

1. SCOPE

- 1.1 This guideline covers the installation of TRYMER® Rigid Polyisocyanurate Insulation on refrigeration piping systems, including associated vessels, tanks, and equipment. Guidelines are provided for both indoor and outdoor applications.
- 1.2 TRYMER insulation is also suitable for use on defrost drain piping and hot gas system piping. For details on these applications, see the JM guideline on the use of TRYMER insulation in hot applications.
- 1.3 Product data sheets and other JM literature are referenced throughout this guideline. Visit www.jm.com for the latest version of these documents.
- 1.4 The information contained in this guideline and referenced JM documents are current as of January 2, 2020. This guideline is subject to revision without notice. Contact the Johns Manville Customer Information Group at 800-231-1024 or your local JM Representative for the most recent version of this guideline or other JM referenced literature.
- 1.5 Due to the variations in service conditions and use, this guideline may not be pertinent for every application. A design or specifying engineer can create specifications tailored to particular applications or owner's needs. Such a design or specification engineering service may be more familiar with local conditions, budgets, environment, and desired service life of the system allowing them to generate a precise specification.
- 1.6 It is the intent of this document to provide guidelines for the installation of TRYMER insulation. This guideline may not be suitable and shall not be used for the purpose of installing another insulation manufacturer's products. While supplemental insulation products may be referenced in this guideline, JM recommends consulting the manufacturers of such products for proper installation and handling.
- 1.7 This guideline is offered as a guide for the purpose described herein. No warranty of procedures, either expressed or implied is intended. All other express or implied warranties of merchantability or fitness for a particular purpose are disclaimed.

2. GENERAL

- 2.1 All piping shall be free of foreign substances and free of surface moisture or frost prior to the application of insulation.
- 2.2 All insulation material shall be delivered to the project site in original, unbroken factory packaging labelled with product designation and thickness. The shipping package should not be air-tight. Shipment of materials from the manufacturer to the installation location shall be in weather-tight transportation. Insulation materials delivered to the job-site shall be stored so as to protect the materials from moisture

and weather during storage and installation. Insulation material shall be protected from sunlight to avoid exposure to UV light from the sun.

- 2.3 All testing of piping systems shall be completed prior to the installation of the insulation system.
- 2.4 Refer to insulation thickness charts in Appendix C to determine recommended insulation thickness based on desired design criteria for ambient and service conditions.

3. MATERIALS OF CONSTRUCTION

3.1 INSULATION MATERIALS FOR PIPING, FITTINGS, AND VALVES

- 3.1.1 Insulation shall be TRYMER 1800 or 2000 XP Rigid Polyisocyanurate Insulation manufactured by Johns Manville
- 3.1.2 Insulation shall have a maximum thermal conductivity of 0.19 BTU-in/hr.-ft²-°F (0.027 W/m-°C) at 75°F mean.

3.2 FABRICATION OF INSULATION

- 3.2.1 Insulation shall be fabricated in required shapes from bun stock in accordance with ASTM C-450 "Standard Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments" and C-585 "Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)". Insulation shall be factory fabricated from bun stock.
- 3.2.2 Fittings, such as valves, valve stations, flanges, 90° and 45° elbows, and tees shall be two-piece fly cut or routed as the preferred fabrication method. For diameters too large for fly cutting or routing, the pieces shall be fabricated in two halves with each half made up of mitered sections. Both methods shall be in accordance with ASTM C-450 and ASTM C-585. Larger outer diameter valves and flanges may be slightly oversized, and cavities filled with tightly packed loose fiberglass or polyurethane spray foam (see Figure 1 in Appendix B). The size and number of cavities shall be kept to a minimum. Refer to applications sections 4.1.3 and 4.1.4 for related additional information.
- 3.2.3 Store the bun stock at normal shop (indoor) conditions for at least 24 hours before fabrication. This will allow the TRYMER bun stock to equilibrate to the shop conditions. For best fabrication quality, it is recommended that TRYMER buns be fabricated into pipe shells in conveyor direction (36" direction) to maximize flatness. For factory applied vapor retarder, the fabricated pipe shells may be aged for 24 hours before vapor retarder attachment. Similarly, after fabrication of the fittings/elbows/tees, allow the cut pieces to age for 24 hours before factory application of the vapor retarder to the fabricated pieces. After application of vapor retarder, fabricated pipe shells shall not be stored for

more than one month either in the warehouse or at a job site.

3.3 ADHESIVES, JOINT SEALERS & MASTICS

- 3.3.1 Solvent based adhesives, joint sealers and mastics may be used in contact with TRYMER insulation. Mastics shall remain flexible at the lowest expected ambient temperature.
- 3.3.2 Joint sealers for sealing joints of insulation or PVC jacketing slip joints, shall be vapor retarder type, moisture and water resistant, non-hardening, and flexible with a service temperature range from -50°F to +200°F.
- 3.3.3 Vapor retarder type mastic or joint sealers should be applied on insulation longitudinal joints and butt joints to prevent moisture and moisture vapor infiltration. Typical mastic or joint sealer can be CHIL-PERM CP-30, CHIL-PERM WB CP-35, AK-CRYL CP-9, VI-CRYL CP-10/ 11 from Childers Products Company or approved equal. Please consult mastic or joint sealant manufacturer for recommended products.
- 3.3.4 Solvent or water adhesives may be used to attach the Saranex® CX Film to the outer surface of the TRYMER insulation for factory applied Saranex CX Film. Refer to the Saranex CX installation guidelines. Consult adhesive manufacturer's literature for instructions on handling adhesives including required operating temperatures. Potential adhesives for use in this application include:
- Childers CP 88 adhesive (solvent based)
 - Foster 81-05 adhesive (solvent based)
 - Foster 85-50 adhesive (water based)
 - Childers CP 56 adhesive (water based)
 - Foster 85-60 adhesive (water based)

3.4 VAPOR RETARDER

- 3.4.1 For pipe, vessels, and equipment the vapor retarder shall be Saranex 540 CX Vapor Retarder Film and Saranex 520 CX Vapor Retarder Tape or approved equal. If greater physical strength of the vapor retarder is desired, Saranex 560 CX Film or approved equal shall be used. Refer to ASTM standards C755, C921, and C1136 for information on selection and specification of vapor retarders. Refer to product literature and installation guidelines on Saranex CX film and tape for recommended application instructions.
- 3.4.2 Elbows and fittings shall be wrapped with Saranex 520 CX Vapor Retarder Tape. When operating temperature is $\leq 32^{\circ}\text{F}$ or when a permeance of 0.02 perms or better is required, elbows and fittings shall be wrapped with Saranex 520 CX Vapor Retarder Tape with a 50% overlap of successive courses. When operating temperature is $> 32^{\circ}\text{F}$, elbows and fittings shall be wrapped with a single layer of Saranex 520 CX Tape with minimum overlap of successive courses. When the nominal insulation outer diameter is 6" or less, use 1" wide Saranex 520 CX tape. When the nominal insulation outer diameter is between 6" and 12", use

2" wide Saranex 520 CX tape. When the nominal insulation outer diameter is greater than 12", use 3" wide Saranex 520 CX tape.

- 3.4.3 When operating temperature is $\leq 32^{\circ}\text{F}$ or when a permeance of 0.02 perms or better is required, butt joints shall be wrapped with either two layers of 3" wide Saranex 520 CX Vapor Retarder Tape or a single layer of 3" wide Saranex 560 CX Tape. When operating temperature is $> 32^{\circ}\text{F}$, butt joints shall be wrapped with a single layer of 3" wide Saranex 520 CX Tape. When a single layer of tape is applied at butt joints, it shall have a 25% (1 ¼ wraps) circumferential overlap (see Figure 15 in Appendix B).
- 3.4.4 Vapor Retarder shall have a maximum permeance of 0.02 perms for applications at or below 32°F and a maximum permeance of 0.030 perm for applications above 32°F.
- 3.4.5 Vapor retarder may be factory or field applied to the outer surface of pipe insulation, but factory applied is preferred. Refer to Installation Guideline on Saranex CX Vapor Retarder Film for additional information.
- 3.4.6 Where Self Sealing Lap (SSL) tape is used to seal the longitudinal seams of the vapor retarder, all vapor retarder surfaces should be cleaned and free of dust/grease/oil/etc. before application of the SSL tape to ensure good adhesion between the tape and vapor retarder. The width of the SSL tape shall be 1½" or greater. The recommended SSL tapes can be: Venture SSL 1124, Venture SSL 3693 FLE, Venture SSL 1163, or Venture SSL 514CW. JM does not recommend the use of mastics as the only means of sealing the longitudinal joint.
- 3.4.7 JM does not recommend the use of mastics over Saranex CX tape.
- 3.4.8 Saranex CX shall not be left exposed in outdoor applications for longer than 2 weeks.

