DIVISION 15
SECTION 15600

CRYOFLEX POLYETHYLENE INSULATION

For

AMMONIA REFRIGERATION SYSTEMS

Nomaco Insulation

Approved 07/10

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1.0 GENERAL

1.1 SCOPE

1.1.1 This section includes the schematic designs, pictures, and notes that supplement and clarify the standard specification. Contractor to coordinate with end user for implementation of this scope.

2.0 PRODUCTS

2.1 MANUFACTURERS AND BRAND NAMES

Listed in the standard specification.

2.2 SUCTION LINES, LIQUID LINES, AND VALVES

2.2.1 All insulation material for cold service shall be Cryoflex® brand extruded polyethylene cellular plastic foam insulation as manufactured by Nomaco Insulation.

2.2.2 Extruded polyethylene insulation shall have the following minimum properties:

- Density: 1.90 lb/ft3
- Temperature Range: -200°F to +200°F
- Coeff. Lin. Exp. 182(in/in°F) x 10-6
- Compressive Strength: 6 lb/in2 @ 10%

Cryoflex (extruded polyethylene cellular plastic).

2.3 HOT GAS PIPING AND VALVES, DEFROST DRAIN PIPING

2.3.1 Insulation for hot gas lines shall be Polyethylene “Cryoflex” as manufactured by Nomaco Insulation, in accordance with ASTM C 1427.

- Insulation shall be factory extruded or factory fabricated from extruded plank.
- Insulation fittings shall be fabricated in required shapes from bun stock in accordance with ASTM C 450 and C 585.

2.3.2 Insulation shall have a minimum density of 1.9 lbs. per cubic foot.

- Density: 1.90 lb/ft3
- Temperature Range: -200°F to 200°F
- Closed Cell Content: >90%
- Compressive Resistance: 6 lb/in2 @ 10% compression
- Thermal Conductivity: 0.261 Btu-in. /hr-ft2°F max (at 75°F)

2.3.3 The fittings, such as valves, flanges, 90 deg and 45 deg elbows, and tees, shall be two piece prefabricated router cut for 9 5/8” outside diameter and smaller pieces mitered for 10 ¾” outside diameter and /or 4” IPS or larger in accordance with ASTM C-450 and C-585. Larger OD valves and flanges may be fabricated as oversized and cavities may be filled with one component urethane foam as manufactured by Convenience Products.

2.4 VESSEL INSULATION

2.4.1 All material of construction for vessel covers and insulation shall be the same as the pipe and insulation for outdoors.

- All vessels (outdoor or indoor) shall be covered with Insulrap 30, Insulrap 50, Fabwrap 20 or ZeroPerm A vapor retarder.

2.4.2 Vessel heads segments shall be double radius pieces, pre-formed to precisely fit the contour of the vessel head without voids.

Acceptable manufacturers of head systems are:

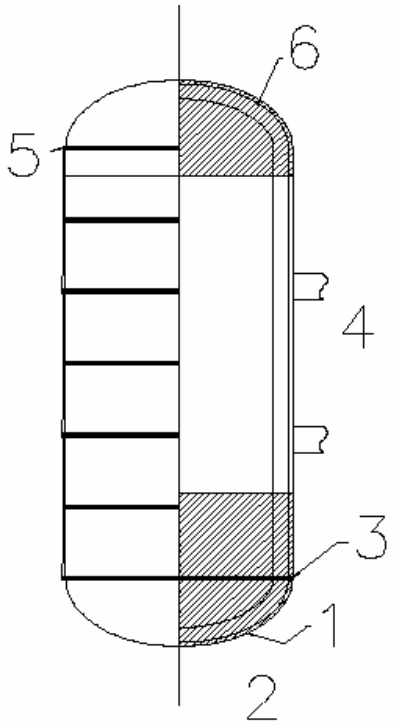
- Extol of Ohio, Inc.
- Pamrod
- Cook Brothers
- PTF Fabricators

2.4.3 Multiple layers of pipe insulation area required when the insulation thickness is 2” or greater. Each layer shall be a minimum of 1” thick.

2.4.4 Single layers of pipe insulation is acceptable when the insulation thickness is 1-1/2” 0r less.

2.4.5 Excel-Lap™ precision fabrication ship-lap pipe-covering, curved sidewall segments and fitting system as manufactured by Extol of Ohio, Inc. may be used when the total insulation thickness required is less than 3”. It may also be used in addition to but not as an alternate or in lieu of double-layering.

- The wall thickness of Excel-Lap™ fabricated items shall be a minimum 2” and maximum 3”.
- In addition, it shall not be used on process lines that cycle in operating temperature.



DETAIL OF TYPICAL BARRIER
JACKET & MASTIC SYSTEM ON A VESSEL

STEP 1: Mastic/Fab/Mastic
For vessel ends: Apply tack coat of vapor barrier mastic, coverage rate = 3-4 gal/100 SF then imbed 6x6 mesh and apply finish coat. Coverage rate = 3-4 gal /100 SF of mastic. Be sure to extend mastic 9-12" beyond tangent line onto side walls of vessel.

STEP 2: Run a 1" wide bead of joint sealer around the tangent line of the tank, over top of dried; cured mastic.

STEP 3: Apply 3" or 4" widths of vapor barrier around sidewalls of insulation. Make sure to imbed edge of jacket into joint sealer for a nice, tight seal between the mastic and the jacket.

STEP 4: Apply the next piece of jacket in a telescoping fashion taking care to maintain a minimum of a 4" overlap around the circumference and also 4" on the longitudinal lap. *Use adhesive compatible with the vapor barrier if necessary.

STEP 5: Apply 1" wide filament tape on 12" centers over top of vapor barrier, overlap tape 24" on itself. Make sure to tape over top of lap edges.

STEP 6: Apply finish as specified, either PVC or aluminum over top of insulation upon completion.

2.5 JOINT SEALER

2.5.1 Joint sealer for sealing all joints of insulation and PVC Slip Joints shall be vapor retarder type, moisture and water resistant, 97% solids by weight, non hardening, flexible with the service temperature range from -50°F to +200°F, Daxcel Foamastik161D, Dow Corning 732 Multi Purpose Sealant or Childers Chil-Joint CP-70.

2.6 VAPOR RETARDER MASTIC

2.6.1 The vapor retarder used to seal all fittings, valves, heads and equipment insulation prior to application of outer covering shall be water-based, compatible with the insulation material and remain flexible at the environmental temperature.

