PART I - GENERAL

1.1 SECTION INCLUDES

A. Underground Steam and Condensate Piping – FRP Jacket
B. Underground Steam and Condensate Piping – HDPE Jacket
C. Underground Steam and Condensate Piping – Cellular Glass Insulated
D. Underground Pumped Condensate Piping – Flexible Pre-insulated
   1. Installation by Horizontal Drilling Method
   2. Installation by Open Trenching Method

1.2 RELATED SECTIONS

A. 23 22 13 – Steam and Condensate Piping

1.3 REFERENCES

A. ASME/ANSI B31.1 – Power Piping
B. BS EN – 489 Buried District Heating Pipes - Joint Assembly
C. Illinois Steel Products Procurement Act

1.4 QUALITY ASSURANCE

A. Products and execution shall be in compliance with applicable codes and standards including those referenced above in paragraph 1.3 REFERENCES.
B. Installation, start-up and operation shall be in compliance with Manufacturer’s recommendations and IOM.

1.5 SUBMITTALS

A. Manufacturer’s Published Product Information
B. Manufacturer’s Installation and Operation Manuals
C. Manufacturer’s Certified Design and Installation Documents
   1. Project Specific Layout Drawings
   2. Project Specific Detail Drawings
   3. Pipe Stress, Thermal Expansion and Heat-loss Calculations (as applicable)
      Note: All manufacturer’s design documents and calculations shall bear stamp of registered professional engineer. Engineer shall be full-time employee of system Manufacturer.
D. Documentation for Factory Testing - HDPE Jacketed Product (as applicable)
   1. Written procedure for Injection of Foam Insulation
   2. Detailed Written Test Report
E. Detailed Record of On-Site Testing
F. Written Warranty, Signed by Manufacture’s Technician
G. Flush Water Samples
H. MSDS for Potentially Harmful Products, Chemicals, Coatings
I. Pipe Certifications
J. Welder Certifications

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Pipe and fittings shall be transported with ends covered water-tight with factory-installed temporary covers.
B. System components and supplies shall be protected from physical damage and inclement weather during transport.
C. Pipe, fittings, system components and supplies shall be stored indoors protected from physical damage and exposure to dust and debris.
D. Large pipe and fittings may be stored outdoors above grade on wood blocking with ends covered water-tight with factory-installed temporary covers.
E. Pipe, fittings, elastomeric materials and other supplies shall be protected from direct sunlight as recommended by manufacturer.

1.7 SITE SERVICES

A. Manufacturer shall provide factory-trained technician for on-site technical oversight and assistance. Technician shall be full-time employee of system Manufacturer.
B. Site services shall include post-delivery inspection of components; pre-construction training of installers; oversight of first end-to-end connection of service piping, casing and jacketing; and witnessing of all tests. Additional assistance shall be provided as deemed necessary by Installing Contractor, AE or Owner.

1.8 WARRANTY

A. Pipe and other system components shall be warranted to be free from defects in material and workmanship for period of 5 years from date of startup.
B. Installed system shall be warranted to perform as designed without leakage in service pipe, casing or jacket for period of 5 years from date of startup.
C. Warranty shall include replacement of defective materials and correction of any deficiency related to project including site restoration. All labor and materials shall be provided at no cost to Owner.
D. Written warranty document shall be formally submitted to Owner by system Manufacturer for review and approval at completion of project. Document shall be signed and dated by Manufacturer’s site technician indicating that installation is fully compliant with Manufacturer’s instructions and recommendations.

PART 2 – PRODUCTS

[Note to AE: The University prefers that steam distribution piping be located within accessible tunnels. However, it is not uncommon for economic considerations to promote the use of direct-buried underground systems in lieu of tunnel systems. When buried systems are utilized it is the goal of the University to use conduit type systems of the highest quality available. Such systems are available with either FRP or HDPE jacketing. A separate specification has been provided for each system type. With FRP systems there are two viable methods for sealing the jacket at joints in the system. The preferred method yields a continuum of FRP via hand layup of glass fabric and epoxy over each joint. The more common, yet less desirable, method involves the use of heat-shrink material to seal each joint. The specification provided herein is based upon a combination of the two methods. Hand layup is required as the primary sealing method. Heat shrink overlay is required as a secondary sealing system for additional leak protection.]
For steam and/or condensate piping serving small buildings and/or limited-life facilities it may be acceptable to use a less sophisticated non-conduit system. A product that has been used successfully by the University for such applications consists of service pipe with cellular glass insulation (i.e. Pittsburgh Corning “Foamglas”) wrapped with asphaltic membrane (i.e. “Pittwrap”). A specification for this type of system has been provided herein. This approach is typically reserved for “in-house” projects and requires project-specific University approval. Project cost and delivery requirements typically drive use of this type of system.

Options for pumped condensate systems: Conduit type systems are preferred for underground condensate piping. However, in certain cases, more economical systems may be utilized as approved by the University. One such system utilizes flexible preinsulated PEX piping. The University has installed such systems as “quick fixes” with success. Flexible systems are especially attractive for such projects given that they can be installed via horizontal directional boring. Specifications have been provided below for both directional boring and open trench installations.

A “middle ground” approach that uses a rigid preinsulated piping system for steam condensate (e.g. PermaPipe Polytherm, Rovanco Insul-8) is not approved. These systems rely upon field installation of compressive material outside the jacket for expansion compensation. The University has had negative experience with these products.

2.1 UNDERGROUND PIPING FOR STEAM AND CONDENSATE APPLICATIONS

– CONDUIT TYPE, FRP JACKET

Special Note: Specifications herein incorporate specific requirements more stringent than typical specifications for this type of system. Please read thoroughly before bidding and constructing.

A. General

1. Each underground piping system for steam and condensate applications shall be conduit type system incorporating an insulated steel service pipe surrounded by an air gap within an externally insulated steel casing covered with fiberglass (FRP) jacket.

2. Each individual conduit system shall incorporate a single service pipe within a casing unless indicated otherwise in project documents. This typically results in multiple conduits within a single trench. Exception: Pumped condensate and steam trap discharge lines may be factory-installed within a single casing.

3. Each system shall be Class 1 “drainable, dryable and air testable”. It shall accommodate continuous drainage at bottom of casing and continuous ventilation airflow at top of casing over its entire length.

4. All system components, including straight sections, fittings, anchors, etc. shall be factory pre-fabricated to final installed dimensions such that field modification not required.

5. Compensation for thermal expansion shall be accomplished utilizing factory pre-fabricated and pre-insulated expansion elbows, Z-bends, expansion loops and anchors specifically designed for intended application.

6. System shall be designed for HS-20 loading at 2’ cover, minimum.


8. System components shall comply with requirements of Illinois Steel Products Procurement Act

B. Approved Manufacturers:

1. Perma-Pipe Multi-Therm 500 (with UIUC modifications)

2. Perma-Pipe Multi-Therm 750 (with UIUC modifications)

3. Rovanco Insul-800 (with UIUC modifications)
4. Thermacor Duo-Therm 505 (with UIUC modifications)

C. Design Parameters
1. High pressure “Utility” steam system: 450 Deg. F, Pressure class 300
2. Medium pressure “Campus” steam system: 450 Deg. F, Pressure class 150
3. Condensate return system (pumped or gravity): 250 Deg. F, Pressure class 150

D. Service Pipe
1. Internal service piping shall be ASTM A106 Grade B seamless carbon steel pipe. As applicable, piping shall be supplied in 40-foot random lengths.
2. Steam pipe and fittings shall be standard weight. Condensate pipe and fittings shall be schedule extra strong.
3. Pipe shall be plain end for sizes 2” and smaller, beveled for sizes 2 ½” and larger.
4. Fittings shall be socket-welded for sizes 2” and smaller, butt-welded for sizes 2 ½” and larger.
5. All fittings shall be standard fittings.
6. All elbows shall be long radius.
7. Service piping shall be exposed 6” at each end to facilitate field joint fabrication.