3.5 PROTECTIVE JACKETING MATERIALS

- 3.5.1 Indoor Applications
- 3.5.1.1 Jacketing shall be PVC material. Consult jacketing manufacturer for recommended PVC thicknesses. Typical thicknesses are 0.010 to 0.030". Jacketing shall be tough and capable of enduring frequent wash downs with hot water or cleaning agents. All joints of PVC jacket shall be solvent welded to prevent moisture and moisture vapor infiltration into the insulation system.
- 3.5.1.2 Supply preformed PVC covers for all fittings, tees, elbows, valves, caps, etc. at same PVC thickness as on straight pipe sections. See section 3.4.1 for vapor retarder recommendations.
- 3.5.1.3 PVC protective jacketing shall not be considered a vapor retarder. See section 3.4 for vapor retarder recommendations.
- 3.5.1.4 Neither rivets, screws, staples nor any other

fastener capable of penetrating the underlying vapor retarder shall be used to secure the PVC jacketing.

3.5.2 Outdoor Jacketing

- 3.5.2.1 Jacketing shall be aluminum metal cladding. Jacketing shall be aluminum alloys 3003, 1100 or 3105 meeting ASTM B-209 with H-14 temper and a minimum 2 ½ mil thickness polyfilm moisture barrier on the inner side. Use white painted aluminum jacketing for all outdoor applications operating at 32°F and below. Consult Johns Manville for recommended thicknesses. Typical thickness is 0.016".
- 3.5.2.2 Aluminum jacketing for all fittings, tees, elbows, valves, caps, etc. shall be sectional, factory contoured, or field fabricated to fit closely around insulation.
- 3.5.2.3 Banding for jacketing shall be 0.02" thick by 1/2" wide stainless steel.
- 3.5.2.4 Aluminum protective jacketing shall not be considered a vapor retarder. See section 3.4 for vapor retarder recommendations.
- 3.5.2.5 Neither rivets, screws, staples nor any other fastener capable of penetrating the underlying vapor retarder shall be used to secure the aluminum jacketing.

4. APPLICATION

4.1 PIPING GENERAL

- 4.1.1 Stagger insulation half sections so that butt joints are staggered between top and bottom half sections by 6 to 18 inches on insulation layers that do not have a vapor retarder factory applied to them. On a single layer system, orient longitudinal joints between half sections in the 3 and 9 o'clock position on the pipe. Refer to Figure 2 in appendix B.
- 4.1.2 Where insulation thickness required is greater than 2 ½", employ a double layer system. Stagger all longitudinal joints between the inner and outer layers. Install the inner and outer layer longitudinal joints 90° to each other with the inner layer joints in the 12 and 6 o'clock positions and the outer layer joints in the 3 and 9 o'clock positions. All butt joints between the inner and outer layers shall be staggered between 6 and 18 inches. Refer to Figure 3 in Appendix B.
- 4.1.3 Install pre-fabricated insulation fittings on elbows, tees, and valves. Insulation shall be the same thickness at fittings as pipe sections.
- 4.1.4 If a double layer system is required, all fittings shall be double layered. Fittings may be cut to full thickness in lieu of double layered if they are fabricated with shi lap butt ends. Depth of the shi lap shall be cut to the thickness of the inner layer to allow the outer layer to overlap creating a staggered joint. Refer to Figure 4 in Appendix B.
- 4.1.5 Install half-length pipe section half round on bottom of all pipe hanger saddles with a full pipe section half round on the top to maintain a staggered joint through the pipe hanger saddle (see Figure 5 in Appendix B). In double layer systems install nested half and full pipe half round sections in bottom of saddle or use a full thickness single layer pipe section with shi lap ends cut to the depth of the inner layer thickness so the outer layer will overlap (see Figure 6 and Figure 7 in appendix B).
- 4.1.6 Bottom insulation sections in hanger saddles shall be TRYMER 3000, 4000 or 6000 Insulation for resistance to compression on pipe diameters 4" and greater. Depending on the saddle length and span chosen for a specific job, lower density TRYMER insulation such as TRYMER 2000 XP insulation may be sufficient to be used as saddle insulation. Consult manufacturer for your specific scenario. Saddles shall wrap the insulation in an arc between 120° and 180° depending upon the load.
- 4.1.7 Single layer insulation shall be applied to piping with all joints sealed full depth with joint sealant and spread to uniform thickness so that joints appear tight and uniform. Refer to Figure 8 in Appendix B. In double layer insulation system, inner layer shall not be installed with sealants. In double layer systems, inner and outer layer shall remain independent of each other so as to allow movement between the layers. Refer to Figure 3 in appendix B.
- 4.1.8 Insulation shall be secured to the pipe with 3/4" wide fiber reinforced tape. Tape shall be applied as per Figure 9 in Appendix B.
- 4.1.9 Insulation shall be secured with fiber reinforced tape on both inner and outer layers of a double layered system except as noted in section 4.1.11.
- 4.1.10 Insulation shall be secured with fiber reinforced tape prior to installation of the vapor retarder material when vapor retarder is field applied.
- 4.1.11 Outer layer or single layer insulation and vapor retarder shall be secured with fiber reinforced tape. Use a 25% circumferential overlap on 12" centers when vapor retarder is factory applied to insulation. Fiber tape shall be applied to the exterior of the insulation/vapor retarder system. Contraction/expansion joints in double layer systems shall be installed per Figure 10 in Appendix B or approved alternate design.
- 4.1.12 Contraction/expansion joints in single layer service shall be installed per Figure 11 in Appendix B or approved alternate design. The appropriate designer or engineer must specify the spacing of contraction/expansion joints separately for each system. Recommended expansion/contraction joint spacing is shown in table 1 in Appendix B.
- 4.1.13 All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor retarder must be continuous. All fasteners and bands shall be neatly aligned, and overall work must be of high-quality appearance and workmanship.
- 4.1.14 Vapor stops shall be used on either side of valves

frequently removed for servicing, valve stations left exposed, or odd fittings, elbows, tees, etc. where the chance of moisture infiltration is high. Install per detail in Figure 12 in Appendix B or an approved alternate design.

- 4.1.15 Saranex CX Vapor Retarder Film to be cut to length longitudinally and wrapped around the circumference of the pipe with lap joint facing downward avoiding the placement of the joint at the top or bottom of the pipe.
- Lap joint to be sealed using SSL tape or liquid adhesive. Butt joints shall be covered with Saranex CX Vapor Retarder Tape. Spiral wrap configuration can be used in lieu of the above installation. Spiral wrapping will require adhesive placed on one edge of the Saranex CX Film as it is wrapped over the previous layer.
- 4.1.16 Elbows and fittings shall be wrapped with Saranex 520 CX Vapor Retarder Tape or covered with a mastic type vapor retarder product. Saranex CX Tape to be wrapped in a spiral configuration. Where permeance less than 0.02 perms is required, Saranex 520 CX tape shall be spiral wrapped with a minimum 50% overlap. If using mastic type vapor retarder at fittings and elbows, form mastic so that fitting covers can be applied true and tight. Contractor may not install PVC jacket with polyurethane foam fill in lieu of vapor retarder at fittings and elbows without special approval by Owner.
- 4.1.17 On factory applied Saranex CX Vapor Retarder Film, lap joint to be sealed with SSL tape. All vapor retarder surfaces should be cleaned and free of dust/ grease/ oil/ etc. before application of the SSL tape to ensure good adhesion between the tape and vapor retarder. Refer Figure 13 in Appendix B. to Apply the Saranex CX Tape around the butt joint with a 25% circumference overlap (refer to Figure 14 in appendix B). For other types of factory applied vapor retarders, consult manufacturer's recommendations on installation.
- 4.1.18 Before jacketing can be installed on a portion of the piping, the vapor retarder system on that portion must be complete and continuous.
- 4.1.19 A pipe coating system may be recommended to minimize the likelihood of pipe corrosion. Consult Appendix A for conditions where pipe coating systems are suggested.