- Childers Chil-Perm WB CP-35.
    - The material shall meet the following minimum requirements:
        - Wet Flammability: No flash to boiling
        - Water Vapor Permeance: Maximum 0.02 US Perms
        - Average Non Volatile: 58% by volume
        - Service Temperature Range: -20°F to 190°F
        - Apply in accordance with the manufacturer's recommendations

2.7 REINFORCING FABRIC FOR VAPOR BARRIER MASTIC

2.7.1 The membrane for reinforcement of vapor retarder mastic shall be 6x6 glass fiber reinforcing mesh, Chil Glas #5 made by Childers or PC-79 Fabric, 5x6 mesh, by Pittsburgh Corning.

2.8 VAPOR RETARDER FOR INDOOR AND OUTDOOR SERVICE

2.8.1 The vapor retarder used to seal all piping insulation for both indoor and outdoor service prior to application of cladding shall be Polyguard Insulrap 30, Insulrap 50, Zero-Perm A, Alumaguard, Alumaguard LT All Weather, or Alumaguard Lite.

- Permeance shall not exceed 0.015 perms per ASTM E96.
- Install in accordance with the manufacturer's recommendations
- The vapor retarder membrane shall be protected at all times from sunlight. Degradation from exposure to ultraviolet (UV) rays will occur if not protected properly.

2.8.2 As an alternative to the above, metallic foil or PVDC type vapor retarder shall be applied to the surface of the insulation by the fabricator or field applied. Acceptable products include: Polyguard Products ZeroPerm and ZeroPerm Super White.

- Permeance shall not exceed 0.02 perms per ASTM E96
- Install in accordance with the manufacturer's recommendations
- If factory applied, inspect for damage before installation
- Protect vapor retarders from UV exposure per manufacturer's recommendations

2.9 FABRICATION ADHESIVE

2.9.1 Fabrication adhesive for fabrication of Cryoflex polyethylene insulation shall be one of the following:

- H. B. Fullers' SC-1454, a contact adhesive
- H. B. Fullers' HL-2278, hot melt adhesive
- Approved equal.

2.10 PVC CLADDING FOR INDOOR USE

2.10.1 Jacketing shall be tough, all-purpose, UV resistant capable of enduring frequent washing with hot water and caustic cleaning agents. The jacketing to provide protection to insulation and vapor retarder shall be one of the following:

- 0.030 inch thick Ceel-Co 300 series UVR PVC Jacketing
- Proto LoSmoke 25/50 UVR PVC.

2.10.2 All joints of PVC jackets shall be solvent welded with one of the following:

- Ceeltite
- Proto PVC Adhesive.

2.10.3 The color selection shall be decided before the awarding of the project. Consult the end user for color selection.

- **THE USE OF PVC CLADDING IS NOT RECOMMENDED FOR OUTDOOR USE.**

2.11 ALUMINUM CLADDING FOR OUTDOOR USE

2.11.1 The metal cladding weather barrier to provide protection from weather, mechanical wear or other damage shall be aluminum alloys 1100 meeting ASTM B209 with H-14 temper, 0.016 inch thick with Surlyn Film moisture barrier on the back side.

- **DO NOT USE POLY-KRAFT PAPER AS A VAPOR BARRIER.**

2.11.2 Surlyn Film – Grade 1652

- Specifications
  - Major Ion – Zinc
  - Density – gm/CC – 0.939
  - Yield – Sq. in/lb @ .001 – 29,470
  - Melt Index – Decigrams/Min. – 4.0
  - Tensile Strength – PSI – 2,850
  - MVTR – gm/100 sp. in/24 hrs – 1.8
  - Dart Drop – gm/mil – 200 (@ .002)

2.11.3 The cladding to cover all pipe insulation shall have a ½" safety hem on the longitudinal lap and shall be "cut and pre-curled" up to and including 26" O.D.

2.11.4 Roof Penetration

1. Refer to end user requirements for specific roof penetration construction details.
2. Indoor PVC must protrude a minimum of twelve inches.
3. A vapor break must be installed where the indoor PVC terminates.
4. A water diversion boot must be installed adhering to the PVC and roof.
5. Outdoor aluminum is then installed around the pipe to the base of the water diversion boot.

Roof penetration before aluminum cladding.

2.11.5 Wall penetration

1. Refer to end user requirements for specific wall penetration construction details.
2. Indoor layer of PVC jacketing must protrude through the wall 12 inches.
3. There must be a vapor break installed where the indoor PVC terminates outside.
4. Aluminum outdoor cladding is butted to the wall.

2.12 FASTENING ACCESSORIES (TAPE, STRAPPING, ETC.)

2.12.1 Tape for fastening pipe covering insulation shall be ¾" fiberglass reinforced strapping tape made by National Tape Company.

2.12.2 Stainless steel type T304/T316 strapping for fastening aluminum jacketing outdoors and outer layer of vessel and/or large diameter (above 16" O.D.) pipe insulation shall be ½" x 0.020" thick with wing seal made by one of the following:

- RPR Products
- Childers Products

2.12.2.1 RPR No. 7 or breather spring 4" long made from stainless steel type T304 shall be used for securing large diameter vessel's metal jacketing.

2.12.3 Polypropylene ½" wide, 0.50" thick banding and clips, Q-ban/Q-clip made by Band-It Inc. shall be used for securing PVC jacketing indoors.

- Banding shall not be used in food processing areas where bacterial growth is anticipated.
- Banding may be used to temporarily secure jacketing until PVC joint adhesive cures.
- The PVC jacketing must be completely sealed at all joints to prevent entry of water or Moisture

2.13 CAULKING

2.13.1 Caulking compound for sealing laps and penetrations on all cladding (Metal: color-gray and PVC: color-clear) to prevent entry of water shall be weather resistant.

- Dow Corning RTV 732 silicone caulking compound for metal and PVC jacketing.
- Childers CP-76, butyl caulking, gray for sealing laps on metal jacketing.

Dow Corning RTV 732 silicone caulking is a one component sealant which cures to a strong durable resilient rubber meets the following specifications:
USDA approved for use in federally inspected meat and poultry plants.
FDA registered 21 CFR 177.2600, TT-SOO1543A
COM-NBS CLASS A, TT-S00230C
COM-NBS CLASS A MIL-A-46106A
AMEND 2, TYPE 1.
CANADIAN 19-GP-9MA, TYPE 1.
TEMPERATURE RANGE: 85°F to 500°F

Childers CP-76 Chil-Byl joint sealer.

- Apply in accordance with the manufacturer's recommendations.
  Do not apply CP-76 to Cryoflex surfaces. Immediately remove any incidental contact.