E. Service Pipe Insulation
1. Service pipe insulation shall be mineral wool. Insulation shall pass boiling test requirements of Federal Agency Guidelines and shall be rated for 1,200 degrees F
2. Insulation thickness for steam and condensate applications shall be minimum 1 1/2” for pipe sizes 2” and smaller, 2 1/2” for pipe sizes 3” through 6”, 3” for pipe sizes 8” and larger.
3. High compressive strength insulating material (e.g. calcium silicate) shall be provided at pipe supports.
4. Pyrogel insulation may be substituted for mineral wool. Thickness shall be as required to yield equal thermal performance minimum.
5. In all cases, insulation thickness shall limit temperature of interface between steel casing and exterior foam insulation to 208 degrees F maximum. If insulation table or schedule is provided elsewhere within documents it shall dictate.
6. Service pipe insulation shall be secured to pipe with stainless steel bands at 18” intervals maximum.

F. Service Pipe Supports
1. Service pipe supports shall be installed within casing at 10’ maximum.
2. Supports shall be installed within annular space between OD of service pipe insulation and ID of casing in manner that maintains thermal isolation between service pipe and casing.
3. Each support shall occupy maximum 10% annular space and shall be open at top and bottom of casing to accommodate complete venting and draining as specified above.
4. Outer surface of service pipe insulation shall be protected from damage at supports by sleeve not less than 12 inches long, fitted with traverse and, where required, rotational arresters.

G. Casing
1. Casing shall be smooth wall, continuous seal welded, steel construction, 10 gauge for sizes 26” and smaller, 6 gauge for sizes 28” and larger.
2. Sections of oversized casing shall be incorporated within overall conduit system as required to accommodate movement of service piping due to thermal expansion/contraction without compressing service pipe insulation and without exceeding specified maximum temperature of casing/foam interface.

3. Transitions in casing size shall be made by system manufacturer and accomplished with eccentric fittings as required to accommodate specified requirements for draining and venting.

H. Casing Insulation
1. Casing insulation shall be spray applied polyurethane or polyisocyanurate foam.

2. Foam shall meet ASTM C591 for all straight lengths and fittings with characteristics as follows:
   a. Maximum K-factor:
      (a) 0.130 BTU-In/Hr./Ft2/Deg. F at 75F
      (b) 0.235 BTU-In/Hr./Ft2/Deg. F at 200F
   b. Minimum density: 2.0 lb./ft³
   c. Minimum closed cell content: 90%
   d. Minimum compression strength: 30 PSI

3. Insulation thickness shall be 1” minimum.

4. Foam shall be spray applied onto casing and visually inspected prior to jacketing to insure no voids are present.

I. Outer Jacket
1. Outer jacket shall be factory-applied filament-wound fiberglass applied directly onto foam insulation.

2. Elbows in jacketing system shall be constructed entirely of fiberglass and sealed by multiple layers of hand-laid fiberglass cloth. Use of chopped fiberglass spray applied and hand rolled is acceptable. No other material or construction method is allowed.

3. Jacket thickness on straight sections shall be 90 mil minimum. Jacket thickness on elbows, joints and anchors shall be 120 mil minimum.

J. Insulation Seals
1. Seal shall be provided over exposed foam insulation at ends of pipes and fittings. Seal shall prevent ingress of water even if components are completely submerged. Seal shall protect against moisture migration from one section of piping to another throughout entire length of system. Seal shall incorporate impervious film or membrane. Mastic as primary sealing agent not acceptable.

K. Anchors
1. Anchor plate shall be provided to restrain movement of service pipe at anchor location. Anchor plate shall be ½” thickness minimum.

2. Anchor plate shall not be welded directly to service pipe. Plate shall be thermally isolated to maintain temperature well below maximum recommended temperature of jacket.

3. Anchor plate shall have adequate open area at top and bottom within casing to accommodate complete venting and draining as specified above.

4. Steel casing shall be continuous seal welded to anchor plate on each side to provide watertight seal.
5. 10 gauge steel sleeve with diameter approximately equal to jacket shall be continuous seal welded to anchor plate on each side to provide water tight seal. Each sleeve shall be 24” length minimum.

6. Outer jacket shall butt or lap sleeve on each side.

7. High temperature insulation shall be provided within annular space between casing and sleeve on each side of anchor to prevent heat damage to foam insulation. Insulation shall be fiberglass, mineral wool or calcium silicate.

8. Continuum of FRP jacket shall be factory applied over sleeves and anchor plate.

L. Terminations

1. At each end of complete piping system where piping passes through building, vault or tunnel wall 10 gauge steel sleeve with diameter approximately equal to jacket shall be provided. Sleeve shall be 24” in length minimum and shall be centered over casing.

2. Continuum of FRP jacket shall be provided over full length of sleeve.

3. High temperature insulation shall be provided within annular space between casing and sleeve to prevent heat damage to foam insulation. Insulation shall be fiberglass, mineral wool or calcium silicate.

4. Steel cover plate shall be provided over annular space between casing and outer sleeve. Plate shall be continuous seal welded to casing and sleeve to provide watertight seal.

5. Steel cover plate shall be provided over annular space between service pipe and casing for stationary service pipe applications. Plate shall be continuous seal welded to service pipe and casing to provide watertight seal. All exposed metal surfaces shall be epoxy coated. Gland seal shall be provided in lieu of weld cover plate for non-stationary service pipe applications.

6. ¾” or 1” NPT drain and vent connections shall be provided in conduit and/or cover plate for draining and venting system. Ball valve with nipple and cap shall be provided at drain connection. Vertically oriented check valve shall be provided at vent connection. Valves shall comply with requirements specified elsewhere in project documents. [Note to AE: Insert reference to project-specific valve specification.]

M. Heat Shrink Field Joint Closure Material (for installation over fiberglass hand lay-up at field joints to provide extra leak protection)

1. Cross-linked polyolefin backing coated with protective heat activated adhesive and closure tab.
   a. 67 mil (1.7mm) “supplied” thickness.
   b. 195 degrees F minimum installation temperature.
   c. 175 degrees F minimum pipeline operating temperature

2. Basis of Design
   a. CanusaWrap WTNN

2.2 PIPING FOR STEAM AND CONDENSATE APPLICATIONS

– CONDUIT TYPE, HDPE JACKET

A. Special Note: Specifications herein incorporate specific requirements more stringent than typical specifications for this type of system. Please read thoroughly before bidding and constructing.

B. General

1. Each underground piping system for steam and condensate applications shall be a conduit type system incorporating an insulated steel service pipe surrounded by an air
gap within an externally insulated steel casing covered with high density polyethylene (HDPE) jacket.

2. Each individual conduit system shall incorporate a single service pipe within a casing unless indicated otherwise in project documents. This typically results in multiple conduits within a single trench. Exception: Pumped condensate and steam trap discharge lines may be factory-installed within a single casing.

3. Each system shall be Class 1 “drainable, dryable and air testable”. It shall accommodate continuous drainage at bottom of casing and continuous ventilation airflow at top of casing over its entire length.

4. All system components, including straight sections, fittings, anchors, etc. shall be factory pre-fabricated to final installed dimensions such that field modification not required.

5. Compensation for thermal expansion shall be accomplished utilizing factory pre-fabricated and pre-insulated expansion elbows, Z-bends, expansion loops and anchors specifically designed for intended application.

