PART I - GENERAL

1.1

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 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 jackets. FRP jacketed systems incorporate improved designs at end seals, anchors and fitting connections as compared to HDPE jacketed systems, thus reducing potential for jacket failure and resultant ingress of ground water. For this reason, FRP jacketed systems are preferred and shall be basis of design whenever possible. With FRP systems there are two viable methods for sealing jackets 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 specification provided below is based upon this method. The more economical approach involves the use of heat-shrink material to seal each joint. If economics determine that this approach be used the following specification for FRP jacketed systems must be edited to reflect this. Contrary to common opinion, FRP jackets are equally resistant to physical damage as HDPE jackets. Regardless, due to competitive bidding requirements it may be necessary to specify an HDPE system in lieu of an FRP system. Thus, a standard specification for HDPE jacketed systems has been provided (see articles 2.2 and 3.2 of this document).

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 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 consists of 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. Given positive experience to-date, the University is considering approving these systems for new installations. Specifications have been provided below for both directional boring and open trench installations.

A “middle ground” approach that uses rigid preinsulated piping system for steam condensate (e.g. PermaPipe Polytherm) 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

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 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. 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.

3. 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.

4. Each system shall be “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.

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


7. System design pressures / temperatures shall be as follows:
   a. High pressure “Utility” steam system: 450 Deg. F, Pressure class 300
   b. Medium pressure “Campus” steam system: 450 Deg. F, Pressure class 150
   c. Condensate return system (pumped or gravity): 250 Deg. F, Pressure class 150

8. Manufacturer’s design and installation documents, including system specific layout drawings, stress calculations, heat-loss calculations and installation details, shall be formally submitted to AE and Owner by system Manufacturer for review prior to approval.

9. All Manufacturer’s design documents shall bear stamp of registered professional engineer. Engineer shall be full-time employee of system Manufacturer.

10. Manufacturer shall provide factory-trained technician for on-site technical oversight and assistance. Technician shall be full-time employee of system Manufacturer. 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.

11. Manufacturer of piping system shall have minimum five years experience providing complete systems of this type. [Note to AE: Some projects do not allow the inclusion of this language. Please check with the UI Project Manager.]


13. Regardless of manufacturer, outer jacket shall be fiberglass construction as specified herein.

C. 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 160.

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 elbows shall be long radius.

6. Service piping shall be exposed 6” at each end to facilitate field joint fabrication.
D. Service Pipe Insulation

1. Service pipe insulation shall be mineral wool. Insulation shall pass boiling test requirements of Federal Agency Guidelines.

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. Aerogel 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 provided within specifications, insulation table shall dictate.

6. System design documents shall include heat calculations confirming 208 Deg. F. temperature limitation will not be exceeded. Documents shall be submitted for review prior to approval and shall be stamped by registered professional engineer as specified above.

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

E. Service Pipe Supports

1. Service pipe supports shall be installed within casing at maximum 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.

F. 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. Casing shall be epoxy coated including all field joints.

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.

G. Casing Insulation

1. Casing insulation shall be spray applied polyurethane foam.

2. Foam shall meet ASTM C591 with characteristics as follows for all straight lengths and fittings: Maximum K-factor 0.18 BTU-In/Hr/Fl2/Deg. F, minimum density 2 lb/ft³, minimum closed cell content 90%, minimum compression strength 40 PSI.

3. Insulation thickness shall not exceed 1”.

4. Foam shall be spray applied onto casing and visually inspected prior to jacketing 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 allowed 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.

H. 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. After hand application of fiberglass material, entire area shall be covered with heat shrink material to provide additional leak protection.
3. Joints in jacketing system and terminations at anchors shall be sealed in same manner.
4. Jacket thickness on straight sections shall be 90 mil minimum. Jacket thickness on elbows, joints and anchors shall be 120 mil minimum.

I. Heat Shrink Field Joint Closure Material (for installation over fiberglass jacket at field joints)
   a. 110 mil thickness.
   b. 195 degrees F minimum installation temperature.
   c. 175 degrees F minimum pipeline operating temperature.