2.13.2 Aluminum cladding

2.13.2.1 Caulk all laps, penetrations, and covers

Aluminum cladding cover.

Aluminum cladding reducer.

Aluminum cladding valve.

Aluminum cladding valve.

Aluminum cladding valve.

Aluminum cladding valve stem.

Wall penetration.

2.14 INSPECTION PLUGS

2.14.1 Cryoflex polyethylene insulation is flexible, non-friable and easily cut with a sharp knife, making it easy to remove for inspection and replace afterwards.

2.14.2 When specified, NDT inspection plugs made from EPDM and aluminum metal cap as manufactured by Parker Special products shall be installed on pipe and equipment requiring frequent inspections.

- Use 1-1/2 inch NDT plug for pipe and equipment insulation jacket OD of less than 9
- inches.
- Use 2-1/2 inch and 3 inch NDT plug for a pipe and equipment between 9” and 24”
- insulation jacket OD.
- Use 5” NDT plug for pipe and equipment insulation jacket OD above 24”.

2.15 CORROSION PROTECTION

2.15.1 All ammonia piping and vessels shall be painted or protected from corrosion in accordance with the end user’s requirements.

- Paints and primers shall be completely dry prior to installation of Cryoflex.
  - Heavy paint / primer build up can result in a poor insulation fit. Mechanically remove any large runs or drips that would inhibit proper fit.
- Cryoflex is compatible with anti-corrosive gels such as Polyguard RG-2400LT. Prior to application of anti-corrosive gels, mask off all areas to receive vapor stops and expansion joints. Field prime / paint these areas as required by the end user.
- Avoid contaminating the butt and longitudinal joints of the Cryoflex insulation during installation. Once installed, avoid rotating the insulation as this will cause uneven distribution of the gel.
- Clean gel from pipes with a solvent as recommended by the gel manufacturer.

3.0 EXECUTION

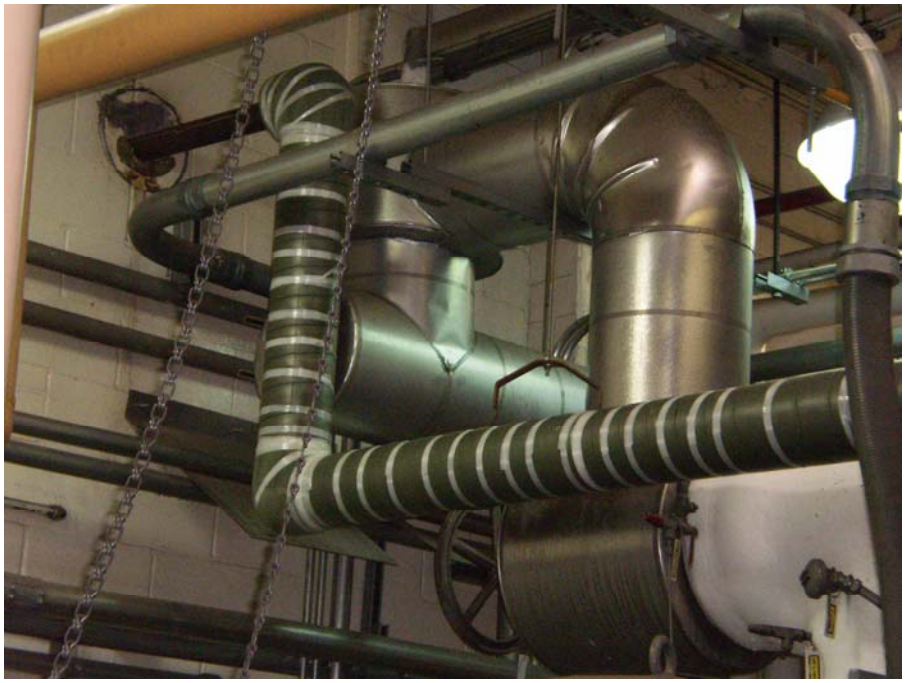
3.1 GENERAL

3.1.1 Where non-insulated lines branch from or join insulated lines, the non-insulated branch shall be insulated for a minimum distance of 18" (450 mm) from the insulated line.

- Insulation shall be the same type and thickness as required on the insulated line.
- Termination of the insulation shall be neatly and positively vapor sealed to the pipe with vapor barrier mastic.

Aluminum cladding (transition to non-insulated line with cap).

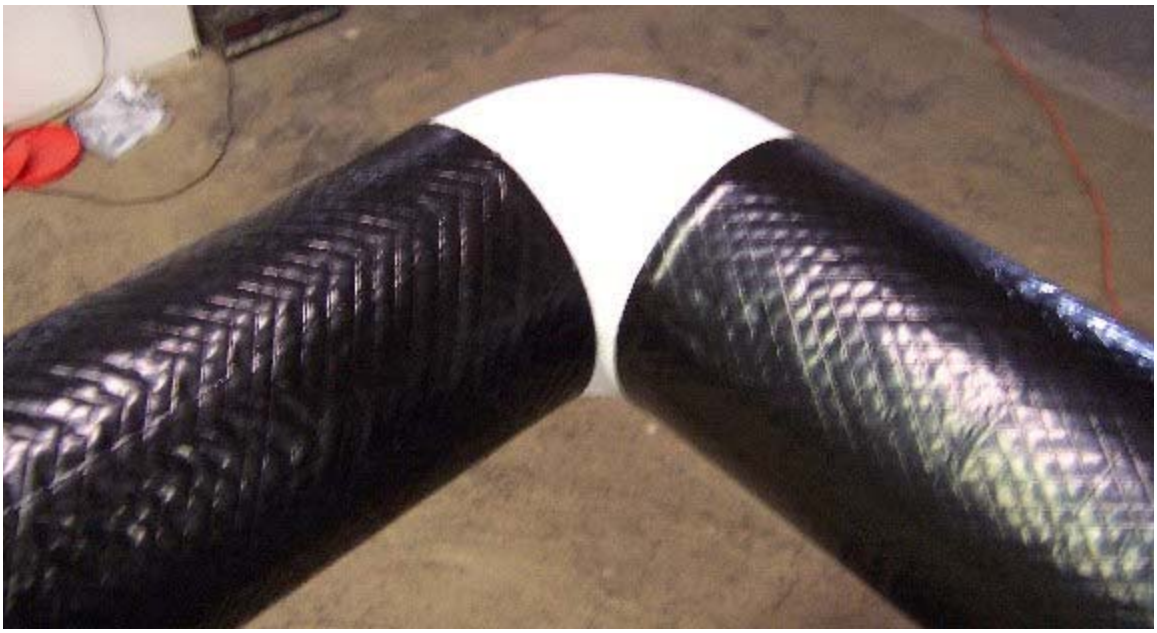
3.1.2 All insulation shall be tightly butted and free of voids and gaps.