4.2 INDOOR PIPING

- 4.2.1 This section covers indoor areas including, but not limited to, mechanical rooms, process areas and inhabited areas. Consult applicable building codes for areas where flame spread, and smoke developed requirements may apply.
- 4.2.2 Allow mastics to dry prior to installing PVC Jacketing.
- 4.2.3 Refer to section 3.5.1 for material specification on indoor Jacketing.
- 4.2.4 Insulation systems on indoor piping, valves and flanges shall all be covered with PVC jacketing.

- 4.2.5 Seal around protrusions, such as valve stems with a full bead of silicone sealant.

4.3 OUTDOOR PIPING

- 4.3.1 This section covers outdoor areas including, but not limited to, process areas, rooftops and rooftop equipment.
- 4.3.2 TRYMER Insulation shall be protected from prolonged exposure to UV light and weather upon installation.
- 4.3.3 Outdoors, Saranex CX Products shall be covered with a jacketing material within two weeks of installation to eliminate long-term exposure to UV light.
- 4.3.4 Refer to section 3.5.2 for material specification on outdoor jacketing.
- 4.3.5 Outdoor jacketing overlap shall be a minimum of 2" at butt joints and a minimum of 2" at longitudinal joints. Jacketing shall be caulked before closing and banding and positioned in an orientation to avoid water infiltration.
- 4.3.6 Straight sections of jacketing shall be neatly secured with bands and seals with a maximum spacing of 9" on center. End joints shall be secured with bands and seals centered directly over joint. Do not use screws, staples or other fasteners on lines containing a vapor retarder system.

4.4 TANK, VESSEL, AND EQUIPMENT INSULATION

- 4.4.1 All insulation materials shall be the same as those used on the pipe associated with the tank, vessel, or equipment.
- 4.4.2 Tank and vessel head segments shall be curved or flat cut to fit in single piece or segments per ASTM C-450. Head segments shall be cut so as to eliminate voids at the head section and in a minimum number of pieces so as to eliminate through joints.
- 4.4.3 Prefabricated flat head sections shall be installed in the same number of layers and thicknesses as the vessel walls. Void area behind the flat head shall be filled with spray applied polyurethane.
- 4.4.4 Curved segments shall be fabricated to fit the contour of the surface in equal size pieces to go around the vessel with a minimum number of through joints. Cutting in the field shall be minimized. All sections shall be tightly butted and free of voids and gaps. Refer to Figure 15 in Appendix B.
- 4.4.5 Vertical vessels greater than 4 feet in diameter require an insulation support ring welded or bolted around the bottom of the tank to prevent the shell insulation from sliding down.
- 4.4.6 Seal all outer layer and single layer butt joints with joint sealer. Refer to section 3.3.
- 4.4.7 In double layer applications, the horizontal and vertical joints of the inner and outer layer curved segments shall be staggered (see Figure 15 in Appendix B).
- 4.4.8 The top of the outer layer of wall insulation in a double layer system shall be held below the inner layer top a

minimum of the insulation thickness. The tank head insulation layers shall be cut so as to meet the staggered joint. Refer to Figure 15 in appendix B.

- 4.4.9 Secure the shell insulation with stainless steel bands on 12-inch centers.
- 4.4.10 Install Saranex 540 CX or 560 CX Vapor Retarder Film. Tightly wrap the vessel or equipment insulation circumferentially with Saranex CX Film. Overlap the seams by a minimum of 2 inches. Seal the overlapped seams with Saranex CX Tape. On vertical vessels apply the Saranex CX Film starting with the bottom course and work upwards. Each course should overlap on top of the one below it thus providing a joint that will naturally shed water.
- 4.4.11 The vapor retarder on curved head sections shall be mastic/fab/mastic or approved alternate. Flat head sections can be covered with Saranex 540 CX or 560 CX films. Lap joints shall be covered with Saranex CX Vapor Retarder Tape.
- 4.4.12 Legs and appendages attached directly to the shell shall be insulated out from the vessel head or wall four times the insulation thickness and the insulation termination sealed with a vapor stop.
- 4.4.13 Indoor tanks, vessels, and equipment shall be covered with PVC jacketing per section 3.5.1. On outdoor equipment use aluminum jacketing per section 3.5.2. Rivets and screws shall not be used to attach jacketing on systems using a vapor retarder.

environment and the operating temperature of the metal. The recommendations below represent the general practice in the industry but are not meant to take the place of proper system design and specification by a qualified design engineer familiar with this type of construction. We recommend that the owner consult such an engineer and have them work closely with the fabricator, the contractor, and JM to help insure a properly designed, installed, and long-lasting insulation system free of corrosion.

5.1.2 SPECIFIC RECOMMENDATIONS

5.1.2.1 Stainless Steel All 300 series stainless steel shall be coated with an epoxy primer at 5 mil thickness and an epoxy finish coat at 5 mil thickness if operating in a temperature range between 140°F and 300°F or if in a cycling temperature service where the service temperature is between 140° and 300°F for more than 20% of the time. Consult a coating manufacturer for appropriate coating materials and application methods based on the operating temperature range of the equipment.

5.1.2.2 Carbon Steel All carbon steel operating at a service temperature between 32°F and 300°F or in cycling temperature service where the service temperature is between 32°F and 300°F for more than 20% of the time shall be at a minimum primer coated with an epoxy coating. Consult a coating manufacturer for appropriate coating materials and application methods for the operating temperature range of the equipment.

5 APPENDICES

5.1 APPENDIX A: CORROSION RESISTANT METAL COATINGS

5.1.1 GENERAL NOTE Corrosion of metal pipe, vessels, and equipment under insulation, while not typically caused by the insulation, is still a significant issue that must be considered during the design of any mechanical insulation system. The propensity for corrosion is dependent on many factors including the ambient

5.2 APPENDIX B: DETAILS

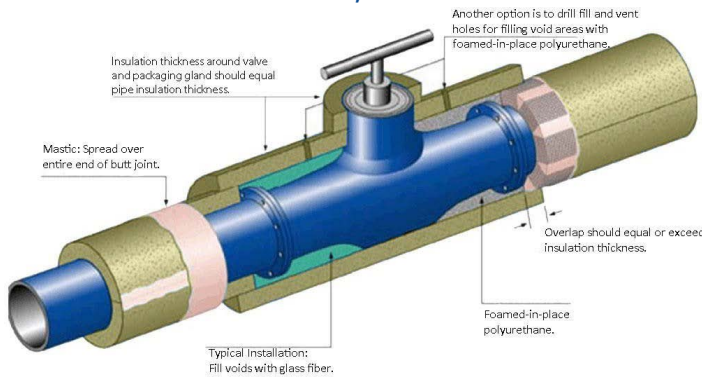
The following details are referenced in the text of this guideline by their Figure numbers. The diagrams included in this section are representative of details used within the industry. However, they are not intended to display the only accepted method of installation but to serve more as an example of commonly used and acceptable practices.