6. System shall be designed for HS-20 loading at 2’ cover, minimum.


C. Approved Manufacturers:
   1. Perma-Pipe Multi-Therm 500 (with UIUC modifications)
   2. Perma-Pipe Multi-Therm 750 (with UIUC modifications)
   3. Rovanco Insul-800 (with UIUC modifications)
   4. Thermacor Duo-Therm 505 (with UIUC modifications)

D. Design Parameters
   1. High pressure “Utility” steam system: 450 Deg. F, Pressure class 300
   2. Medium pressure “Campus” steam system: 450 Deg. F, Pressure class 150
   3. Condensate return system (pumped or gravity): 250 Deg. F, Pressure class 150

E. Service Pipe
   1. Internal service piping shall be ASTM A106 Grade B seamless carbon steel pipe. As applicable, piping shall be supplied in 40-foot random lengths.
   2. Steam pipe and fittings shall be standard weight. Condensate pipe and fittings shall be schedule extra strong.
   3. Pipe shall be plain end for sizes 2” and smaller, beveled for sizes 2 ½” and larger
   4. Fittings shall be socket-welded for sizes 2” and smaller, butt-welded for sizes 2.5” and larger.
   5. All fittings shall be standard fittings.
   6. All elbows shall be long radius.
   7. Service piping shall be exposed 6” at each end to facilitate field joint fabrication.

F. Service Pipe Insulation
   1. Service pipe insulation shall be mineral wool. Insulation shall pass boiling test requirements of Federal Agency Guidelines and shall be rated for 1,200 degrees F.
   2. Insulation thickness for steam and condensate applications shall be minimum 1 1/2” for pipe sizes 2” and smaller, 2 1/2” for pipe sizes 3” through 6”, 3” for pipe sizes 8” and larger.
3. High compressive strength insulating material (e.g. calcium silicate) shall be provided at pipe supports.

4. Pyrogel insulation may be substituted for mineral wool. Thickness shall be as required to yield equal thermal performance minimum.

5. In all cases, insulation thickness shall limit temperature of interface between steel casing and exterior foam insulation to temperature rating of insulation material...

6. Service pipe insulation shall be secured to pipe with stainless steel bands at maximum 18” intervals.

G. Service Pipe Supports

1. Service pipe supports shall be installed within casing at maximum 10’ intervals, maximum.

2. Supports shall be installed within annular space between OD of service pipe insulation and ID of casing in manner that maintains thermal isolation between service pipe and casing.

3. Each support shall occupy maximum 10% annular space and shall be open at top and bottom of casing to accommodate complete venting and draining as specified above.

4. Outer surface of service pipe insulation shall be protected from damage at supports by sleeve not less than 12 inches long, fitted with traverse and, where required, rotational arresters.

H. Casing

1. Casing shall be smooth wall, continuous seal welded, steel construction, 10 gauge for sizes 26” and smaller, 6 gauge for sizes 28” and larger.

2. Sections of oversized casing shall be incorporated within overall conduit system as required to accommodate movement of service piping due to thermal expansion/contraction without compressing service pipe insulation and without exceeding specified maximum temperature of casing/foam interface.

3. Transitions in casing size shall be made by system Manufacturer and accomplished with eccentric fittings as required to accommodate specified requirements for draining and venting.

I. Casing Insulation

1. Casing insulation shall be polyurethane or polyisocyanurate foam.

2. Foam shall meet ASTM C591 for all straight lengths and fittings with characteristics as follows:
   a. Maximum K-factor:
      (a) 0.130 BTU-In/Hr./Ft²/Deg. F at 75F
      (b) 0.235 BTU-In/Hr./Ft²/Deg. F at 200F
   b. Minimum density: 2.0 lb./ft³
   c. Minimum closed cell content: 90%
   d. Minimum compression strength: 30 PSI

3. Insulation thickness shall be 1 1/2 minimum.

4. Foam shall be spray applied onto casing and visually inspected prior to jacketing to insure no voids are present. As an alternate method, foam may be injected into annular space between casing and jacket and inspected with thermographic device to insure no voids are present.
5. Prior to inspection, detailed written procedures for inspection process shall be submitted to AE and Owner for approval. AE and Owner shall be given opportunity to witness all inspections. 72 hour prior notice shall be provided. Inspection of each item shall be conducted to fully satisfy requirements of AE and Owner as determined prior to and/or during on-site observation. Detailed written record of results of inspection shall be provided.

J. Outer Jacket
1. Outer jacket shall be seamless high density polyethylene (HDPE).
2. Elbows in jacketing system shall be HDPE, single-piece molded construction or multi-piece extrusion welded construction.
3. Thickness of HDPE material on straight sections, elbows, joints and anchors shall be 0.125" for jackets smaller than 12" diameter, 0.150" for jackets 12-24" diameter, and 0.175" for jackets larger than 24" diameter.
4. Jacket shall be completely bonded to foam insulation.

K. Insulation Seals
1. Seal shall be provided over exposed foam insulation at ends of pipes and fittings. Seal shall prevent ingress of water even if components are completely submerged. Seal shall protect against moisture migration from one section of piping to another throughout entire length of system.

L. Field Joints
1. Joints in jacketing system at straight runs and elbows shall be EN 489 certified heat shrinkable, double-sealing field joint system. System shall be Canusa CSC-X w/ Ultraceal or Rovanco RhinoJoint. Standard heat-shrink sealing system not acceptable. EN 489 field joint sealing system shall consist of:
   a. Inner foam sealing shrink film.
   b. Separately applied 4" wide adhesive strips.
   c. Outer tubular casing of cross-linked HDPE, thickness per requirements of EN 489.
      (a) Uninterrupted tube, 30" length minimum, slid over pipe jacket prior to welding service pipe.
      (b) Not flat stock wrapped around joint after applying foam.
   d. 6" wide wrap-around heat shrink sleeves with low-preheat / high shear strength properties applied over ends of casing. Shrink sleeves shall be Canusa UltraSeal or equal.

M. Anchors
1. Anchor plate shall be provided to restrain movement of service pipe at anchor location. Plate shall be ½" thickness minimum.
2. Anchor plate shall not be welded directly to service pipe. Plate shall be thermally isolated to maintain temperature well below maximum recommended temperature of jacket.
3. Anchor plate shall have adequate open area at top and bottom within casing to accommodate complete venting and draining as specified above.
4. Steel casing shall be continuous seal welded to anchor plate on each side to provide watertight seal.
5. 10 gauge steel sleeve with diameter approximately equal to jacket shall be centered over casing and continuous seal welded to anchor plate on each side to provide watertight seal. Sleeves shall extend 36" minimum on each side of anchor plate. Sleeves
shall be fusion bonded epoxy coated, factory applied. Coating thickness shall be 20 mil, minimum.

6. High temperature insulation shall be provided within annular space to prevent heat damage to foam insulation. Insulation shall be fiberglass, mineral wool or calcium silicate.

7. Jacket shall butt or lap sleeve at interface.

8. Canusa CRP (Coating Repair Patch) shrink material shall be applied over interface of jacket and sleeve. Standard heat shrink material not allowed.

9. Anchor plate and sleeve welds shall be coated with high temperature mastic.

N. Terminations

1. At each end of complete piping system where piping passes through building, vault or tunnel wall 10 gauge steel sleeve with diameter approximately equal to jacket shall be provided. Sleeve shall be 24" in length minimum and shall be centered over casing. Sleeve shall be fusion bonded epoxy coated, factory applied. Coating thickness shall be 20 mil, minimum.

2. Jacket shall butt or lap sleeve at interface. Canusa CRP (Coating Repair Patch) shrink material shall be applied over interface of jacket and sleeve. Standard heat shrink material not allowed.

3. High temperature insulation shall be provided within annular space between casing and sleeve to prevent heat damage to foam insulation. Insulation shall be fiberglass, mineral wool or calcium silicate.

4. At end of sleeve steel cover plate shall be provided over annular space between casing and sleeve. Plate shall be continuous seal welded to casing and sleeve to provide watertight seal.

5. Steel cover plate shall be provided over annular space between service pipe and casing. Plate shall be continuous seal welded to service pipe and casing to provide watertight seal. All exposed metal surfaces shall be epoxy coated. Gland seal shall be provided in lieu of welded cover plate for non-stationary service pipe applications.