All joints to be tightly fitted and properly sealed.

3.1.3 Vapor retarder must be continuous.

Vapor barrier to be continuous on all insulated piping (Insulrap 30 vapor retarder shown)



Vapor barrier must be continuous on all materials.

3.1.4 All fasteners and bands shall be neatly aligned and overall appearance of work must be of first-class workmanship.

3.1.5 Ammonia pumps shall not be insulated.

3.1.6 Pump suction lines shall be insulated to the pump flange.

3.1.7 The temporary strainer on the pump suction and pump discharge piping shall be completely insulated.

3.1.8 Pipe insulation described in this section shall not be installed on the strainers until three weeks after start-up as pump outs may be required for strainer cleaning during this period.

3.1.9 Strainer caps, jacking stems, adjusting stems, set screw and packing nuts and glands must be left exposed for service.

- The vapor seal at these exposed surfaces shall be protected against normal service damage and seal must prevent moisture migration under the insulated jacket.

3.1.10 Any insulation damaged during the start-up and shakedown operation must be repaired prior to final acceptance.

3.1.11 All work and materials must comply with government regulations.

3.1.12 Piping will be temporarily supported by wood blocks inserted between the piping and their supports.

- Blocks shall be sized to match the insulation thickness.
- The wood blocks are to be removed when installing the insulation and saddles, and hangers shall be re-checked when insulation is complete.

3.1.13 Insulation shall not be applied until piping has been leak tested and proven tight.

3.1.14 Contractor shall not install more insulation than can be 100% completed (vapor sealed) in the same day.

- Uncompleted pipe insulation shall receive proper watertight seal to protect from moisture infiltration.
- All exposed or wet insulation shall be replaced.

3.2 PIPE INSULATION

3.2.1 Surfaces to be insulated shall be clean, dry and free of rust and scale and shall be prime coat painted as specified by the end user.

- Cryoflex insulation shall be placed on pipe and vessels with all joints tightly butted.
- All outer layer insulation joints, surfaces of insulation shall be sealed with non-hardening water and weather resistant, vapor barrier sealant. Inner layers may be “dry fit”.

Remove dirt, rust, and scale on all pipes to be primed and painted.

3.2.2 After insulation joints are sealed, the vapor retarder lap seal shall be made vapor tight in accordance with the manufacturer’s recommendations.

- All butt joints shall be vapor sealed in accordance with the manufacturer’s recommendations.

3.2.3 Multiple layer pipe covering shall be installed so the butt and longitudinal joints of one layer do not coincide with those of any other layer.

- The outer layer joints shall stagger inner layer joints by half sections.
- Minimum overlap shall be 18 inches.
- The outermost layer of insulation shall have its longitudinal seam at the 3 o’clock or 9 o’clock positions.
- Multiple layers of pipe covering are required where insulation is 2” thick or greater.
- Each layer shall be a minimum 1” thick.

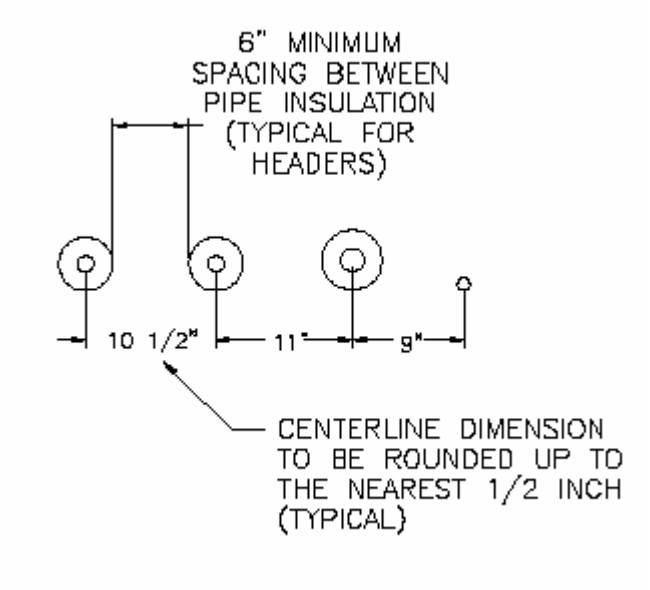
3.2.4 Pipe covering and curved shapes shall be fabricated in accordance with ASTM C 450 and 585 with minimum number of through joints.

- All insulation shall be pre-formed for valves and fittings.
- The fittings, such as valves, flanges, 90° and 45° elbows, and tees, shall be two piece prefabricated fly cut or routed for 9 5/8” outside diameter and smaller and shall be two pieces mitered for 10 ¾” outside diameter and/or 4” IPS or larger in accordance with ASTM C-450 and C-585
- Curved segments shall be fabricated per ASTM C 450 to fit the contour of surface in equal pieces to go around vessel with minimum number of through joints.
- Vessels 24” diameter and less may also be insulated using Cryoflex pipe insulation.
- Vessels greater than 24” diameter may also be insulated using Cryoflex sheet insulation in 1” or 2” thickness.
- Cutting in the field shall be minimized.

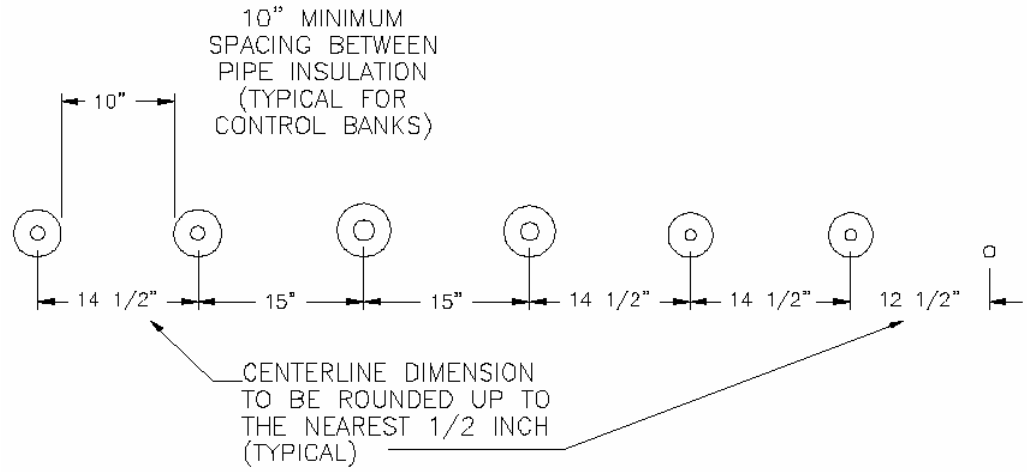
3.2.5 Pipe Spacing

3.2.5.1 Pipe spacing shall be adequate to allow the full thickness of insulation with sufficient clearance provided for installation of vapor retarders and jacketing.