TABLE 1: RECOMMENDED EXPANSION/CONTRACTION JOINTS

		Service Temperature (F)											
		-75	-65	-55	-45	-35	-25	-15	-5	5	15	25	35
Ambient Temperature	-10	1 joint every 100' for pipe lengths 100' and up											
	0												
	10	1 joint every 30' or less											
	20												
	30	1 joint every 27' for pipe lengths 30' - 130'											
	40												
	40	***											
	50												
	50	1 joint every 36' for pipe lengths 130' and up											
	60												
	60	1 joint upto 17' length											
70													
70	1 joint every 18' for 18' length and up												
80													
80													
90													
90													
100													
100													
110													

***	1 joint for 20' or less
	1 joint every 21' for pipe lengths 21' - 130'
	1 joint every 45' for pipe lengths 130' and up

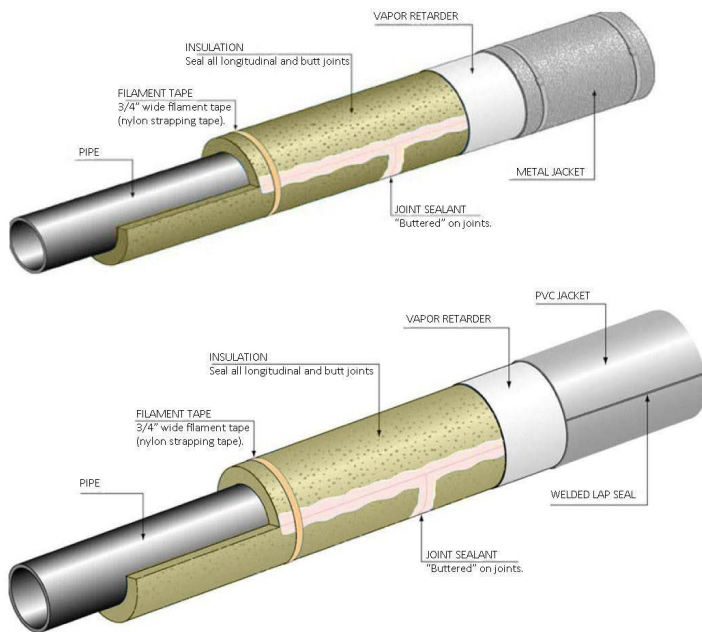
FIGURE 1: VALVE INSULATION DETAIL (INCLUDING OPTIONAL FILLING OF VOIDS)



Detail Notes:

- The preferred way to insulate a valve or fitting is with prefabricated tight-fitting insulation pieces. If that approach is not used, this detail shows an alternative.
- If desired, voids around valve can be filled with foam-in-place polyurethane or glass fiber.
- Vapor retarder on valve shall be continuous with that on attached pipe.

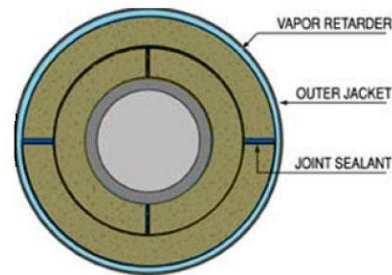
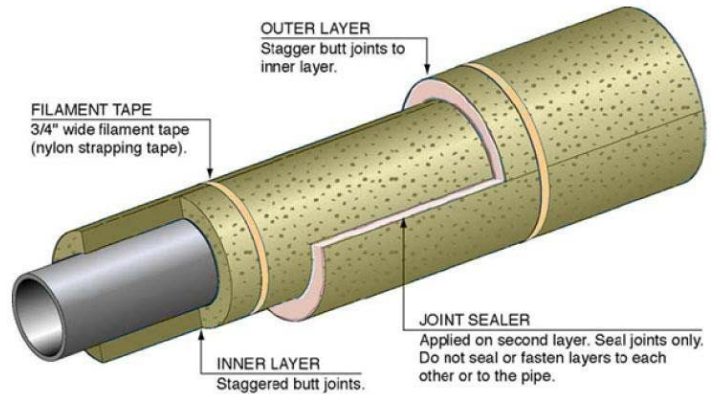
FIGURE 2: SINGLE LAYER INSULATION WITH VAPOR RETARDER AND JACKET



Detail Notes:

- Stagger bottom half round segments from top segments as shown if vapor retarder is field applied.
- Use thin coat of sealant over whole joint depth. Butter excess down face of joint as pictured.

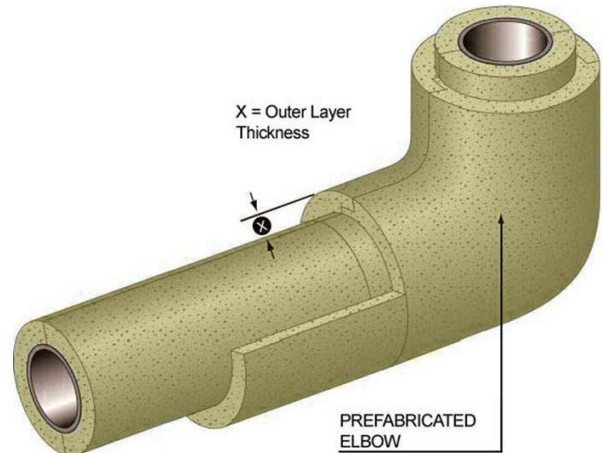
FIGURE 3: DOUBLE LAYERED INSULATION SYSTEM



Detail Notes:

- Inner Layer longitudinal joints at 12 and 6 O'clock. Outer layer joints at 3 and 9 O'clock.
- Stagger half round segments on each layer and between the two layers as shown above.
- Use thin coat of sealant over whole joint depth. Butter excess down the face of the joint. Use sealant on outer layer only.

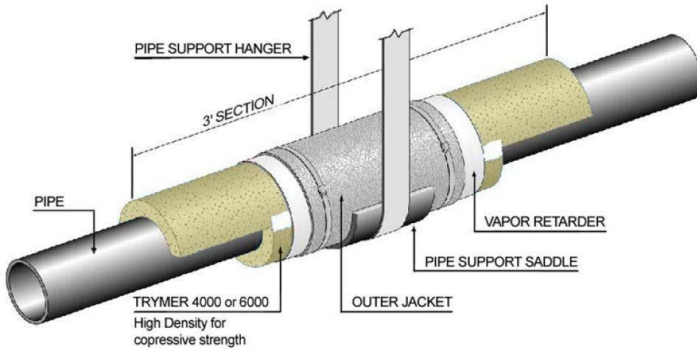
FIGURE 4: FULL THICKNESS SHIPLAP ELBOW FITTING



Detail Notes:

- Shiplap end cut to thickness X to accommodate double layer pipe insulation.
- Use in lieu of double layered fittings.
- Wrap elbow with Saranex 520 CX Vapor Retarder Tape.

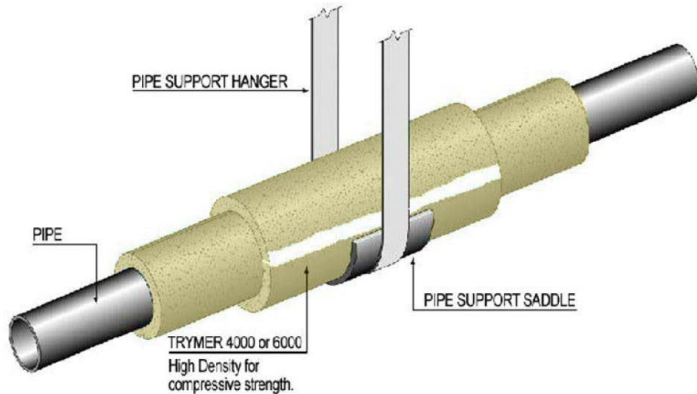
FIGURE 5: SINGLE LAYER INSULATION SYSTEM THROUGH PIPE HANGER SUPPORT



Detail Notes:

- On smaller pipe diameters (3" or less) use TRYMER 1800 or 2000 XP Insulation on bottom of saddle.
- For 4" pipe and up use higher density TRYMER Insulation on bottom of saddle for additional compressive strength.
- Vapor Retarder and Jacketing to be installed in continuous fashion through the pipe support.