J. Anchors
1. Cast-in-place concrete anchor blocks shall be utilized for anchoring underground piping systems and shall be placed as indicated on Manufacturer’s engineering documents. Anchor blocks shall be supported by undisturbed earth.
2. In no case shall anchor plate be welded directly to service pipe. It shall be thermally isolated to maintain its temperature well below maximum recommended temperature of jacket.
3. Anchor plate shall have adequate open area at top and bottom of casing to accommodate complete venting and draining as specified above.
4. Steel casing shall be continuously welded to anchor plate to provide a watertight seal.
5. FRP jacket material shall be sealed to anchor plate in same manner described above for sealing elbows and joints.
6. Anchor plate shall be completely covered with hand-laid or chop sprayed fiberglass for corrosion protection.

K. Terminations
1. Sealant shall be provided on exposed foam insulation at ends of pipes and fittings. Sealant shall prevent ingress of water even if components are completely submerged. Sealant shall protect against moisture migration from one section of piping to another throughout entire length of system.
2. 10-gauge epoxy coated steel support sleeve shall be provided immediately beneath outer jacket at end of complete piping system to provide increased rigidity at wall penetration. Sleeve shall be 36” in length minimum. If construction method does not allow sleeve to be installed beneath jacket, sleeve shall be tight fitted over exterior of jacket. Heat shrink sleeve shall be provided over entire steel sleeve and shall overlap jacket 6”, minimum.
3. Steel cover plate shall be provided over annular space between service pipe and casing. It shall be continuous welded to service pipe and casing to provide watertight seal. ¾” or 1” NPT drain and vent connections shall be provided at appropriate locations in cover plate. Ball valve with nipple and cap shall be provided at each connection. Valves shall comply with requirements specified elsewhere in project documents. [Note to AE: Insert reference to project-specific valve specification.]

L. Warranty

1. Pipe and other system components shall be warranted to be free from defects in material and workmanship for period of 25 years.

2. Installed system shall be warranted to perform as designed without leakage in service pipe, casing or jacket for period of 25 years.

3. Warranty shall include replacement of defective materials with like-kind or superior materials at no expense to Owner.

4. Written warranty shall be provided at completion of project. Warrantees shall be signed and dated by Manufacturer’s site technician indicating that installation is fully compliant with Manufacturer’s instructions and recommendations.

2.2 PIPING FOR STEAM AND CONDENSATE APPLICATIONS
– CONDUIT TYPE, HDPE JACKET

[Note to AE: This specification for an HDPE jacketed system is provided only as required to satisfy competitive bidding requirements. FRP jacketed systems are preferred and shall be basis of design when possible. Thus, a standard specification for FRP jacketed systems has also been provided (see articles 2.1 and 3.1 of this document).]

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. 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.

3. 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.

4. Each system shall be “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.

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


7. System design pressures / temperatures shall be as follows:
   a. High pressure "Utility" steam system: 450 Deg. , Pressure class 300
   b. Medium pressure "Campus" steam system: 450 Deg. F, Pressure class 150
   c. Condensate return system (pumped or gravity): 250 Deg. F, Pressure class 150

8. Manufacturer’s design and installation documents, including system specific layout drawings, stress calculations, heat-loss calculations and installation details, shall be
formally submitted to AE and Owner by system Manufacturer for review prior to approval.

9. All Manufacturer’s design documents shall bear stamp of registered professional engineer. Engineer shall be full-time employee of system Manufacturer.

10. Manufacturer shall provide factory-trained technician for on-site technical oversight and assistance. Technician shall be full-time employee of system Manufacturer. 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.

11. Manufacturer of piping system shall have minimum five years experience providing complete systems of this type. [Note to AE: Some projects do not allow the inclusion of this language. Please check with the UI Project Manager.]


C. 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 160.

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 elbows shall be long radius.

6. Service piping shall be exposed 6” at each end to facilitate field joint fabrication.

D. Service Pipe Insulation

1. Service pipe insulation shall be mineral wool. Insulation shall pass boiling test requirements of Federal Agency Guidelines.

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. Aerogel 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 provided within specifications, insulation table shall dictate.

6. System design documents shall include heat calculations confirming 208 Deg. F. temperature limitation shall not be exceeded. Documents shall be submitted for review prior to approval and shall be stamped by registered professional engineer as specified above.

