cooled to the touch.

3. The piping systems manufacturer shall furnish all the mineral wool and foam insulation materials, split metal casing, stainless steel bands, split sleeves, and heat shrinkable jacketing materials for making the field joints. The contractor shall furnish the straps, tape, knives, saws, torch, gas, and mastic materials.

PART 3 - EXECUTION

3.1 PREINSULATED PIPING SYSTEM

A. Installation:

1. Provide the service of a manufacturer's representative to instruct the contractor on the installation procedures of the piping system and to be present on site to assist during critical stages of installation and testing. The representative must be qualified by the piping system manufacturer who's responsibility is to provide Field Technical Assistance (FTA).
2. When the manufacturer's representative is on-site, a report shall be produced consisting of the installation log indicating actually installed conditions, field observations, and pressure test results signed by the manufacturer's representative, the contractor, and the engineer's representative. Include documentation by the manufacturer's representative that the installations in conformance with the manufacturer's recommendations.
3. A minimum of six inches (6") of sand or fine gravel bedding shall be placed all around the pipe in the trench. This bedding/fill shall be hand tamped and compacted around the pipes in six-inch (6") lifts until the fill is six inches (6") above the top of the jacketing material. The remaining height of the trench shall be evenly and continuously backfilled and compacted in uniform six inch (6") lifts with suitable clean excavated soil.
4. The field joints shall be installed as described in each product section.

B. Testing – Chilled Water and Condensate Piping

1. The internal pipe shall be hydrostatically tested to 150 psig or 1-1/2 times the operating pressure, whichever is greater. The hydrostatic test pressure shall be held for no less than one hour. In large diameter pipes, pneumatic testing may be an acceptable alternative (at the discretion of the Engineer and the university). Proper safety precautions and coordination must be completes with the university Health and Safety department before testing is initiated.
2. Testing – Welds
   a. Xray first three welds.
   b. If first three pass, X-ray every 10th weld. If failure, xray previous 2 welds after the 10th weld.
   c. After each x-ray failure, x-ray the next three welds.
   d. All welds beyond first three plus every tenth are at no cost to the university

C. Testing – Steam Piping

1. The service piping shall be hydrostatically tested to 150 PSIG or 1-1/2 times the operating pressure, whichever is greater. The hydrostatic test pressure shall be held for no less than one hour. In large diameter pipes, pneumatic testing may be an acceptable alternative (at the discretion of the Engineer and the university). Proper safety precautions and coordination must be completes with the university Health and Safety department before testing is initiated.
2. Testing – Welds
   a. Xray first three welds.
   b. If first three pass, X-ray every 10th weld. If failure, xray previous 2 welds after the 10th weld.
   c. After each x-ray failure, x-ray the next three welds.
   d. All welds beyond first three plus every tenth are at no cost to the university.

END OF SECTION 23 21 13