6. ¾” or 1” NPT drain and vent connections shall be provided in conduit and/or cover plate for draining and venting system. Ball valve with nipple and cap shall be provided at drain connection. Vertically oriented check valve with down-turned piping shall be provided at vent connection. Valves shall comply with requirements specified elsewhere in project documents. [Note to AE: Insert reference to project-specific valve specification.]

2.3 UNDERGROUND PIPING FOR STEAM AND CONDENSATE APPLICATIONS

– NONCONDUIT TYPE, CELLULAR GLASS INSULATED

A. General

1. Each underground piping system for steam and condensate applications shall be steel service pipe with field applied cellular glass insulation and flexible heat sealed asphaltic laminate jacket.

2. Compensation for thermal expansion shall be accomplished utilizing oversized insulation at elbows, Z-bends, and expansion loops.


4. Location and configuration of anchor, piping and insulation shall be as indicated in design documents.

B. Basis of Design

1. Pittsburg Corning FOAMGLAS / PITTWRAP
C. Design Parameters
1. High pressure “Utility” steam system: 450 Deg. F, Pressure class 300
2. Medium pressure “Campus” steam system: 450 Deg. F, Pressure class 150
3. Condensate return system (pumped or gravity): 250 Deg. F, Pressure class 150

D. Service Pipe
1. Steam and condensate service pipe shall be ASTM A106 Grade B seamless carbon steel pipe. As applicable, piping shall be supplied in 40-foot random lengths.
2. Steam pipe and fittings shall be standard weight. Condensate pipe and fittings shall be schedule extra strong.
3. Pipe shall be plain end for sizes 2” and smaller, beveled end for sizes 2 ½” and larger.
4. Fittings shall be socket-welded for sizes 2” and smaller, butt-welded for sizes 2 ½” and larger.
5. All elbows shall be long radius.

E. Anchors
1. Anchors shall consist of steel anchor plate welded to service pipe. Plate shall be ½” thickness minimum.
2. Anchors shall be sized and placed as indicated in design documents.

F. Guides
1. Guides shall utilize steel pipe-in-pipe construction with continuous welded attachment to steel anchoring plate. Plate shall be ½” thickness minimum.
2. Guides shall be sized and placed as indicated in design documents.

G. Pipe Insulation
1. Pipe insulation shall be cellular glass, rigid premolded, ASTM C552 Type II

<table>
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<th>Temp</th>
<th>3/4” &amp; Smaller</th>
<th>1 - 1 ¼”</th>
<th>1 ½ - 3”</th>
<th>4 - 6”</th>
<th>8” &amp; Larger</th>
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</tbody>
</table>

H. Jacket
1. Jacket shall be asphaltic laminate, fiberglass reinforced with aluminum-foil vapor barrier, 125 mil, heat sealed.
2. Basis of Design: Owens Corning PITTWRAP

2.4 UNDERGROUND PIPING FOR PUMPED CONDENSATE APPLICATIONS

- PREINSULATED TYPE, FLEXIBLE

[Note to AE: Although this product is viewed by the University to be lower in quality than a rigid conduit system there are applications for which it is the product of choice. It is suitable for use with directional boring in lieu of open trenching, which yields substantial installed cost reduction. Installation via directional boring minimizes disruption to plantings, surface features and underground structures. Flexible systems of this type can also be used in open trench applications if desired. Specifications for both installation methods are provided below. A disadvantage of non-rigid systems is vulnerability to future damage by excavation/probing operations. Additionally, it can be difficult to determine if a leak exists in the system. By comparison, the presence of a leak is easily determined in conduit systems. Leaking fluid is visible as it flows from conduit drain(s). Given these limitations, installation of a flexible system as specified herein requires project-specific approval from UIUC Utilities and Energy Services Division.]

A. General
1. Underground piping for pumped steam condensate applications shall be flexible piping system consisting of PEX service pipe, foam insulation and polyethylene jacket.
2. System shall not require thermal expansion compensation. Expansion loops or offsets shall not be required. Piping shall expand and contract as a unit without overstressing or adversely affecting materials.

B. Approved Manufacturers
1. Rahau Insulplex
2. Rovanco Rhinoflex

C. Design Parameters
1. Pumped steam condensate system: 200 Degrees F, 80 PSIG

D. Service Pipe
1. Service pipe shall be PEX-A highest quality cross-linked polyethylene. PEX-B and PEX-C materials not allowed. Wall thickness shall be as indicated in Wall Thickness Table below.
2. Joints in piping system shall be kept to minimum. Full roles of piping shall be used as required to achieve this. All joints in service piping and terminations shall use brass F2080 fitting assemblies as manufactured by Sioux Chief or EVERLOC fitting assemblies as manufactured by Rehau.

E. Insulation
1. Insulation shall be polyurethane foam with 2.0 LB/SF minimum density, 90% minimum closed cell content and initial thermal conductivity 0.16 BTU IN / HR SF Deg. F. Systems using open cell insulation are not allowed.
2. Space between service pipe and jacket shall be completely filled with insulation. Insulation shall be void free. Insulation shall be bonded to both surfaces. Systems with non-bonded construction are not allowed.

F. Jacket
1. Jacket shall be seamless polyethylene. Wall thickness shall be as indicated in Wall Thickness Table below.
2. Wall Thickness

G. Service pipe and jacket wall thickness shall be as follows:

<table>
<thead>
<tr>
<th>Nominal Service Pipe Size</th>
<th>Service Pipe Wall Thickness</th>
<th>Jacket Wall Thickness</th>
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<tbody>
<tr>
<td>1”</td>
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<td>0.19”</td>
<td>0.13</td>
</tr>
<tr>
<td>2”</td>
<td>0.25”</td>
<td>0.13</td>
</tr>
<tr>
<td>2 ½”</td>
<td>0.31</td>
<td>0.13</td>
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<td>3”</td>
<td>0.36</td>
<td>0.13</td>
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PART 3 – EXECUTION

3.1 UNDERGROUND PIPING FOR STEAM AND CONDENSATE APPLICATIONS – CONDUIT TYPE, FRP JACKET

A. General
1. All aspects of transportation, handling, storage, installation, testing and cleaning of system components shall be in compliance with Manufacturer’s recommendations.

B. Storage
1. Pipe, fittings and other system components shall be stored above grade on wood blocking or equivalent thereof and shall not be stored on ground or at ground level.
2. Pipe and fittings shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by Manufacturer.
3. Factory-installed temporary covers shall be kept in place over open ends of system components during storage. All components shall be adequately protected in manner that prevents ingress of dirt and water to satisfaction of AE and Owner.
4. Heat shrink material shall be protected from heat and shall be stored in shade at job site.

C. Pipe Laying
1. Pipe shall be placed in trench in lengths not to exceed 40’ random
2. Pipe shall be located within trench with all clearances between pipes and trench walls in compliance with project documents and Manufacturers recommendations. [Note to AE: Provide reference to project specific drawings.]
3. After placement within trench and throughout installation process, open ends of system shall be kept covered in manner that provides positive watertight seal even if/when piping system becomes submerged. Strict and consistent compliance shall be maintained to satisfaction of AE and Owner.
4. Piping systems shall be installed so as to maintain 36” minimum depth of cover.
5. Steam and condensate piping shall be installed with minimum pitch of 1” in 40’ in direction of flow.

D. Field Joints
1. Service pipe shall be welded and tested. Welds shall be red mill primed. Bare section of pipe at each joint shall be covered with split insulation to match prefabricated system. Insulation shall be mechanically secured.

2. After service pipe has been insulated, steel closure sleeve shall be installed over gap in casing at each joint and shall overlap it on both ends. Wall thickness of sleeve shall be comparable to that of casing. All potential leak paths at sleeve shall be continuous seal welded. Welds shall be red mill primed.