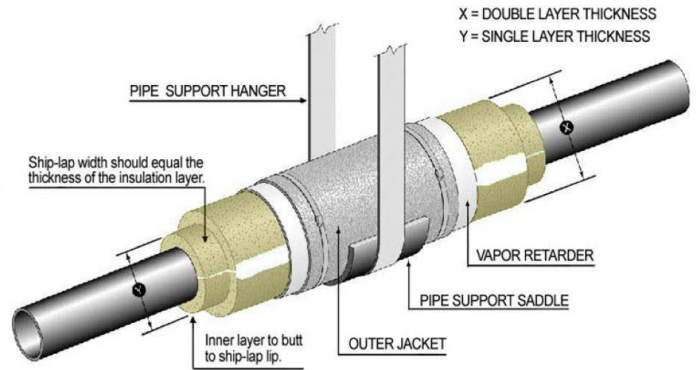
FIGURE 6: DOUBLE LAYER INSULATION SYSTEM THROUGH PIPE HANGER SUPPORT



Detail Notes:

- On smaller pipe diameters (3" or less) use TRYMER 1800 or 2000 XP Insulation on bottom of saddle.
- For 4" pipe and up use higher density TRYMER Insulation on bottom of saddle for additional compressive strength.
- Install shorter section on outside layer.
- Vapor Retarder and Jacketing to be installed in continuous fashion through the pipe support.

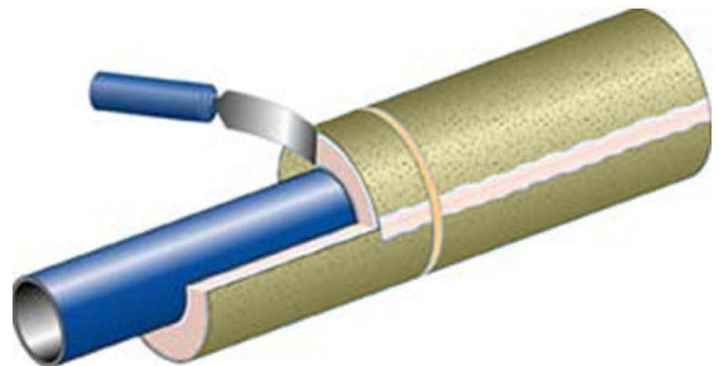
FIGURE 7: FULL THICKNESS INSULATION SECTION IN DOUBLE LAYERED SYSTEM AT PIPE HANGER SUPPORT



Detail Notes:

- On smaller pipe diameters (3" or less) use TRYMER 1800 or 2000 XP Insulation on bottom of saddle.
- For 4" pipe and up use higher density TRYMER Insulation on bottom of saddle for additional compressive strength.
- Width of shiplap ends shall be equal to the thickness of a single insulation layer.
- Butt inner layer to shiplap end. Outer layer shall be staggered by width of shiplap end.
- Vapor Retarder and Jacketing to be installed in continuous fashion through the pipe support.

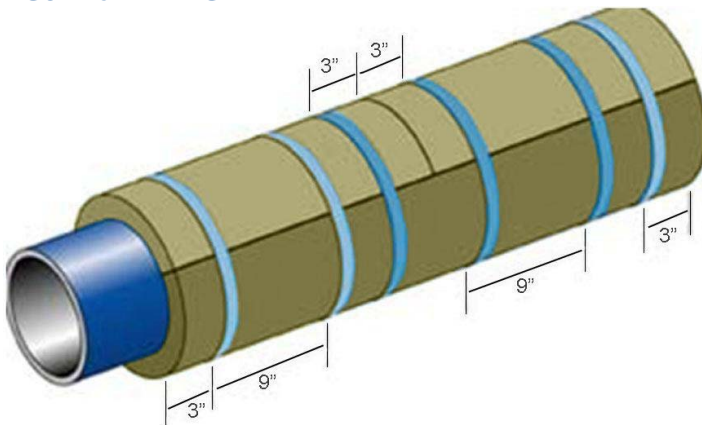
FIGURE 8: SEALANT APPLICATION TECHNIQUE



Detail Notes:

- Use thin coat of sealant over whole joint depth. Butter excess down the face of the joint as shown. Use sealant on outer layer only.

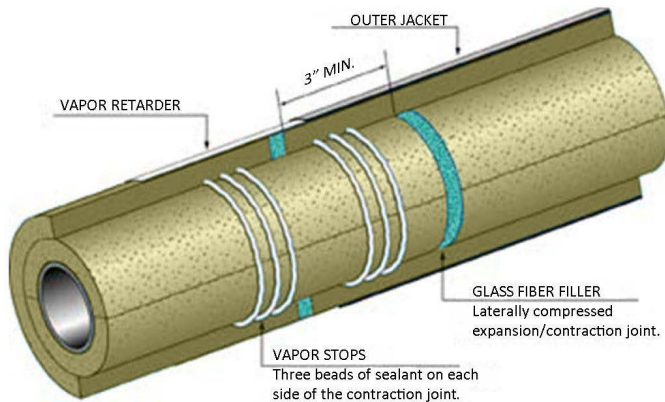
FIGURE 9: TAPING PATTERN



Detail Notes:

- Use two wraps of tape to insure adequate bond.
- Use nylon or glass filament type tape 3/4" wide

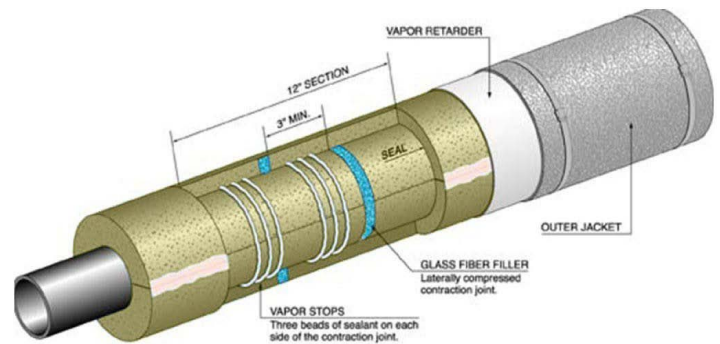
FIGURE 10: DOUBLE LAYER EXPANSION/CONTRACTION JOINT DETAIL



Detail Notes:

- Allow sealant beads to cure prior to installation of outer layer.
- Position outer layer packed glass fiber between sealant dams on inner layer as shown above.
- After glass fiber in contraction joint is installed, insulation sections on either side of contraction joint shall be forced together as tightly as possible.

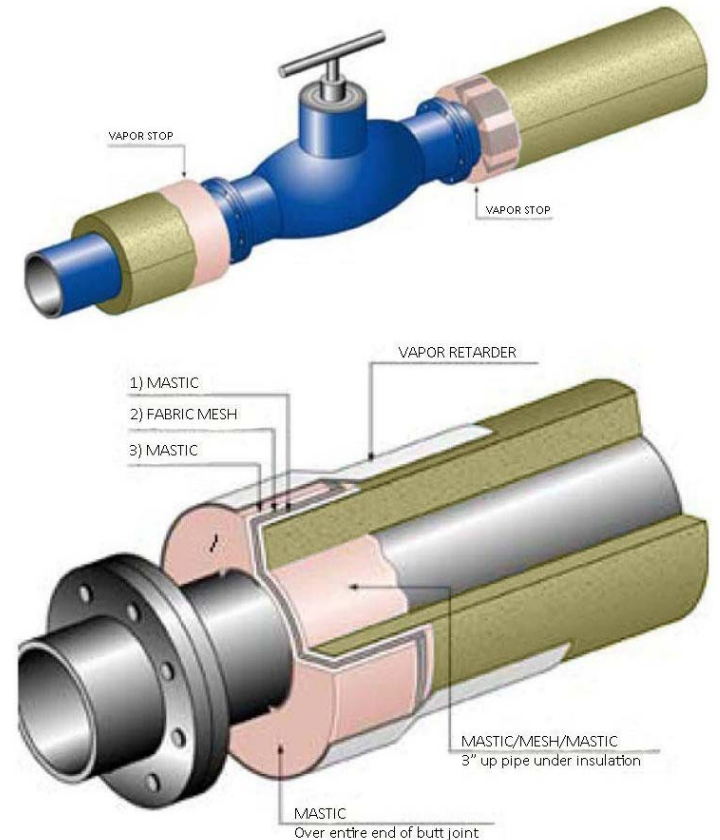
FIGURE 11: SINGLE LAYER EXPANSION/CONTRACTION JOINT DETAIL



Detail Notes:

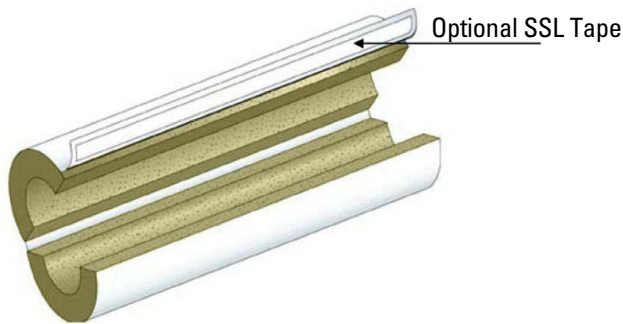
- For use in single layer refrigeration applications below 32°F.
- Allow sealant beads to cure prior to installation of outer layer.
- Position outer layer packed glass fiber between sealant dams on inner layer as shown above.
- After glass fiber in contraction joint is installed, insulation sections on either side of contraction joint shall be forced together as tightly as possible.