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

E. 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.

F. 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. Casing shall be epoxy coated, including all field joints.

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.

G. Casing Insulation

1. Casing insulation shall be spray applied polyurethane foam.

2. Foam shall meet ASTM C591 with characteristics as follows for all straight lengths and fittings: Maximum K-factor 0.18 BTU-In/Hr/Ft2/Deg. F, minimum density 2 lb/ft3, minimum closed cell content 90%, minimum compression strength 40 PSI.

3. Insulation thickness shall not exceed 1”.

4. Foam shall be spray applied onto casing and visually inspected prior to jacketing 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 allowed 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.

H. 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. Hot-air welded joints not acceptable. Tape of any kind is not acceptable as joint sealant. Elbows in jacketing system may also be constructed entirely of fiberglass (FRP) and sealed by multiple layers of hand-laid fiberglass cloth. Use of chopped fiberglass spray applied and hand rolled also acceptable. After hand application of fiberglass material, entire area shall be covered with heat shrink material to provide additional leak protection.

3. Joints in jacketing system at straight runs, elbows and anchors shall be sealed with heat shrink material or with FRP applied as described above.

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

I. Heat Shrink Field Joint Closure Material (for additional protection)

   a. 110 mil thickness.
b. 195 degrees F minimum installation temperature.
c. 175 degrees F minimum pipeline operating temperature


J. Anchors
1. Cast-in-place concrete anchor blocks shall be utilized for anchoring underground piping systems. Anchor blocks shall be placed as indicated on Manufacturer’s engineering documents. Anchor blocks shall be supported by undisturbed earth.
2. In no case shall anchor plate be welded directly to service pipe. It 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 of casing to accommodate complete venting and draining as specified above.
4. Steel casing shall be continuously welded to anchor plate to provide watertight seal.
5. HDPE jacket material or heat shrink material shall not come into direct contact with anchor plate.
6. Special Configuration Required: 10-gauge epoxy coated steel sleeve with ID slightly greater than OD of HPDE jacket shall be attached to each side of anchor plate. Each sleeve shall be minimum 20” long and shall be continuous welded to plate to provide watertight seal. Heat shrink material shall not be used for sleeve-to-plate seal. HDPE jacket shall extend within sleeve for distance of 6” minimum. Heat shrink sleeve shall be installed at outer end of steel sleeve to yield watertight seal between steel sleeve and jacket. Heat shrink material shall overlap jacket and steel sleeve for minimum 6” each direction.
7. Anchor plate and steel sleeves shall be epoxy coating to provide corrosion protection.

K. Terminations
1. Sealant shall be provided on exposed foam insulation at ends of pipes and fittings. Sealant shall prevent ingress of water even if components are completely submerged. Sealant shall protect against moisture migration from one section of piping to another throughout entire length of system.
2. 10-gauge epoxy coated steel support sleeve shall be provided immediately beneath outer jacket at ends of complete piping system to provide increased rigidity at wall penetration. Sleeve shall be 36” in length, minimum. If construction method does not allow sleeve to be installed beneath jacket, sleeve shall be tight fitted over exterior of jacket. Heat shrink sleeve shall be provided over entire steel sleeve and shall overlap jacket 6” minimum.
3. Steel cover plate shall be provided over annular space between service pipe and casing shall be continuous welded to service pipe and casing to provide watertight seal. ¾” or 1” NPT drain and vent connections shall be provided at appropriate locations in cover plate. Ball valve with nipple and cap shall be provided at each connection. Valves shall comply with requirements specified elsewhere in project documents. [Note to AE: Insert reference to project-specific valve specification.]

L. Warranty
1. Pipe and other system components shall be warranted to be free from defects in material and workmanship for period of 25 years.
2. Installed system shall be warranted to perform as designed without leakage in service pipe, casing or jacket for period of 25 years.
3. Warranty shall include replacement of defective materials with like-kind or superior materials at no expense to Owner.
4. Written warranty shall be provided at completion of project. It shall be signed and dated by Manufacturer’s site technician indicating that installation is fully compliant with Manufacturer’s instructions and recommendations.