3. After casing has been sealed, coated and tested, casing sleeve shall be insulated with foam to match prefabricated system using removable mold. After foam insulation has cured, mold shall be removed and foam shall be visually inspected for voids. Any voids shall be filled with additional foam insulation. Non-removable molds that do not allow foam inspection are not acceptable.

4. Exposed insulation shall be covered with multiple layers of hand-laid fiberglass cloth and epoxy yielding non-interrupted fiberglass jacket at each joint. Thickness of hand-laid fiberglass shall be 120 mil, minimum. No other material or construction method allowed. After application of fiberglass entire area shall be covered with heat shrink material to provide additional leak protection. Heat shrink material shall extend 6” minimum beyond hand-worked area.

E. Anchors

1. Cast-in-place concrete anchor block shall be provided at location of each anchor plate to capture and encase plate. Anchor block shall be cast within forms on undisturbed earth to design dimensions. Anchor block shall not be cast without use of forms.

2. Anchor block shall be positioned an adequate distance from wall of adjacent structure to allow access to sealing device at wall penetration (e.g. “LinkSeal”). Distance shall be 18” minimum.

3. In lieu of anchor block, existing structure (e.g. building foundation wall, steam vault, etc.) may be utilized for directly anchoring of piping system with approval of Manufacturer and AE. In such case adequate structural support shall be provided and anchor plate shall be attached in manner that prevents leakage. Anchor system shall be approved by Manufacturer and AE prior to installation.

F. Wall Penetrations

1. Jacketed pipe shall be inserted through sleeve or core-drilled hole in wall structure at each end. Annular space shall be sealed with link-type modular rubber seal (e.g. “LinkSeal”) with stainless steel hardware. Rubber material shall be “low durometer” per Manufacturer’s recommendations.

2. Two “LinkSeals” shall be provided at each wall penetration to ensure perpendicular orientation of piping relative to wall, one at exterior and one at interior of wall. Nuts shall be exposed to facilitate seal removal.

G. Testing

1. Service piping in its entirety shall be hydrostatically tested to 150 psig or 1.5 times operating pressure, whichever is greater prior to installation of mineral wool insulation at each joint.

2. Casing in its entirety shall be air pressure tested at 10 PSIG prior to installation of foam insulation in addition to bubble testing at each joint.

3. In each case, test pressure shall be held for two hours minimum.

4. AE and/or Owner shall witness all testing. 24 hour prior notice shall be provided.

H. Cleaning
1. Each length of pipe and each fitting shall be inspected for internal cleanliness prior to installation and shall be cleaned to satisfaction of AE and Owner.

2. As specified above, piping system shall be kept clean during installation process.

3. After testing is complete, entire piping system shall be chemically cleaned and flushed in compliance with project documents and to satisfaction of AE and Owner. [Note to AE: Provide reference to project specific specification.]

4. After flushing is complete, a sample of flush water shall be submitted to Owner for testing and approval. Cleaning and/or flushing shall be repeated as required to achieve approved sample.

I. Excavation and Backfilling

1. Trench excavation and backfilling shall be in accordance with project documents and to satisfaction of AE and Owner. [Note to AE: Provide reference to project specific drawings and specification.]

2. Prior to laying pipe in trench, bedding material shall be provided in manner that will provide uniform support of piping system over its full length. Bedding material shall be compacted sand with minimum thickness of 4”.

3. After laying pipe, trace wire shall be provided in accordance with project documents. Trace wire shall be provided full length for each conduit. [Note to AE: Provide reference to project-specific trace wire specification and drawing. Specification shall comply with UIUC Facility Standards Section 33 05 26.23 – Utility Identification Trace Wires.

4. After laying piping and prior to backfilling, Owner shall be contacted to allow GPS recording of all system locations.

5. After pipe testing and cleaning operations have been completed, trench shall be evenly backfilled with sand in 6” compacted layers to 6” minimum height above top of insulated piping system. Compaction shall be 95% Modified Proctor. Remaining trench shall be backfilled with suitable material in 6” compacted lifts. Compaction shall be 90% Modified Proctor. Compaction shall be monitored by independent testing agency. 12” minimum topsoil shall be provided at surface.

6. During backfill operation warning tape shall be provided in accordance with project documents. [Note to AE: Insert reference to project-specific specification and/or trench drawing detail].

7. Trace wire termination box and concrete support pad shall be provided at each end of piping system. Wires shall be landed and labeled within termination box. All aspects of trace wire installation shall be in compliance with project documents. [Note to AE: Insert reference to project-specific specification.]

J. Site Management

1. Site shall be prepared and managed in accordance with project documents and to satisfaction of AE and Owner. [Note to AE: Insert reference to project-specific specification.]

2. Trees, plantings, structures, etc. shall be protected.

K. Site Restoration

1. At completion of project, site shall be returned to original condition.

2. Disturbed areas shall be seeded/sodded and maintained in compliance with project documents and to satisfaction of Owner. [Note to AE: Provide specification reflecting requirements of UIUC Grounds Department.]

3.2 UNDERGROUND PIPING FOR STEAM AND CONDENSATE APPLICATIONS – CONDUIT TYPE, HDPE JACKET
A. General
1. All aspects of transportation, handling, storage, installation, testing and cleaning of system components shall be in compliance with Manufacturer’s recommendations.

B. Storage
1. Pipe, fittings and other system components shall be stored above grade on wood blocking or equivalent thereof and shall not be stored on ground or at ground level.
2. Pipe and fittings shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by Manufacturer.
3. Factory-installed temporary covers shall be kept in place over open ends of system components during storage. All components shall be adequately protected in manner that prevents ingress of dirt and water to satisfaction of AE and Owner.

C. Pipe Laying
1. Pipe shall be placed in trench in lengths not to exceed 40’ random
2. Pipe shall be located within trench with all clearances between pipes and trench walls in compliance with project documents and Manufacturers recommendations. [Note to AE: Provide reference to project specific drawings.]
3. After placement within trench and throughout installation process, open ends of system shall be kept covered in manner that provides positive watertight seal even if/when piping system becomes submerged. Strict and consistent compliance shall be maintained to satisfaction of AE and Owner.
4. Piping systems shall be installed so as to maintain 36” minimum depth of cover.
5. Steam and condensate piping shall be installed with minimum pitch of 1” in 40’ in direction of flow.

D. Anchors
1. Cast-in-place concrete anchor block shall be provided at each anchor plate to capture and encase plate. Anchor block shall be cast within forms on undisturbed earth to design dimensions. Anchor block shall not be cast without use of forms.
2. Anchor block shall be positioned an adequate distance from wall of adjacent structure to allow access to sealing device at wall penetration (e.g. “LinkSeal”). Distance shall be 18” minimum.
3. In lieu of anchor block, existing structure (e.g. building foundation wall, steam vault, etc.) may be utilized for directly anchoring of piping system with approval of Manufacturer and AE. In such case adequate structural support shall be provided and anchor plate shall be attached in manner that prevents leakage. Anchor system shall be approved by Manufacturer and AE prior to installation.

E. Field Joints
1. See paragraph above entitle 2.2 L Field Joints for specifications for EN 489 certified field joint system.
2. Tubular heat shrink material shall be slid over conduit system to one side of joint. Heat shrink material shall be uninterrupted tube as required per EN 489 certification.
3. Service pipe shall be welded and tested. Welds shall be red mill primed. Bare section of pipe at each joint shall be covered with split insulation to match prefabricated system. Insulation shall be mechanically secured.
4. After service pipe has been insulated, steel closure sleeve shall be installed over gap in casing at each joint and shall overlap it on both ends. Wall thickness of sleeve shall be comparable to that of casing. All potential leak paths at sleeve shall be seal welded. Welds shall be red mill primed.
5. After casing has been sealed, coated and tested, casing sleeve shall be insulated with foam to match prefabricated system. After foam insulation has cured, mold shall be removed and foam shall be visually inspected for voids. Any voids shall be filled with additional foam insulation. Non-removable molds that do not allow foam inspection are not acceptable.