3.2.5.2 Headers



3.2.5.3 Control Banks



3.3 APPLICATION OF TAPE & BANDING

3.3.1 Insulation shall be fastened circumferentially with ¾ inch wide tape two inches from each end and one in the middle of pipe section and a minimum of two tapes per each section of equipment insulation.

- The tapes shall be pulled tight to seal all joints.
- Bands shall be used above 16 inch O.D. and on all curved wall segments where tapes do not close insulation joints tightly.

3.3.2 All tapes shall be overlapped at least 50 percent on itself.

3.3.3 Tightening of tapes or bands shall not compress the insulation or damage the cladding.

3.3.4 The outer layer or single layer of equipment insulation shall be fastened with the use of T-304 stainless steel ½ inch wide bands on 12 inch centers.

3.4 HAND VALVE INSULATION

3.4.1 Valves shall be full-formed with no voids on the inside of the valve insulation cover.

3.4.2 Valve insulation shall not cover valve packing.

Angle valve installation (vapor barrier applied).

Angle valve installations (secure and tape).

3.5 CONTROL VALVE INSULATION

3.5.1 Control valves with operating temperatures at and below -1°F will be covered with corresponding pipe schedule thickness.

3.5.2 Control valves with operating temperatures at and above 0°F will be insulated as specified by the end user.

- Insulation shall be terminated 3” from the control valve flange or as necessary to allow clearance for removal of flange bolts without removing insulation.
- Insulation terminations on either side of an un-insulated valve shall be terminated with vapor stops.

3.6 VESSEL HEAD INSULATION

3.6.1 Prior to installation of Cryoflex insulation, its thickness shall be verified in accordance with the operating temperature, diameter, and end user specifications.

- The insulation thickness must follow the requirements shown in ASTM C585 and NOT the nominal thickness.
- All insulation sections shall be trimmed and tightly butted to eliminate voids, gaps, or open joints.
- Joint sealer shall not be used to fill these imperfections.
- The insulation ends shall be compressed to achieve tight fit.

3.6.2 Vessel Insulation

3.6.2.1 Where specified, curved segments shall be fabricated from Cryoflex Block per ASTM C 450 to fit contour of surface in equal pieces to go around the vessel with a minimum number of through joints.

3.6.2.1 As an alternative to the above, vessels may be insulated using Cryoflex pre-formed pipe insulation or Cryoflex flexible sheet insulation.

- Field cutting shall be minimized.

3.6.3 Head Segment Layout

3.6.3.1 It is CRITICAL to locate the center of the vessel head.

- ‘Snap’ a “cross-hair” in center.
- Install the center piece(s); on the center of the vessel.
- Depending on size of vessel, the centerpiece will be one piece round or two each half round disk pieces.
- The insulation pieces are installed in courses.
- The first course, closest to the center piece(s) is numbered 1.
- The second course is numbered 2, and so on.
- For double-layered head segments, the Inner Layer will also be labeled with an “I”.
- The outer layer will also be labeled with an “O”.
- A drawing shall be supplied with each head segment identifying the number of courses and the amount of pieces per course.

3.6.3.2 Layout a piece of each layer from the center to vessel sidewall prior to application of any adhesive/mechanical fasteners to verify starting point.

3.6.4 Application of Multiple Layers

3.6.4.1 Multiple layers shall be installed so the butt and longitudinal joints of one layer do not coincide with those of any other layer.

- The outer layer joints shall stagger inner layer joints by half sections.

3.6.5 Application of Head Insulation Utilizing Adhesive

3.6.5.1 Where the end user requires Cryoflex bonded to the substrate metal with adhesive (cold); the lower and upper temperature limit and/or adhesive product limitations shall be per manufacturer’s recommendations.

3.6.5.2 Temperature of the surface to be insulated shall not be lower than +40ºF during application of insulation (cold service).

- Temperature of the adhesive shall be maintained between +55ºF and +95ºF during application.

3.6.5.3 The face and the two adjoining edges of each insulation segment shall be fully coated with the adhesive using a notched steel trowel as recommended by the adhesive manufacturer (cold service).

- The entire joint area of each insulation segment shall be coated with 1/16” thick adhesive using a notched steel trowel.
- The adhesive shall fully ‘wet’ the insulation surfaces.
- Joining one coated surface with another un-coated surface is not permitted.
- Both surfaces to be joined shall be individually coated.

3.6.5.4 The coated insulation shall be pressed firmly into the correct position.

- Excess adhesive shall be removed.

3.7 APPLICATION OF HEAD INSULATION UTILIZING MECHANICAL FASTENING SYSTEM

3.7.1 Cryoflex head segments shall be applied on vessel and equipment heads with joints staggered.

- The butt edges shall be coated with a 1/16” thick layer of approved joint sealer.
- Where multiple layers are installed, only the outermost layer shall be sealed.

3.7.2 Cryoflex segments shall be coated or ‘tacked’ in place with adhesive (See Section 4.0).

3.7.3 Cryoflex shall be secured with bands attached to a 3/8" diameter centralized floating ring of stainless steel or carbon steel rod or bar (which matches the alloy of vessel) at the tangent line of the vessel top head.

- The rod or bar shall be located such that it secures the Cryoflex firmly against the vessel head.

3.7.4 Vessel skirt itself shall have some type of holding device to hold the insulation support rod or bar in place; supplied by vessel fabricator.

3.7.5 When securing insulation with bands to the floating rings, bands shall be drawn down radially from the tangent line circumferential body and pulled tight to eliminate any gap between insulation and vessel head

- Band spacing shall be on 12" maximum centers at the tangent line.
- Headbands should alternately be attached to the first and second rows at the tangent ends of the vessel.

3.7.6 Vessel transitions shall closely fit the curvature of the shell.

- Coat butt edges of head segments to curved segments/block/lags at tangent line with 1/16" thick layer of joint sealer.