FIGURE 12: VAPOR STOP DETAILS

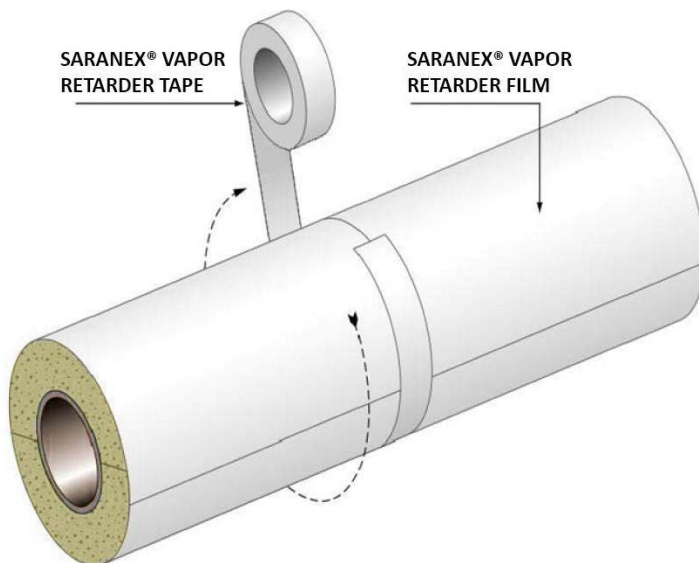


Detail Notes:

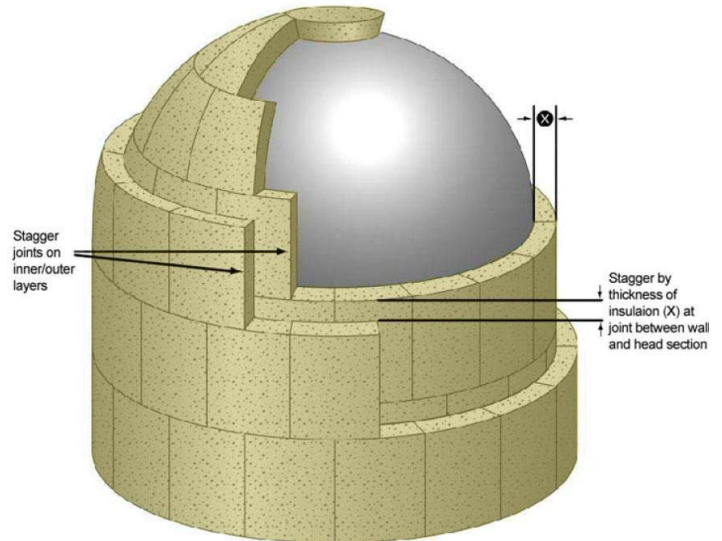
- Mastic should be selected based on the service temperature of the system.
- Mastic shall be sealed to the pipe face and lapped back over the top of the vapor retarder if fitting is left exposed.

FIGURE 13: DETAIL OF FACTORY APPLIED VAPOR RETARDER**Detail Notes:**

- Vapor Barrier can be installed using SSL tape as shown above or using liquid adhesives.
- Butt joints to be covered a minimum of 1.5" on each side of joint by Saranex CX Tape or butt strip.

FIGURE 14: FACTORY APPLIED SARANEX VAPOR RETARDER**Detail Notes:**

- Lap seal on Saranex CX Film to be SSL Tape or liquid adhesive per Installation Guide on Saranex CX Film.
- When operating temperature is $\leq 32^{\circ}\text{F}$ or when a permeance of 0.02 perms or better is required, butt joints shall be wrapped with either two layers of Saranex 520 CX Vapor Retarder Tape or a single layer of Saranex 560 CX Tape. When operating temperature is $> 32^{\circ}\text{F}$, butt joints shall be wrapped with a single layer of Saranex 520 CX Tape.
- Saranex CX Tape used at butt joints shall be 3 inches wide.
- Wrap tape around butt joint a minimum of 1.25 times the circumference.

FIGURE 15: TANK HEAD INSULATION DETAIL**Detail Notes:**

- In multiple layer systems, each layer shall be installed so that the horizontal and vertical joints in that layer are staggered from the corresponding joints in the preceding layer by half the height or width of a full section.
- At joint between wall and head section, the outer layer shall be staggered below the inner layer by the thickness of a single layer.
- Where mastics or sealants are required to bond the insulation sections to the tank head consult the manufacturer's recommendations on service and application temperatures.

5.3 APPENDIX C: THICKNESS TABLES

The following tables primarily show the insulation thickness necessary to prevent condensation on the outer surface of the insulation system jacketing. In a few cases, the tables also include the insulation thickness necessary to limit the heat gain to a specific value (usually 8 btu/hr.-ft of outer jacketing surface) and are noted as such. These thickness recommendations are solely based on various design conditions that are shown with each table. A number of assumptions are also made, including proper system design and installation. There may be additional factors the tables do not address that could influence the end results.

These thickness tables are not meant to replace a proper system design and specification by a qualified design engineer familiar with specific ambient design parameters for a given locality. We recommend that you consult such an engineer and have them work closely with the contractor, and JM to help insure a properly designed, installed, and long-lasting insulation system.

Thickness calculations are performed using the 3E Plus software program that uses heat flow algorithms based on ASTM C680-95. The required insulation thicknesses do not include a safety factor. Actual operating conditions can vary. Consult a design engineer for an appropriate safety factor.

INSULATION THICKNESS IN INCHES NECESSARY TO PREVENT CONDENSATION OR LIMIT HEAT GAIN TO 8 BTU/HR. • FT², WHICHEVER IS GREATER

TABLE 2: AMMONIA REFRIGERATION INDOORS

NPS (in)	Service Temperature (°F)							
	-100	-80	-60	-40	-20	0	20	40
0.5	2	2	2	1.5	1.5	1.5	1	1
0.75	2.5	2	2	2	1.5	1.5	1.5	1
1	2.5	2	2	2	1.5	1.5	1	1
1.5	2.5	2	2	2	2	1.5	1	1
2	2.5	2.5	2	2	2	1.5	1.5	1
2.5	2.5	2.5	2	2	1.5	1.5	1.5	1
3	3	2.5	2.5	2	2	1.5	1.5	1
3.5	3	2.5	2.5	2	1.5	1.5	1	1
4	3	3	2.5	2.5	2	1.5	1.5	1
4.5	3	2.5	2.5	2	2	1.5	1	1
5	3	3	2.5	2.5	2	2	1.5	1
6	3.5	3	3	2.5	2	2	1.5	1
7	3.5	3	3	2.5	2	2	1.5	1
8	3.5	3	2.5	2.5	2	2	1.5	1
9	3.5	3	3	2.5	2	2	1.5	1
10	3.5	3	3	2.5	2	2	1.5	1
11	3.5	3.5	3	2.5	2	2	1.5	1
12	3.5	3.5	3	2.5	2	2	1.5	1
14	4	3.5	3	2.5	2.5	2	1.5	1
15	4	3.5	3	3	2.5	2	1.5	1
16	4	3.5	3	3	2.5	2	1.5	1
17	4	3.5	3	3	2.5	2	1.5	1
18	4	3.5	3	3	2.5	2	1.5	1
19	4	3.5	3	3	2.5	2	1.5	1
20	4	3.5	3	3	2.5	2	1.5	1
Tank								
Side	4.5	4	3.5	3	2.5	2	1.5	1.5
Bottom	4.5	4	3.5	3	2.5	2	1.5	1.5
Top	4.5	4	3.5	3	2.5	2	1.5	1.5

Ambient temp: 90°F

Ambient relative humidity: 80%

Dew point: 83.0°F

Wind velocity: 0 mph

Outer surface: Saranex CX, PVC, ASJ, or mastic (e = 0.90)

Geometry: Horizontal pipe

This table is based on ASTM C 680-95 heat transfer algorithms. The suggested insulation thickness values assume proper system design and installation, do not include a safety factor, and are applicable only for the specified scenario. JM recommends that the user consult a qualified design engineer familiar with this type of construction for proper system design and specification.