6. After foam inspection, joint shall be sealed with EN 489 double-sealing field joint system as specified. After application and heating of inner sealing shrink film and adhesive strips, tubular heat shrink casing shall be slid over joint, centered and heat applied. 6” wide wrap-around heat shrink sleeves shall be applied over ends of casing for additional seal.

7. Manufacturer of EN 489 joint sealing system (not manufacturer of conduit system) shall oversee installation of first joint to certify installation.

F. Wall Penetrations

1. Jacketed pipe shall be inserted through sleeve or core-drilled hole in wall structure at each end. Annular space shall be sealed with link-type modular rubber seal (e.g. “LinkSeal”) with stainless steel hardware. Rubber material shall be “low durometer” per Manufacturer’s recommendations.

2. Two “LinkSeals” shall be provided at each wall penetration to ensure perpendicular orientation of piping relative to wall, one at exterior and one at interior of wall. Nuts shall be exposed to facilitate seal removal.

G. Testing

1. Service piping in its entirety shall be hydrostatically tested to 150 psig or 1.5 times operating pressure, whichever is greater prior to installation of mineral wool insulation at each joint.

2. Casing in its entirety shall be air pressure tested at 10 PSIG prior to installation of foam insulation in addition to bubble testing at each joint.

3. In each case, test pressure shall be held for two hours minimum.

4. AE and/or Owner shall witness all testing. 24 hour prior notice shall be provided.

H. Cleaning

1. Each length of pipe and each fitting shall be inspected for internal cleanliness prior to installation and shall be cleaned to satisfaction of AE and Owner.

2. As specified above, piping system shall be kept clean during installation process.

3. After testing is complete, entire piping system shall be chemically cleaned and flushed in compliance with project documents and to satisfaction of AE and Owner. [Note to AE: Provide reference to project specific specification.]

4. After flushing is complete, a sample of flush water shall be submitted to Owner for testing and approval. Cleaning and/or flushing shall be repeated as required to achieve approved sample.

I. Excavation and Backfilling

1. Trench excavation and backfilling shall be in accordance with project documents and to satisfaction of AE and Owner. [Note to AE: Insert reference to project-specific specification and/or trench drawing detail].

2. Prior to laying pipe in trench, bedding material shall be provided in manner that will provide uniform support of piping system over its full length. Bedding material shall be compacted sand with minimum thickness of 4”.

3. After laying pipe, trace wire shall be provided in accordance with project documents. Trace wire shall be provided full length for each conduit. [Note to AE: Provide...
reference to project-specific trace wire specification and drawing. Specification shall comply with UIUC Facility Standards Section 33 05 26.23 – Utility Identification Trace Wires.

4. After laying piping and prior to backfilling, Owner shall be contacted to allow GPS recording of all system locations.

5. After pipe testing and cleaning operations have been completed, trench shall be evenly backfilled with sand in 6” compacted layers to 6” minimum height above top of insulated piping system. Compaction shall be 95% Modified Proctor. Remaining trench shall be backfilled with suitable material in 6” compacted lifts. Compaction shall be 90% Modified Proctor. Compaction shall be monitored by independent testing agency. 12” minimum topsoil shall be provided at surface.

6. During backfill operation warning tape shall be provided in accordance with project documents. [Note to AE: Insert reference to project-specific specification and/or trench drawing detail].

7. Trace wire termination box and concrete support pad shall be provided at each end of piping system. Wires shall be landed and labeled within termination box. All aspects of trace wire installation shall be in compliance with project documents. [Note to AE: Insert reference to project-specific specification.]

J. Site Management

1. Site shall be prepared and managed in accordance with project documents and to satisfaction of AE and Owner. [Note to AE: Insert reference to project-specific specification.]

2. Trees, plantings, structures, etc. shall be protected.

K. Site Restoration

1. At completion of project, site shall be returned to original condition.

2. Disturbed areas shall be seeded/sodded and maintained in compliance with project documents and to satisfaction of Owner. [Note to AE: Provide specification reflecting requirements of UIUC Grounds Department.]

3.3 UNDERGROUND PIPING FOR STEAM AND CONDENSATE APPLICATIONS
– NONCONDUIT TYPE, CELLULAR GLASS INSULATION

A. General

1. All aspects of transportation, handling, storage, installation, testing and cleaning of system components shall be in compliance with Manufacturer’s recommendations.

B. Storage

1. Insulation, jacket and accessory materials shall be stored indoors in clean dry environment. During staging prior to installation, pipe and materials shall be stored above grade and shall not come into contact with ground. Storage and protection of pipe, insulation and materials shall be to satisfaction of AE and Owner.

2. Pipe and fittings shall be kept dry and free of oil, grease, rust and other contaminants prior to and during installation. Temporary covers shall be kept in place over open ends of pipe and fittings.

C. Pipe Laying

1. Pipe shall be placed in trench in lengths not to exceed 40’ random.
2. Pipe shall be located within trench with all clearances between pipes and trench walls in compliance with project documents and Manufacturer’s recommendations. [Note to AE: Provide reference to project specific drawings.]

3. During pipe placement and joining, pipe shall be supported on temporary wood blocking to maintain final installed pipe elevation to facilitate installation of insulation and jacket. Blocking shall be removed as installation progresses.

4. After placement within trench and throughout installation process, open ends of system shall be kept covered in manner that provides positive watertight seal even if/when piping system becomes submerged. Strict and consistent compliance shall be maintained to satisfaction of AE and Owner.

5. Piping systems shall be installed so as to maintain 36” minimum depth of cover.

6. Steam and condensate piping shall be installed with minimum pitch of 1” in 40’ in direction of flow.

D. Field Joints
   1. Pipe joints shall be socket welded for sizes 2” and smaller, butt welded for sizes 2 1/2” and larger.

E. Anchors
   1. Steel anchor plates shall be provided in accordance with Manufacturer’s design and installation documents. Anchor plates shall be continuous seal welded to pipe.
   2. Anchor blocks shall be cast-in-place concrete within forms to achieve design dimensions. Blocks shall be supported on undisturbed earth.
   3. Piping system shall be designed and installed such that no movement occurs at wall penetrations.

F. Guides
   1. If indicated by design documents, line guides shall be provided at both ends of expansion loops and zees for proper pipe alignment. Guide construction shall be in accordance with Manufacturer’s design and installation documents.
   2. Guide blocks shall be cast-in-place concrete within forms to achieve design dimensions. Blocks shall be supported on undisturbed earth.

G. Wall Penetrations
   1. Insulation shall terminate at wall exterior at each end.
   2. Uninsulated pipe shall be inserted through sleeve or core-drilled hole in wall structure at each end. Annular space shall be sealed with link-type modular rubber seal (e.g. “LinkSeal”).
   3. Two LinkSeals shall be provided at each wall penetration to ensure perpendicular orientation of piping relative to wall, one at exterior and one at interior of wall. Nuts shall be exposed to facilitate seal removal.

H. Testing
   1. Service piping in its entirety shall be hydrostatically tested to 150 psig or 1.5 times operating pressure, whichever is greater prior to installation of mineral wool insulation at each joint.
   2. Casing in its entirety shall be air tested at 10 PSIG prior to installation of foam insulation including bubble testing at each joint.
   3. In each case, test pressure shall be held for two hour minimum.
   4. AE and/or Owner shall witness all testing. 24 hour prior notice shall be provided.
I. Cleaning

1. Each length of pipe and each fitting shall be inspected for internal cleanliness prior to installation and shall be cleaned to satisfaction of AE and Owner.

2. As specified above, piping system shall be kept clean during installation process.

3. After testing is complete, entire piping system shall be chemically cleaned and flushed in compliance with project documents and to satisfaction of AE and Owner. [Note to AE: Provide reference to project specific specification.]