3.7.7 Stiffener rings and insulation support rings shall be enclosed in block insulation.

- Butt edges of all insulation shall be coated with a 1/16" thick layer of joint sealer.

3.7.8 The Cryoflex shall be secured in place with a band in the center of each ring.

3.8 VAPOR RETARDER FOR INDOOR AND OUTDOOR SERVICE

3.8.1 Self adhesive vapor retarders seal better when applied in warm weather. Liquid Adhesive or a light pass may be made with a heat gun over the face of the adhesive mass just prior to application will improve initial adhesion. Consult manufacturer recommendations.

3.8.2 Heads must be sealed with mastic and fabric.

3.8.3 The vapor retarder membrane shall be protected at all times from sunlight.

- Degradation resulting from exposure to ultraviolet (UV) rays will occur if not protected properly.

3.9 CLADDING FOR OUTDOOR AND INDOOR USE

3.9.1 All cladding shall be installed in accordance with industry standards and manufacturer recommended installation procedures or as specified by the end user.

3.9.2 Aluminum cladding shall be used on all outdoor piping systems and equipment.

- The cladding to cover all pipe insulation shall have a ½" safety hem on the longitudinal lap and shall be "cut and pre-curled" up to and including a 20" O.D.

3.9.3 Use of aluminum cladding is recommended for indoor use in areas subject to physical abuse.

3.9.4 PVC cladding shall be used for indoor applications.

- PVC cladding shall be extra heavy duty, all purpose, UV resistant and capable of enduring frequent washing with hot water or cleaning agents.
- PVC cladding shall meet the requirements of the end user for specific use areas (e.g. USDA approval).

3.10 CONTRACTION/VAPOR JOINTS

3.10.1 Contraction joints for jacketing materials

- Refer to the manufacturer of the jacketing material and / or end user requirements for location and fabrication of contraction joints.

3.10.2 Insulation contraction joints for horizontal piping and equipment shall be provided as shown in the table below:

	PIPE TEMPERATURE	
	BELOW 0ºF	**0ºF AND ABOVE**
Straight Run	Every 30 ft	Every 40 ft.

.

3.10.3 Contraction joints for vertical piping and equipment shall be provided immediately below each insulation support ring in each layer of insulation.

Double layer expansion joint assembly, 8" gap in 1st layer.

Double layer expansion joint assembly, 16” gap in 2nd layer.

Double layer expansion joint assembly, vapor barrier and mastic / mesh applied.

Double layer expansion joint assembly, 7" Cryoflex and 1" fiberglass installed on 1st layer.

Double layer expansion joint assembly, 15" Cryoflex and 1" fiberglass installed on 2nd layer.

Double layer expansion joint assembly, vapor retarder being installed.

Double layer expansion joint assembly completed, location to be identified on jacket.

- **For *single layer* expansion joint, duplicate steps for 1st layer of insulation, then install a 2nd layer of insulation 1" wall thickness and 16" length over the 1st layer.**

- **Apply mastic and mesh to ends of 2nd layer, extending a minimum 2" onto 1st layer and 2nd layer of Cryoflex.**
- **Install vapor barrier over insulation and mastic / mesh.**
- **Install jacket and identify location of the expansion joint.**

3.11.1 Vapor stops shall be installed at all changes in configuration such as elbow, flanges, valves, manways, nozzles and insulation terminations and all locations on piping and equipment requiring maintenance including instrumentation connections.

3.11.2 Vapor stops shall be constructed using reinforced vapor barrier mastic and fabric.

- After vapor stop becomes dry, adjacent section of insulation shall be installed using joint
- sealer.
- Depending on spacing of expansion/contraction joints, the vapor stop may be
- incorporated into the expansion/contraction joint.

Vapor retarder mastic application - fitting in position with adhesive and tape. Note mastic applied to pipe prior to anti-corrosion gel application.

Vapor retarder mastic application completed.

Vapor barrier must be applied to all terminations.

Vapor barrier at control valve.

3.12 PVC SLIDING LAP SLIP JOINT

3.12.1 PVC sliding lap expansion-contraction joints shall be constructed in accordance with the end user or jacket manufacturer's requirements. Frequency of slip joints shall be as specified by the end user or jacket manufacturer.

3.12.2 Location of PVC sliding lap slip joins shall be identified on the jacketing.

3.13 CORROSION PROTECTION

3.13.1 All piping and vessels shall be clean and free of dirt, oil, rust and scale and any foreign matter that would inhibit the satisfactory performance of vapor stops.

3.13.2 All ammonia piping and vessels to be insulated shall be surface prepped and primed / painted per the end user's specification. All paints / primers shall be dried per the paint / primer manufacturer's recommendations prior to the installation of Cryoflex.

3.13.3 Paint / primer application thickness should not interfere with the proper fit of Cryoflex on the piping or vessels.

3.13.4 Where specified, anti-corrosion gel application shall be in accordance with the end user's or manufacturer's requirements.

3.13.5 Prior to application of anti-corrosion gel, dry fit all fittings and mask off all areas to receive vapor stops.

3.13.6 Avoid contamination of Cryoflex bonding surfaces with anti-corrosion gel as the gel will inhibit proper sealing. The use of a screeding device such as the Accutrowel™ is recommended to control gel application thickness.

3.13.7 When anti-corrosion gel is used, install Cryoflex with the longitudinal joint in the correct position. Avoid excessive movement of the insulation as this will re-distribute the anti-corrosion gel.