TABLE 3: AMMONIA REFRIGERATION OUTDOORS

NPS (in)	Service Temperature (°F)							
	-100	-80	-60	-40	-20	0	20	40
0.5	2.5	2.5	2.5	2	2	1.5	1.5	1
0.75	3	3	2.5	2.5	2	2	1.5	1.5
1	3.5	3	3	2.5	2	2	1.5	1
1.5	3.5	3	3	2.5	2	2	1.5	1.5
2	4	3.5	3	3	2.5	2	1.5	1.5
2.5	4	3.5	3	3	2.5	2	1.5	1.5
3	4.5	4	3.5	3	3	2.5	2	1.5
3.5	4.5	4	3.5	3	2.5	2	1.5	1.5
4	4.5	4.5	4	3.5	3	2.5	2	1.5
4.5	4.5	4	3.5	3	2.5	2.5	2	1.5
5	5	4.5	4	3.5	3	2.5	2	1.5
6	5	4.5	4	3.5	3.5	2.5	2	1.5
7	5	5	4.5	4	3	3	2.5	1.5
8	5.5	5	4.5	4	3.5	3	2.5	1.5
9	5.5	5	4.5	4	3.5	3	2	2
10	6	5.5	4.5	4	3.5	3	2.5	1.5
11	6	5.5	5	4	3.5	3	2.5	2
12	6	5.5	5	4.5	3.5	3	2.5	2
14	6	5.5	5	4.5	4	3.5	2.5	2
15	6.5	6	5	4.5	4	3.5	2.5	2
16	6.5	6	5	4.5	4	3.5	2.5	2
17	6.5	6	5.5	4.5	4	3.5	2.5	2
18	6.5	6	5.5	4.5	4	3.5	2.5	2
19	6.5	6	5.5	4.5	4	3.5	2.5	2
20	6.5	6	5.5	5	4	3.5	3	2
Tank								
Side	7	6	5.5	4.5	4	3.5	2.5	2
Bottom	6	5	4.5	4	3.5	3	2	1.5
Top	9	8	7	6	5	4	3.5	2.5

Ambient temp: 90°F

Ambient relative humidity: 90%

Dew point: 86.6°F

Wind velocity: 7 mph

Outer surface: Aluminum paint (e=0.50)

Geometry: Horizontal pipe

This table is based on ASTM C 680-95 heat transfer algorithms. The suggested insulation thickness values assume proper system design and installation, do not include a safety factor, and are applicable only for the specified scenario. JM recommends that the user consult a qualified design engineer familiar with this type of construction for proper system design and specification.

INSULATION THICKNESS IN INCHES NECESSARY TO PREVENT CONDENSATION

TABLE 4: INDOORS - HIGH HUMIDITY CONDITIONS

NPS (in)	Service Temperature (°F)																		
	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35
0.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	1.5	1.5	1.5	1.5	1.5	1	1
0.75	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	1.5	1.5	1.5	1.5	1.5
1	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	1.5	1.5	1.5	1.5	1
1.5	3	3	3	3	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2	1.5	1.5	1.5	1.5
2	3.5	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2	2	2	2	1.5	1.5	1.5	1.5
3	4	4	3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2	2	2	1.5	1.5	1.5
4	4	4	4	3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2	2	2	1.5	1.5
5	4.5	4	4	4	4	3.5	3.5	3.5	3	3	3	2.5	2.5	2.5	2	2	2	1.5	1.5
6	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3	3	3	2.5	2.5	2.5	2	2	2	1.5
8	4.5	4.5	4.5	4	4	4	3.5	3.5	3.5	3	3	3	2.5	2.5	2.5	2	2	2	1.5
10	5	5	4.5	4.5	4.5	4	4	3.5	3.5	3.5	3	3	3	2.5	2.5	2	2	2	1.5
12	5	5	5	4.5	4.5	4	4	4	3.5	3.5	3	3	3	2.5	2.5	2	2	2	1.5
14	5.5	5	5	5	4.5	4.5	4	4	4	3.5	3.5	3	3	3	2.5	2.5	2	2	1.5
16	5.5	5.5	5	5	4.5	4.5	4.5	4	4	3.5	3.5	3.5	3	3	2.5	2.5	2	2	2
18	5.5	5.5	5	5	5	4.5	4.5	4	4	3.5	3.5	3.5	3	3	2.5	2.5	2	2	2
20	5.5	5.5	5	5	5	4.5	4.5	4	4	4	3.5	3.5	3	3	2.5	2.5	2.5	2	2
24	6	5.5	5.5	5	5	4.5	4.5	4.5	4	4	3.5	3.5	3	3	2.5	2.5	2.5	2	2
30	6	5.5	5.5	5.5	5	5	4.5	4.5	4	4	3.5	3.5	3	3	3	2.5	2.5	2	2
36	6	6	5.5	5.5	5	5	4.5	4.5	4	4	4	3.5	3.5	3	3	2.5	2.5	2	2
48	6	6	5.5	5.5	5.5	5	5	4.5	4.5	4	4	3.5	3.5	3	3	2.5	2.5	2	2

Ambient temp: 70°F

Ambient relative humidity: 90%

Dew point: 67.0°F

Wind velocity: 0 mph

Outer surface: Saranex CX, PVC, ASJ, or mastic (e = 0.90)

Geometry: Horizontal pipe

This table is based on ASTM C 680-95 heat transfer algorithms. The suggested insulation thickness values assume proper system design and installation, do not include a safety factor, and are applicable only for the specified scenario. JM recommends that the user consult a qualified design engineer familiar with this type of construction for proper system design and specification.

**INSULATION THICKNESS IN INCHES NECESSARY TO PREVENT CONDENSATION OR LIMIT HEAT GAIN TO
8 BTU/HR. • FT², WHICHEVER IS GREATER**

TABLE 5: INDOORS - 90% R.H.

NPS (in)	Service Temperature (°F)																
	-260	-240	-220	-200	-180	-160	-140	-120	-100	-80	-60	-40	-20	0	20	40	60
0.5	4.5	4.5	4.5	4	4	4	3.5	3.5	3	3	2.5	2.5	2	2	1.5	1.5	1
0.75	5	5	4.5	4.5	4.5	4	4	3.5	3.5	3	3	2.5	2.5	2	2	1.5	1
1	5.5	5.5	5	5	4.5	4.5	4.5	4	3.5	3.5	3	2.5	2.5	2	1.5	1.5	1
1.5	5.5	5.5	5.5	5	5	4.5	4.5	4	4	3.5	3	3	2.5	2	2	1.5	1
2	6	6	6	5.5	5.5	5	5	4.5	4	4	3.5	3	3	2.5	2	1.5	1
3	7	6.5	6.5	6	6	5.5	5.5	5	4.5	4.5	4	3.5	3	2.5	2	1.5	1
4	7.5	7	7	6.5	6	6	5.5	5	5	4.5	4	3.5	3	3	2.5	1.5	1
6	8	8	7.5	7	7	6.5	6	6	5.5	5	4.5	4	3.5	3	2.5	2	1.5
8	8.5	8.5	8	7.5	7.5	7	6.5	6	5.5	5	4.5	4	3.5	3	2.5	2	1
10	9	8.5	8.5	8	7.5	7.5	7	6.5	6	5.5	5	4.5	4	3	2.5	2	1.5
12	9.5	9	8.5	8.5	8	7.5	7	6.5	6	5.5	5	4.5	4	3	2.5	2	1
14	9.5	9.5	9	8.5	8.5	8	7.5	7	6.5	6	5.5	4.5	4	3.5	3	2	1.5
16	10	9.5	9	9	8.5	8	7.5	7	6.5	6	5.5	5	4	3.5	3	2	1.5
18	10	10	9.5	9	8.5	8	7.5	7	6.5	6	5.5	5	4	3.5	3	2	1.5
20	10.5	10	9.5	9	9	8.5	8	7.5	7	6	5.5	5	4.5	3.5	3	2	1.5
24	10.5	10.5	10	9.5	9	8.5	8	7.5	7	6.5	5.5	5	4.5	3.5	3	2	1.5
30	11	10.5	10.5	10	9.5	9	8.5	8	7	6.5	6	5	4.5	3.5	3	2	1.5
36	11.5	11	10.5	10	9.5	9	8.5	8	7.5	6.5	6	5.5	4.5	3.5	3	2	1.5
48	12	11.5	11	10.5	10	9.5	9	8	7.5	7	6	5.5	4.5	4	3	2	1.5