4. A sample of flush water shall be submitted to Owner for testing and approval. Cleaning and/or flushing shall be repeated as required to achieve approved sample.

J. Insulation

1. Factory formed cellular glass insulating blocks shall be applied to pipe with butt joints staggered and tightly butted. All joints shall be tightly fitted to eliminate voids by refitting or replacing sections of insulation.

2. At anchors and guides jacketed insulation shall be butted against plate on each side and sealed with high temperature sealant. Jacketed insulation shall be imbedded and fully captured within cast in place anchor/guide block.

3. Expansion loops, ells, zees and lead-off lines shall be insulated with oversize insulation. Inside diameter of oversize insulation shall be same as exterior diameter of straight run pipe insulation. Oversize insulation shall be same thickness as straight run insulation but not less than 2”. Oversize insulation shall overlap straight run insulation, 9” minimum. All oversize insulation shall be encased in concrete, 3” minimum thickness. Concrete encasement shall extend past oversize insulation 12” minimum.

4. Concrete pad supports shall be provided to center pipe within oversize insulation and allow free movement. Pads shall be located and configured in accordance with Manufacturer’s design documents. Pads shall be molded to inside of oversize insulation and may be prefabricated or field fabricated.

5. Tapered oversize insulation shall be applied over pipe insulation at wall exterior and sealed to pipe insulation and wall with asphalt coating and reinforcing fabric.

6. First section of installed insulation shall be inspected and approved by Engineer and Owner to ensure proper procedure prior to continuance of installation.

K. Jacket

1. Jacket material shall be stored in cool area out of direct sunlight during periods of hot weather. Jacket shall be stored indoors in heated environment during cold weather.

2. Jacketing shall be kept free of dirt and other contaminants during installation.

3. Jacket material shall be cut to appropriate length and wrapped tight around circumference of insulation. 2” longitudinal overlap shall be provided. Overlap shall be heat sealed using propane torch. Lap shall be pressed in place using pointed trowel.

4. Successive sections of jacket shall be applied with 2” overlap at butt joints. After overlap is sealed, 4” butt strip shall be applied and sealed to ensure joint integrity.

5. At irregular surfaces such as elbows, tees, tapers, etc. jacket material shall be precut to fit contour. 3” overlap shall be provided.

6. Each lap seal shall be visually inspected to ensure molten asphalt has flowed into and cooled in lap.

7. Completed installation shall be inspected and approved by Engineer and Owner prior to backfilling.

L. Excavation and Backfilling
1. Trench excavation and backfilling shall be in accordance with project documents and to satisfaction of AE and Owner.  [Note to AE: Provide reference to project specific drawings and specification.]

2. Prior to laying pipe in trench, bedding material shall be provided in manner that will provide uniform support of piping system over its full length. Bedding material shall be compacted sand with minimum thickness of 4”.

3. When laying pipe, all clearances between pipes and trench walls shall be maintained as recommended by Manufacturer.

4. After laying pipe, trace wire shall be provided in accordance with project documents. Trace wire shall be provided full length for each conduit.  [Note to AE: Provide reference to project-specific trace wire specification and drawing. Specification shall comply with UIUC Facility Standards Section 33 05 26.23 – Utility Identification Trace Wires.]

5. After laying piping and prior to backfilling, Owner shall be contacted to allow GPS recording of all system locations.

6. During backfilling, care shall be taken to prevent damage to vulnerable jacket.

7. After pipe testing and cleaning operations have been completed, trench shall be evenly backfilled with sand in 6” compacted layers to 6” minimum height above top of insulated piping system. Compaction shall be 95% Modified Proctor. Remaining trench shall be backfilled with suitable material in 6” compacted lifts. Compaction shall be 90% Modified Proctor. Compaction shall be monitored by independent testing agency. 12” minimum topsoil shall be provided at surface.

8. During backfill operation warning tape shall be provided in accordance with project documents.  [Note to AE: Insert reference to project-specific specification and/or trench drawing detail].

9. Trace wire termination box and concrete support pad shall be provided at each end of piping system. Wires shall be landed and labeled within termination box. All aspects of trace wire installation shall be in compliance with project documents.  [Note to AE: Insert reference to project-specific specification.]

M. Site Management

1. Site shall be prepared and managed in accordance with project documents and to satisfaction of AE and Owner.  [Note to AE: Insert reference to project-specific specification.]

2. Trees, plantings, structures, etc. shall be protected to satisfaction of AE and Owner.

3.4 UNDERGROUND PIPING FOR PUMPED CONDENSATE APPLICATIONS

- FLEXIBLE PREINSULATED TYPE, DIRECTIONAL BORE INSTALLATION

A. Application Limitations

1. PEX piping shall be exposed to liquid condensate only, 200 degrees F maximum temperature.

2. Piping shall never be exposed to live steam. System design shall preclude any possibility of direct exposure to steam.

B. General

1. All aspects of transportation, handling, storage, installation, testing and cleaning of system components shall be in compliance with Manufacturer’s recommendations.

C. Storage

1. Pipe and other system components shall be stored above grade on wood blocking or equivalent thereof and shall not be stored on ground or at ground level.
2. Pipe shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by Manufacturer.

3. Factory-installed temporary covers shall be kept in place over open ends of piping during storage. All components shall be adequately protected in a manner that prevents the ingress of dirt and water to satisfaction of AE and Owner.

D. Pipe Installation
1. Pipe shall be placed underground using standard directional boring methodology.
2. Pipe shall be dispensed directly from coil during directional bore pull-back. Pipe shall not be uncoiled prior to pull-back.
3. Bore pit shall be provided for each field joint. Number of field joints shall be kept to minimum.
4. Open ends of system shall be kept covered in manner that provides positive watertight seal even if/when piping system becomes submerged (not convenient and easily violated). Strict and consistent compliance shall be maintained to satisfaction of AE and Owner.
5. Buried piping shall be installed with 36” minimum depth of cover.

E. Field Joints
1. Rahau EVERLOC compression fitting assemblies shall be used to join ends of service pipe. Fitting assemblies shall be as manufactured by Rahau only. Installation shall comply with Manufacturer’s installation instructions.
2. Prior to installation of fitting assembly, jacket and insulation shall be cut back on each side per manufactures instructions. After installation of assembly, two-part polyurethane foam insulation and jacket closure shall be provided per manufacturer’s instructions. Heat shrink material shall be applied over entire joint. It shall be extended 6” minimum on each side.

F. Wall Penetrations
1. Jacketed pipe shall be inserted through sleeve or core-drilled hole in structure wall at each end. Annular space shall be sealed with link-type modular rubber seal (e.g. “LinkSeal”).
2. Two LinkSeals shall be provided at each wall penetration to ensure perpendicular orientation of piping relative to wall, one at exterior and one at interior of wall. Nuts shall be exposed to facilitate seal removal.

G. Terminations
1. Jacket and service pipe shall be cut back to desired length and heat shrink end caps shall be applied. Ends of service pipe shall be exposed.
2. Rahau EVERLOC compression fittings shall be used to attach desired metallic connections to ends of service pipe. NPT connections shall typically be provided on service pipe 2” and smaller. Flanged connections shall typically be provided on service pipe 2 ½” and larger.
3. Service piping in its entirety shall be hydrostatically tested to 1.5 times design pressure.
4. In each case, test pressure shall be held for two hours minimum.
5. AE and/or Owner shall witness all testing. 24 hour prior notice shall be provided.

H. Testing
1. Service piping in its entirety shall be hydrostatically tested to 75 psig prior to installation of foam insulation at each joint.
2. Test pressure shall be held for two hours minimum.
3. AE and/or Owner shall witness all testing. 24 hour prior notice shall be provided.