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.
   3. Design documents showing system layout and installation details shall be formally submitted by AE to Owner for review prior to approval. Thermal expansion and stress analysis documentation shall be included.
   5. System design pressures / temperatures shall be as follows:
      a. High pressure “Utility” steam system: 450 Deg. , Pressure class 300
      b. Medium pressure “Campus” steam system: 450 Deg. F, Pressure class 150
      c. Condensate return system (pumped or gravity): 250 Deg. F, Pressure class 150

B. 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 160.
   3. Pipe shall be plain end for sizes 2” and smaller, beveled end for sizes 2 ½” and larger.
   4. Fittings shall be shall be socket-welded for sizes 2” and smaller, butt-welded for sizes 2 ½” and larger.
   5. All elbows shall be long radius.

C. Anchors
   1. Anchors shall consist of steel anchor plate imbedded within cast-in-place concrete anchor block supported on undisturbed earth.
   2. Anchors shall be sized and placed as indicated in design documents.
   3. Configuration of anchor, piping and insulation shall be as indicated in design documents.

D. Guides
   1. Guides shall utilize steel pipe-in-pipe construction with continuous welded attachment to steel plate. Plate shall be imbedded within cast-in-place concrete block supported on undisturbed earth.
   2. Guides shall be sized and placed as indicated in design documents.
   3. Configuration of guide, piping and insulation shall be as indicated in design documents.

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

<table>
<thead>
<tr>
<th>Temp</th>
<th>Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3/4” &amp; Smaller</td>
</tr>
<tr>
<td>351-450F</td>
<td>2.5</td>
</tr>
<tr>
<td>251-350F</td>
<td>1.5</td>
</tr>
<tr>
<td>201-250F</td>
<td>1.5</td>
</tr>
<tr>
<td>141-200F</td>
<td>1.0</td>
</tr>
<tr>
<td>40-140F</td>
<td>1.0</td>
</tr>
</tbody>
</table>

F. 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

G. Warranty
1. Pipe and other system components shall be warranted to be free from defects in material and workmanship for period of 25 years.
2. Installed system shall be warranted to perform as designed without leakage in service pipe and jacket for period of 25 years.
3. Warranty shall include replacement of defective materials with like-kind or superior materials at no expense to Owner.

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 system is vulnerability to future damage by excavation/probing operations. Additionally, it can be difficult to determine if a leak exists in the system. With conduit systems the presence of a leak is easily determined. Leaking fluid will flow from conduit drain(s).]

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.
3. System design pressures / temperatures shall be as follows:
   a. Pumped steam condensate system: 200 Degrees F, 80 PSIG

4. Manufacturer’s design and installation documents including installation details and system specific layout drawings shall be formally submitted to AE and Owner for review prior to approval.

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

6. Manufacturer shall have minimum five years experience providing complete systems of this type. [Note to AE: Some projects do not allow the inclusion of this language. Please check with the UIUC Project Manager.]

7. Approved Manufacturers: Rahau Insulplex, Rovanco Rhinoflex, Permapipe Pex-Gard

B. 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 EVERLOC fitting assemblies as manufactured by Rehau. No other manufacturer of fitting assemblies are approved.

C. 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.

D. Jacket

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

2. Wall Thickness

E. 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>
</tr>
</thead>
<tbody>
<tr>
<td>1”</td>
<td>0.13”</td>
<td>0.09</td>
</tr>
<tr>
<td>1 ¼”</td>
<td>0.16”</td>
<td>0.10</td>
</tr>
<tr>
<td>1 ½”</td>
<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>
</tr>
<tr>
<td>3”</td>
<td>0.36</td>
<td>0.13</td>
</tr>
</tbody>
</table>

F. Warranty
1. Pipe and other system components shall be warranted to be free from defects in material and workmanship for period of 25 years.

2. Installed system shall be warranted to perform as designed without leakage in service pipe, casing or jacket for period of 25 years.

3. Warranty shall include replacement of defective materials with like-kind or superior materials at no expense to Owner.

4. Written warranty shall be provided at completion of project. It shall be signed and dated by Manufacturer’s site technician indicating that installation is fully compliant with Manufacturer’s instructions and recommendations.