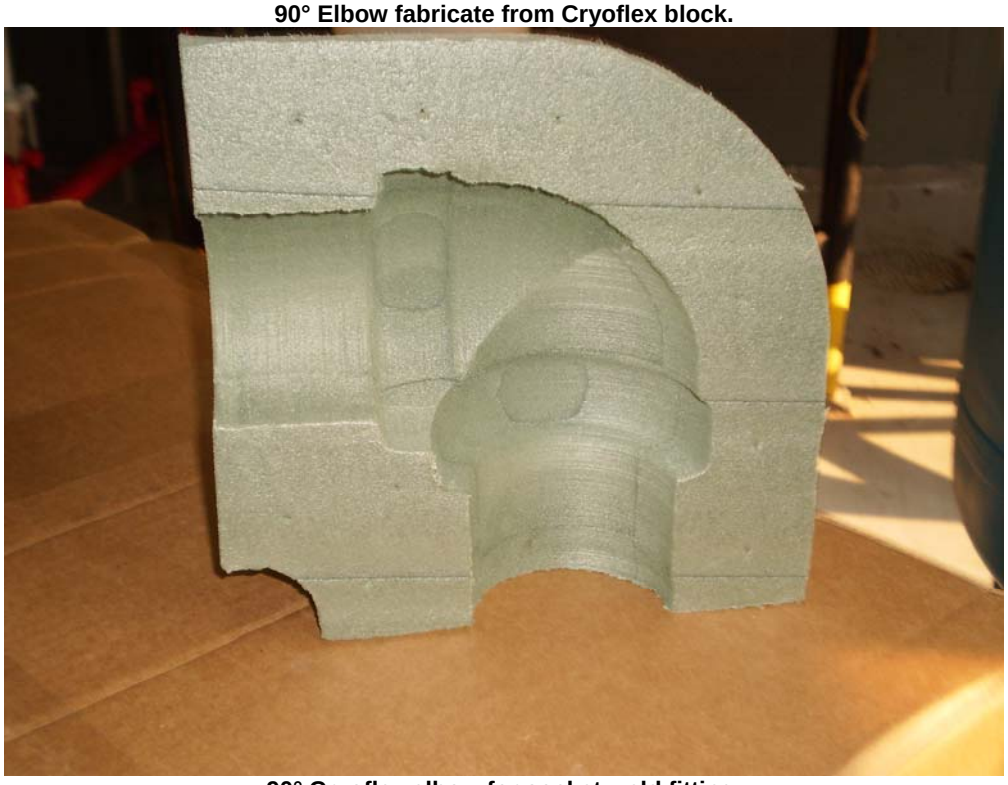
Anti-corrosion gel applied to pipe using an Accutrowel™ screed.

Cryoflex installed on pipes coated with anti-corrosive gel.

3.14 ELBOWS AND FITTINGS

3.14.1 All elbows and fittings shall be fabricated from Cryoflex pipe covering or Cryoflex block insulation. Fittings shall conform to ASTM C450 and C585 requirements.

90° Elbow fabricate from Cryoflex block.



90° Cryoflex elbow for socket weld fitting.

3.15 INSULATION PROTECTION SADDLES

3.15.1 Insulation protection saddles shall be provided and installed by the Contractor at all pipe hangers and supports for insulated lines.

Galvanized saddle banded in place.

- Saddles shall be fabricated from galvanized sheet metal rolled with a true radius to suit the insulation O.D.
- Saddles shall be sized to wrap the insulation in an arc as shown in table 1 below: (Refer to Saddle Detail)

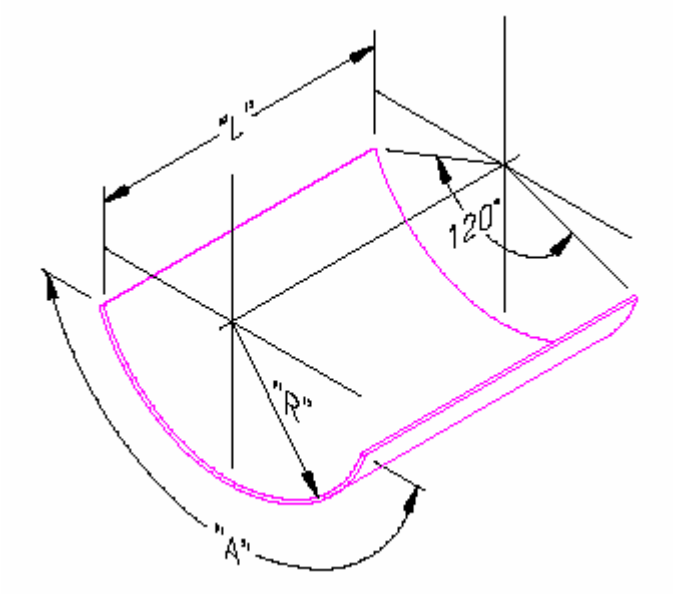


Table 1
Saddle Sizing

INSULATION DIAMETER	GAUGE METAL	"A"	"R"
2-1/2"	20	2-1/2"	1-1/4"
3"	20	3"	1-1/2"
3-1/2"	18	3-1/2"	1-3/4"
4"	18	4"	2"
4-1/2"	18	5"	2-1/4"
5"	16	5-1/2"	2-1/2"
6"	16	6-1/2"	3"
8"	16	8-1/2"	4"
10"	14	10-1/2"	5"
12"	14	12-1/2"	6"
14"	14	14-1/2"	7"
16"	14	17"	8"
18"	12	19"	9"
20"	12	21"	10
22"	12	23"	11
24"	12	25"	12
26"	12	27"	13
28"	12	29-1/2"	14
30"	12	31-1/2"	15

- Saddle length shall be adjusted to minimize the load on the Cryoflex insulation based on pipe size and support spacing. Refer to Table 2 for recommended saddle lengths. Saddle lengths shall not be less than 12".
- All saddles shall be secured to the pipe by strapping the saddle with two stainless steel, Type T304/T316 strapping, on both ends of the saddle

Table 2 – Recommended Saddle Sizes

Pipe Size	OD	Wall Thickness	ID(inches)	ID Circumference (FT)	wt/LFT	Area of 1ft Pipe(ft3)	Ammonia Weight	Calculated Minimum Saddle Size for pipe support (with 20% safety factor)* 7 FT center	10 FT center	15 FT center
1/8"	0.405	0.068	0.269	0.022	0.240	0.00039	0.0167925	6	6	6
1/4"	0.540	0.088	0.364	0.030	0.430	0.00072	0.03074777	6	6	6
3/8"	0.675	0.091	0.493	0.041	0.570	0.00132	0.05640332	6	6	6
1/2"	0.840	0.109	0.622	0.052	0.850	0.00211	0.08978248	6	6	6
3/4"	1.050	0.113	0.824	0.069	1.130	0.00370	0.15756699	6	6	6
1'	1.315	0.133	1.049	0.087	1.680	0.00600	0.25536525	6	6	6
1 1/4"	1.660	0.140	1.380	0.115	2.270	0.01038	0.44194578	6	6	6
1 1/2"	1.900	0.145	1.610	0.134	2.720	0.01413	0.60153731	6	6	6
2"	2.375	0.154	2.067	0.172	3.660	0.02329	0.99149783	6	6	8
2 1/2"	2.875	0.203	2.469	0.206	5.800	0.03323	1.414663	6	6	8
3"	3.500	0.216	3.068	0.256	7.580	0.05131	2.18434647	6	6	10
3 1/2"	4.000	0.226	3.548	0.296	9.120	0.06862	2.92131264	6	8	10
4"	4.500	0.237	4.026	0.336	10.800	0.08836	3.76147653	6	8	10
5"	5.563	0.258	5.047	0.421	14.630	0.13886	5.9112241	6	8	12
6"	6.625	0.280	6.065	0.505	18.990	0.20053	8.53635416	6	10	14
8"	8.625	0.322	7.981	0.665	28.580	0.34723	14.7817358	8	10	16
10"	10.750	0.365	10.020	0.835	40.520	0.54732	23.2994816	10	14	18
12"	12.750	0.406	11.938	0.995	53.570	0.77691	33.0730284	10	16	22
14"	14.000	0.438	13.124	1.094	63.500	0.93894	39.9708384	12	18	24
16"	16.000	0.500	15.000	1.250	82.850	1.22656	52.2147656	12	18	26
18"	18.000	0.562	16.876	1.406	104.760	1.55255	66.0921452	14	20	30
20"	20.000	0.594	18.812	1.568	123.230	1.92920	82.1260159	16	22	32
22"	22.000	0.625	20.750	1.729	170.000	2.34716	99.9187557	18	26	40