I. Cleaning
1. Each length of pipe and each fitting shall be inspected for internal cleanliness prior to installation and shall be cleaned to satisfaction of AE and Owner.
2. As specified above, piping system shall be kept clean during installation process.
3. After testing is complete, entire piping system shall be chemically cleaned and flushed in compliance with project documents and to satisfaction of AE and Owner. [Note to AE: Insert reference to project-specific specification.]
4. After flushing is complete, a sample of flush water shall be submitted to Owner for testing and approval. Cleaning and/or flushing shall be repeated as required to achieve approved sample.

J. Excavation and Backfilling
1. Excavation and backfilling of bore pits shall be in accordance with project documents and to satisfaction of AE and Owner. [Note to AE: Insert reference to project-specific specification.]
2. Prior to placing in pit, bedding material shall be provided in manner that will provide uniform support of piping system. Bedding material shall be compacted sand with minimum thickness of 4”.
3. In conjunction with pipe pull-back trace wire shall be provided in accordance with project documents. [Note to AE: Provide reference to project-specific trace wire specification and drawing. Specification shall comply with UIUC Facility Standards Section 33 05 26.23 – Utility Identification Trace Wires.]
4. After pulling and joining pipe and prior to backfilling, Owner shall be contacted to allow GPS recording of all system locations.
5. After pipe testing and cleaning operations have been completed, pits shall be evenly backfilled with sand in 6” compacted layers to a minimum height of 6” above top of insulated piping system. Remaining open pit shall be backfilled with suitable material in 6” compacted lifts. 12” minimum topsoil shall be provided at surface.
6. Trace wire termination box and concrete support pad shall be provided at each end of piping system. Wires shall be landed and labeled within termination box. All aspects of trace wire installation shall be in compliance with project documents. [Note to AE: Insert reference to project-specific specification.]

K. Site Management
1. Site shall be prepared and managed in accordance with project documents and to satisfaction of AE and Owner. [Note to AE: Insert reference to project-specific specification.]
2. Trees, plantings, structures, etc. shall be protected to satisfaction of AE and Owner.

L. Site Restoration
1. At completion of project, site shall be returned to original condition.
2. Disturbed areas shall be seeded/sodded and maintained in compliance with project documents and to satisfaction of Owner. [Note to AE: Provide specification reflecting requirements of UIUC Grounds Department.]

3.5 UNDERGROUND PIPING FOR PUMPED CONDENSATE APPLICATIONS
- FLEXIBLE PREINSULATED TYPE, OPEN TRENCH INSTALLATION
A. Application Limitations
1. PEX piping shall be exposed to liquid condensate only, 200 degrees F maximum temperature.
2. Piping shall never be exposed to live steam. System design shall preclude any possibility of direct exposure to steam.

B. General
1. All aspects of transportation, handling, storage, installation, testing and cleaning of system components shall be in compliance with Manufacturer’s recommendations.

C. Storage
1. Pipe and other system components shall be stored above grade on wood blocking or equivalent thereof and shall not be stored on ground or at ground level.
2. Pipe shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by Manufacturer.
3. Factory-installed temporary covers shall be kept in place over open ends of piping during storage. All components shall be adequately protected in a manner that prevents the ingress of dirt and water to satisfaction of AE and Owner.

D. Pipe Laying
1. Piping shall be uncoiled along trench without dragging or pulling straight.
2. Once system components have been placed within trench, open ends of system shall be kept covered in manner that provides a positive watertight seal even if/when piping system becomes submerged. Strict and consistent compliance shall be maintained to satisfaction of AE and Owner.
3. Piping shall be located within trench with all clearances between pipes and trench walls in compliance with project documents and Manufacturers recommendations. [Note to AE: Provide reference to project specific drawings.]
4. Buried piping shall be installed with 36” minimum depth of cover.

E. Field Joints
1. If length of piping system exceeds maximum full coil length use compression fitting assembly as manufactured by Sioux Chief or Rehau to join ends of service pipe. Fitting assembly shall be installed per Manufacturer’s installation instructions.
2. Prior to installation of fitting assembly, cut back jacket and insulation on each side per manufactures instructions. After installing assembly, insulate with two-part polyurethane foam and provide jacket closure per Manufacturer’s instructions. Apply heat shrink material over entire joint. Extend 6” minimum on each side.

F. Wall Penetrations
1. Jacketed pipe shall be inserted through sleeve or core-drilled hole in structure wall at each end. Anular space shall be sealed with link-type modular rubber seal (e.g. “LinkSeal”).
2. Two LinkSeals shall be provided at each wall penetration to ensure perpendicular orientation of piping relative to wall, one at exterior and one at interior of wall. Nuts shall be exposed to facilitate seal removal.

G. Terminations
1. Jacket and service pipe shall be cut back to desired length and heat shrink end caps shall be applied. Ends of service pipe shall be exposed.
2. Sioux Chief F2080 or Rehau EVERLOC compression fittings shall be used to attach desired metallic connections to ends of service pipe. NPT connections shall typically
be provided on service pipe 2” and smaller. Flanged connections shall typically be provided on service pipe 2 ½” and larger.

H. Testing
1. Service piping in its entirety shall be hydrostatically tested to 75 psig prior to installation of foam insulation at each joint.
2. Test pressure shall be held for two hours minimum.
3. AE and/or Owner shall witness all testing. 24 hour prior notice shall be provided.

I. Cleaning
1. Each length of pipe and each fitting shall be inspected for internal cleanliness prior to installation and shall be cleaned to satisfaction of AE and Owner.
2. As specified above, piping system shall be kept clean during installation process.
3. After testing is complete, entire piping system shall be chemically cleaned and flushed in compliance with project documents and to satisfaction of AE and Owner. [Note to AE: Insert reference to project-specific specification.]
4. After flushing is complete, a sample of flush water shall be submitted to Owner for testing and approval. Cleaning and/or flushing shall be repeated as required to achieve approved sample.

J. Excavation and Backfilling
1. Trench excavation and backfilling shall be in accordance with project documents and to satisfaction of AE and Owner.
2. Prior to laying pipe in trench, bedding material shall be provided in manner that will provide uniform support of piping system over its full length. Bedding material shall be compacted sand with minimum thickness of 4”.
3. After laying pipe, trace wire shall be provided in accordance with project documents. Trace wire shall be provided full length for each conduit. [Note to AE: Provide reference to project-specific trace wire specification and drawing. Specification shall comply with UIUC Facility Standards Section 33 05 26.23 - Utility Identification Trace Wires.]
4. After laying piping and prior to backfilling, Owner shall be contacted to allow GPS recording of all system locations.
5. After pipe testing and cleaning operations have been completed, trench shall be evenly backfilled with sand in 6” compacted layers to 6” minimum height above top of insulated piping system. Compaction shall be 95% Modified Proctor. Remaining trench shall be backfilled with suitable material in 6” compacted lifts. Compaction shall be 90% Modified Proctor. Compaction shall be monitored by independent testing agency. 12” minimum topsoil shall be provided at surface.
6. During backfill operation warning tape shall be provided in accordance with project documents. [Note to AE: Insert reference to project-specific specification and/or trench drawing detail.]
7. Trace wire termination box and concrete support pad shall be provided at each end of piping system. Wires shall be landed and labeled within termination box. All aspects of trace wire installation shall be in compliance with project documents. [Note to AE: Insert reference to project-specific specification.]

K. Site Management
1. Site shall be prepared and managed in accordance with project documents and to satisfaction of AE and Owner. [Note to AE: Insert reference to project-specific specification.]
2. Trees, plantings, structures, etc. shall be protected to satisfaction of AE and Owner.

L. Site Restoration

1. At completion of project, site shall be returned to original condition.

2. Disturbed areas shall be seeded/sodded and maintained in compliance with project documents and to satisfaction of Owner. [Note to AE: Provide specification reflecting requirements of UIUC Grounds Department.]

END OF SECTION 33 63 13

This section of the U of I Facilities Standards establishes minimum requirements only. It should not be used as a complete specification.