Ambient temp: 90°F

Ambient relative humidity: 90%

Dew point: 86.6°F

Wind velocity: 0 mph

Outer surface: Saranex CX, PVC, ASJ, or mastic (e = 0.90)

Geometry: Horizontal pipe

This table is based on ASTM C 680-95 heat transfer algorithms. The suggested insulation thickness values assume proper system design and installation, do not include a safety factor, and are applicable only for the specified scenario. JM recommends that the user consult a qualified design engineer familiar with this type of construction for proper system design and specification

**INSULATION THICKNESS IN INCHES NECESSARY TO PREVENT CONDENSATION OR LIMIT HEAT GAIN TO
8 BTU/HR. • FT², WHICHEVER IS GREATER**

TABLE 6: OUTDOORS - 90% R.H.

NPS (in)	Service Temperature (°F)																
	-260	-240	-220	-200	-180	-160	-140	-120	-100	-80	-60	-40	-20	0	20	40	60
0.5	4.5	4.5	4.5	4	4	4	3.5	3.5	3	3	2.5	2.5	2	2	1.5	1.5	1
0.75	5	5	4.5	4.5	4.5	4	4	3.5	3.5	3	3	2.5	2.5	2	2	1.5	1
1	5.5	5.5	5	5	4.5	4.5	4.5	4	3.5	3.5	3	2.5	2.5	2	1.5	1.5	1
1.5	5.5	5.5	5.5	5	5	4.5	4.5	4	4	3.5	3	3	2.5	2	2	1.5	1
2	6	6	6	5.5	5.5	5	5	4.5	4	4	3.5	3	3	2.5	2	1.5	1
3	7	6.5	6.5	6	6	5.5	5.5	5	4.5	4.5	4	3.5	3	2.5	2	1.5	1
4	7.5	7	7	6.5	6	6	5.5	5	5	4.5	4	3.5	3	3	2.5	1.5	1
6	8	8	7.5	7	7	6.5	6	6	5.5	5	4.5	4	3.5	3	2.5	2	1.5
8	8.5	8.5	8	7.5	7.5	7	6.5	6	5.5	5	4.5	4	3.5	3	2.5	2	1
10	9	8.5	8.5	8	7.5	7.5	7	6.5	6	5.5	5	4.5	4	3	2.5	2	1.5
12	9.5	9	8.5	8.5	8	7.5	7	6.5	6	5.5	5	4.5	4	3	2.5	2	1
14	9.5	9.5	9	8.5	8.5	8	7.5	7	6.5	6	5.5	4.5	4	3.5	3	2	1.5
16	10	9.5	9	9	8.5	8	7.5	7	6.5	6	5.5	5	4	3.5	3	2	1.5
18	10	10	9.5	9	8.5	8	7.5	7	6.5	6	5.5	5	4	3.5	3	2	1.5
20	10.5	10	9.5	9	9	8.5	8	7.5	7	6	5.5	5	4.5	3.5	3	2	1.5
24	10.5	10.5	10	9.5	9	8.5	8	7.5	7	6.5	5.5	5	4.5	3.5	3	2	1.5
30	11	10.5	10.5	10	9.5	9	8.5	8	7	6.5	6	5	4.5	3.5	3	2	1.5
36	11.5	11	10.5	10	9.5	9	8.5	8	7.5	6.5	6	5.5	4.5	3.5	3	2	1.5
48	12	11.5	11	10.5	10	9.5	9	8	7.5	7	6	5.5	4.5	4	3	2	1.5

Ambient temp: 90°F

Ambient relative humidity: 90%

Dew point: 86.6°F

Wind velocity: 7 mph

Outer surface: Saranex CX, PVC, ASJ, or mastic (e = 0.90)

Geometry: Horizontal pipe

This table is based on ASTM C 680-95 heat transfer algorithms. The suggested insulation thickness values assume proper system design and installation, do not include a safety factor, and are applicable only for the specified scenario. JM recommends that the user consult a qualified design engineer familiar with this type of construction for proper system design and specification

**INSULATION THICKNESS IN INCHES NECESSARY TO PREVENT CONDENSATION OR LIMIT HEAT GAIN TO
8 BTU/HR. • FT², WHICHEVER IS GREATER**

TABLE 7: INSIDE A COLD STORAGE ROOM

NPS (in)	Service Temperature (°F)															
	-300	-280	-260	-240	-220	-200	-180	-160	-140	-120	-100	-80	-60	-40	-20	0
0.5	6.5	6	6	5.5	5.5	5	5	4.5	4.5	4	3.5	3	2.5	2.5	2	1.5
0.75	6.5	6.5	6.5	6	6	5.5	5.5	5	4.5	4	4	3.5	3	2.5	2	1.5
1	7	7	7	6.5	6	6	5.5	5.5	5	4.5	4	3.5	3	2.5	2	1.5
1.5	7.5	7.5	7	7	6.5	6	6	5.5	5	5	4.5	4	3.5	2.5	2	1.5
2	8.5	8	8	7.5	7	7	6.5	6	5.5	5.5	5	4	3.5	3	2.5	2
3	9.5	9	8.5	8.5	8	7.5	7	6.5	6	5.5	5	4.5	4	3.5	2.5	2
4	10	9.5	9	9	8.5	8	7.5	7	6.5	6	5.5	5	4.5	3.5	3	2
6	11	10.5	10	9.5	9.5	9	8.5	8	7.5	6.5	6	5.5	4.5	4	3	2
8	11.5	11	10.5	10.5	10	9.5	9	8.5	8	7	6.5	5.5	5	4	3	2.5
10	12	11.5	11.5	11	10.5	10	9.5	9	8	7.5	7	6	5	4.5	3.5	2.5
12	12.5	12	11.5	11.5	11	10.5	9.5	9	8.5	8	7	6	5.5	4.5	3.5	2.5
14	13	12.5	12	11.5	11	10.5	10	9.5	9	8	7.5	6.5	5.5	4.5	3.5	2.5
16	13.5	13	12.5	12	11.5	11	10.5	9.5	9	8.5	7.5	6.5	5.5	4.5	3.5	2.5
18	13.5	13	12.5	12	11.5	11	10.5	10	9	8.5	7.5	6.5	6	5	3.5	2.5
20	14	13.5	13	12.5	12	11.5	10.5	10	9.5	8.5	7.5	7	6	5	3.5	2.5
22	14	13.5	13	12.5	12	11.5	11	10	9.5	8.5	8	7	6	5	4	2.5
24	14.5	14	13.5	13	12.5	11.5	11	10.5	9.5	9	8	7	6	5	4	2.5

Ambient temp: 40°F

Ambient relative humidity: 90%

Dew point: 37.3°F

Wind velocity: 0 mph

Outer surface: Saranex CX, PVC, ASJ, or mastic (e = 0.90)

Geometry: Horizontal pipe

This table is based on ASTM C 680-95 heat transfer algorithms. The suggested insulation thickness values assume proper system design and installation, do not include a safety factor, and are applicable only for the specified scenario. JM recommends that the user consult a qualified design engineer familiar with this type of construction for proper system design and specification.