*Saddle length shall not be less than 12".

3.16 INSULATION SHALL BE KEPT DRY AT ALL TIMES DURING STORAGE AND INSTALLATION

- Wet insulation shall not be installed or allowed to become wet on the pipe prior to installing the vapor retarder and weather retarder.
- Follow procedure used by plant and as directed by Plant Engineer and Project Engineer.
- Systems will be identified as well as direction of flow where it is indicated.

3.17 IDENTIFICATION OF PIPING AND SYSTEM COMPONENTS

3.17.1 See Division 15 – Section 15601 Identification of Ammonia Refrigeration Piping.

3.18 SCHEDULES

3.18.1 Thickness tables are based on ASTM C 680 heat transfer algorithms. The suggested insulation values assume proper system design and installation, do not include a safety factor, and are applicable only to the specific application s. It is recommended that the end user consult a qualified ammonia refrigeration design engineer for proper system design and specification.

INSULATION THICKNESS SCHEDULE
FOR REFRIGERATION SYSTEMS – OUTDOOR

Insulation Thickness to Prevent Condensation or Limit Heat Gain to 8 btu/hr-ft², whichever is Greater

Nominal Pipe Size, (in)	Service Temperature, °F							
	-100	-80	-60	-40	-20	0	20	40
0.5	3.5	3.5	3	2.5	2.5	2.5	2	1.5
0.75	4	3.5	3.5	3	2.5	2.5	2	2
1	4	4	3.5	3.5	3	2.5	2	2
1.25	4.5	4	4	3.5	3	3	2.5	2
1.5	4.5	4	4	3.5	3	3	2.5	2
2	5	4	4	4	3.5	3	2.5	2
2.5	5	4.5	4	4	3.5	3	2.5	2
3	5.5	5	5	4.5	4	3.5	3	2.5
4	6	5.5	5	4.5	4	3.5	3	2.5
5	6.5	6	5.5	5	4.5	4	3.5	2.5
6	6.5	6	5.5	5	4.5	4	3.5	2.5
8	7	6.5	6	5.5	5	4	3.5	3
10	7.5	7	6.5	6	5	4.5	4	3
12	7.5	7	6.5	6	5.5	4.5	4	3
14	8	7.5	7	6	5.5	5	4	3
16	8	7.5	7	6.5	5.5	5	4	3.5
18	8	7.5	7	6.5	6	5	4	3.5
20	8.5	8	7	6.5	6	5	4	3.5
Tank Side	9	8	7.5	6.5	6	5	4	3
Tank Top	7.5	7	6.5	5.5	5	4	3.5	2.5
Tank Bottom	12	11	10	9	8	6.5	5.5	4

100F Ambient	97F dew point	Horizontal orientation
90% RH	Metal outer jacket	7.5 mph wind speed

* Thicknesses calculated per 3E Plus Program. No safety factor included.
Actual jobsite conditions may vary.

INSULATION THICKNESS SCHEDULE
FOR REFRIGERATION SYSTEMS - INDOOR

Insulation Thickness to Prevent Condensation or Limit Heat Gain to 8 btu/hr-ft², whichever is Greater

Nominal Pipe Size, (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	2.5	2.5	2.5	2.5	2	2	1.5	1
1	3	2.5	2.5	2.5	2	2	1.5	1.5
1.25	3	3	3	2.5	2	2	1.5	1.5
1.5	3	3	3	2.5	2	2	1.5	1.5
2	3.5	3	3	2.5	2.5	2	1.5	1.5
2.5	3.5	3	3	2.5	2.5	2	1.5	1.5
3	3.5	3.5	3	3	2.5	2	2	1.5
4	3.5	3.5	3	3	2.5	2.5	2	1.5
5	4	3.5	3.5	3	2.5	2.5	2	1.5
6	4	4	3.5	3	3	2.5	2	1.5
8	4.5	4	3.5	3.5	3	2.5	2	1.5
10	4.5	4	3.5	3.5	3	2.5	2	1.5
12	4.5	4	4	3.5	3	2.5	2	1.5
14	4.5	4	4	3.5	3	2.5	2	1.5
16	5	4.5	4	3.5	3	2.5	2.5	1.5
18	5	4.5	4	3.5	3	3	2.5	1.5
20	5	4.5	4	3.5	3.5	3	2.5	1.5
Tank Side	5.5	5	4.5	4	3.5	3	2.5	1.5
Tank Top	5.5	5	4.5	4	3.5	3	2.5	1.5
Tank Bottom	5.5	5	4.5	4	3.5	3	2.5	1.5

90F Ambient	83°F dew point	Horizontal orientation
80% RH	PVC outer jacket	0 mph wind speed

* Thicknesses calculated per 3E Plus Program. No safety factor included.
Actual jobsite conditions may vary.

3.19 Cleaning, Roof Protection and Repairs of Damages

3.19.1 It will be the responsibility of the Contractor to maintain a clean and safe environment in and around the project area.

- **The Contractor will remove ALL debris from the site daily**.
- **All construction materials, equipment, debris, and waste shall be managed daily.**
- Contractor shall provide proper protection to all roof surfaces where work is being conducted.
- Roof protection shall consist of 1.0" extruded insulation and ¼" plywood sheathing.
- Roof protection and repairs of damages shall be in accordance with Division 1, Section 01525 – Protection of Roofing Membrane