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.

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 42” 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 blocks shall be supported on undisturbed earth and shall be cast within forms to maintain design dimensions.

2. Existing structures (e.g. building foundation wall, steam vault, etc.) may be utilized for anchoring piping system. In such cases adequate structural support shall be provided and anchor plate shall be attached in manner that prevents leakage. Anchor system shall be approved by Manufacturer prior to installation.
E. Field Joints

1. Service pipe shall be welded and tested. 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 seal welded.

3. Epoxy coating shall be applied to uncoated surfaces at field joints. Bare metal and adjacent factory coating shall be thoroughly cleaned of oil, weld slag and debris to satisfaction of AE and Owner prior to field coating.

4. After casing has been sealed, coated and tested, casing sleeve shall be insulated with foam to match prefabricated system. Accomplish with 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.

5. Exposed insulation shall be covered with multiple layers of hand-laid fiberglass cloth yielding non-interrupted fiberglass jacket at each joint. Use of chopped fiberglass, spray applied and hand rolled is also acceptable. 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.

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”).

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 tested at 10 PSIG prior to installation of foam insulation at each joint.

3. Test pressure shall be held for one hour 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. [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. Remaining trench shall be backfilled with suitable material in 6” compacted lifts. 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 in compliance with project documents. [Note to AE: Insert reference to project-specific specification and/or trench drawing detail].

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 42” 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 blocks shall be supported on undisturbed earth and shall be cast within forms to maintain design dimensions.

2. Existing structures (e.g. building foundation wall, steam vault, etc.) may be utilized for anchoring piping system. In such cases adequate structural support shall be provided and anchor plate shall be attached in manner that prevents leakage. Anchor system shall be approved by Manufacturer prior to installation.

E. Field Joints

1. Service pipe shall be welded and tested. 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 seal welded.

3. Epoxy coating shall be applied to uncoated surfaces at field joints. Bare metal and adjacent factory coating shall be thoroughly cleaned of oil, weld slag and debris to satisfaction of AE and Owner prior to field coating.

4. After casing has been sealed, coated and tested, casing sleeve shall be insulated with foam to match prefabricated system. Accomplish with 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.

5. After foam inspection, joint shall be covered with heat-shrinkable sleeve that extends a minimum of 6” beyond end of factory-fabricated jacket on each side.

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”).

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 tested at 10 psig. This shall be accomplished prior to installation of foam insulation at each joint.

3. Test pressure shall be held for one hour 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. [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. Remaining trench shall be backfilled with suitable material in 6” compacted lifts. 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 in compliance with project documents. [Note to AE: Insert reference to project-specific specification and/or trench drawing detail.]

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 42” 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 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”).

H. Testing

1. Piping in its entirety shall be hydrostatically tested to 150 psig or 1.5 times operating pressure, whichever is greater, prior to installation of insulation.

2. Test pressure shall be held for one hour 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: 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. [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. Trench shall be evenly backfilled with sand in 6” compacted layers to 6” minimum height above top of insulated piping system. Remaining trench shall be backfilled with suitable material in 6” compacted lifts. 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 in compliance with project documents. [Note to AE: Insert reference to project-specific specification and/or trench drawing detail].

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.

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. 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.
   4. Buried piping shall be installed with 42” 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”).

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. Testing
   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 a minimum of one hour.
5. AE and/or Owner shall witness all testing. 24 hour prior notice shall be provided.

H. Testing
1. Piping in its entirety shall be hydrostatically tested to 150 psig or 1.5 times operating pressure, whichever is greater prior to installation of insulation.
2. Test pressure shall be held for one hour 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 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.

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 Manufacturer’s recommendations. [Note to AE: Provide reference to project specific drawings.]
   4. Buried piping shall be installed with 42” 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 Rahau 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”).

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. 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. Testing
H. Testing
1. Piping system in its entirety shall be hydrostatically tested to 1.5 times design pressure.
2. In each case, test pressure shall be held for one hour 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. [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 a minimum height of 6” above top of insulated piping system. Remaining trench shall be backfilled with suitable material in 6” compacted lifts. 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 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.

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