



# **INSTALLATION GUIDELINES FOR COLD/CRYOGENIC PIPE INSULATION**

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**Temperature Range**  
**-310°F to 32°F**

**PERMATHERM, INC. SPECIFICATIONS**  
**PIPE & EQUIPMENT INSULATION – CHILLED WATER**

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1.0 SCOPE



1.1 This guide covers recommended insulation materials, fabrication, installation and application of rigid, cellular, thermal insulation for above ground piping and equipment to be used in Cold Service. This guideline should be followed unless local building codes dictate otherwise.

## 2.0 INSTALLATION SUBCONTRACTOR RESPONSIBILITY

- 2.1 Any conflict between the requirements of this specification and related codes, standards, data sheets, drawings, attached commercial contract, etc. Shall be referred to Contractor for clarification/resolution.
- 2.2 Subcontractor shall not make assumptions to replace information not furnished by Contractor. Subcontractor is required to obtain necessary information from Contractor other reliable sources. Any and all claims arising from lack of knowledge of required information will be rejected by Contractor.
- 2.3 Subcontractor shall list and fully describe all deviations from this specification and the related codes.
- 2.4 Subcontractor shall field verify all (existing) dimensions and conditions shown on Contractor drawings. The lines and equipment to be insulated are identified in the drawings.
- 2.5 Subcontractor shall follow manufacturer's recommendation in safe handling of insulation materials and use of required safety equipment.

## 3.0 DESIGN

### 3.1 Definitions

- 3.1.1 The term "Cold Service" shall normally apply to below freezing temperatures.
- 3.1.2 The term "cylindrical surfaces" applies to equipment such as vessel shells, heat Exchangers, ect., as well as to piping.
- 3.1.3 The abbreviation "OD" when used without a description applies to outside diameter.
- 3.1.4 The term "Vapor Barrier" refers to a material which retards the passage of water vapor.
- 3.1.5 The other terms used in the specification shall be in accordance with ASTM C168 "Standard Terminology Relating to Thermal Insulating Materials."
- 3.1.6 The term "Contractor" refers to PermaTherm, Inc.

### 3.2 Specification Requirements

- 3.2.1 Insulation application shall not proceed until after the following have been completed:
  - \*The pipe surface must be dry.
  - \*All required pressure testing.
  - \*Application of required substrate protective coating systems, including touch-up of previously applied coatings.
  - \*Installation of tracing system

- 3.2.1.1 In cases where it is necessary to insulate before completing the above work, prior written approval of the Contractor or his designated representative must be obtained.
- 3.2.2 Only proven stress-corrosion safe insulation material meeting the requirements of ASTM 795 “Wicking Type Thermal Insulation for Use Over Austenitic Stainless Steel” shall be applied over stainless-steel.
  - 3.2.2.1 Insulation materials containing greater than 150 PPM leachable chlorides per ASTM C871 shall not be used on austenitic stainless-steel.
- 3.2.3 Asbestos containing materials shall not be used.
- 3.2.4 All insulation and finish shall be applied using the best modern practice and finished work shall display a neat appearance.
- 3.3 Extent of Insulation
  - 3.3.1 General
    - 3.3.1.1 The Contractor’s drawings show equipment, i.e., vessels, heat exchangers, machinery, ect., and piping which are to be insulated in accordance with the specifications.
    - 3.3.1.2 If insulation is unavailable in thickness shown, the next larger thickness commercially available shall be applied.
    - 3.3.1.3 All valves, fittings, vessel drains, and flanges on cold equipment and piping be fully insulated.
    - 3.3.1.4 Attachment to cold service vessels such as instrument bridges, gauge glass, ect., shall be insulated.
    - 3.3.1.5 Skid mounted piping and equipment shall be insulated per this specification and unless otherwise specified in applicable purchase documents, shall be insulated by the insulation sub-contractor.
  - 3.3.2 Insulation Thickness
    - 3.3.2.1 Insulation thicknesses are designed to minimize condensation on the outer surfaces at various ambient conditions as shown. The insulation thicknesses are shown on the drawings.
    - 3.3.2.2 The maximum thickness of a single layer insulation shall be 2”. For multi-layers insulation, thickness of each layer shall conform to Attachment II.
    - 3.3.2.3 Insulation thickness shall be based on normal operating temperatures and shall not be based on design temperatures.

#### 4.0 ADDITIONAL REQUIREMENTS

##### 4.1 Welding

- 4.1.1 Field welding, such as welding of studs or nuts for insulation, on any piece of equipment or pipeline is prohibited.

##### 4.2 Surface Preparation and Painting



- 4.2.1 Before application of insulation, all surfaces shall be cleaned to remove loose rust, paint, dirt, grease, or other foreign matter.
- 4.2.2 Insulation shall not be installed until after field welds and other surfaces which require painting have been leak tested and painted (if required).

## 5.0 MATERIAL

### 5.1 General

- 5.1.1 All materials shall be new; materials such as insulation blocks, molded pipe covering, mastics, adhesives and weatherproofing shall be delivered to job-site in factory sealed cartons, containers, and/or packages.
- 5.1.2 Items specified by their properties represent minimum quality requirements. Alternates or deviations must be submitted to the Contractor for approval.
- 5.1.3 Unless otherwise specified, manufacturer's recommendation shall be adhered to in application and handling including all safety requirements for the materials.

### 5.2 Storage and Handling

- 5.2.1 Storage of insulation and accessory materials must provide adequate protection from damage due to moisture and temperature. All flammable materials must be stored away from ignition sources, such as welding operations.
- 5.2.2 Storage temperature for adhesives, and sealers shall be within temperature ranges required by the material manufacturer. All materials which are improperly stored and exposed to temperatures outside the recommended temperature ranges should be removed from the site and replaced with new material.
- 5.2.3 All insulation material shall be kept dry and off the ground with adequate protection against moisture and inadequate drainage. Wet or damaged material shall be replaced with new material.

### 5.3 Acceptable Materials

- 5.3.1 All insulation material for cold service shall be rigid closed cell polystyrene cellular plastic foam insulation with the following typical physical properties:

<b>Physical Properties</b>	<b>ASTM TEST</b>
Density 2.0 lbs./cu.ft.	0.90
min dry weight	



Thermal Conductivity	20°F	0.21
K Factor	55°F	0.22
	75°F	0.23
Thermal Resistance	20°F	4.8
R-value	55°F	4.6
	75°F	4.4
Compressive 10% Deformation		33.12
Flexural		71.1
Tensile		23-27
Shear		33-37
Shear Modulus		600-640
Modulus of Elasticity		460-500
Water Vapor Permeance		
0.6-1.5 perm. Inch maximum		1.64
Water Absorption		
Less than 1.0%		1.85
Maximum Service Temperature		
Long Term Exposure		167
Intermittent Exposure		180
Oxygen		24.0

- 5.3.2 Prior to delivery of pipe and vessel insulation to the project, the Insulation Contractor will submit a certification from the manufacturer that all insulation material to be provided will meet all the above requirements. All polystyrene shall be manufactured from virgin materials, NO recycled material shall be permitted, 12-week aging process or equivalent 2 weeks in drying room at 153° F. Any material which is found in violation of these requirements shall be removed from the project and replaced with materials which do meet the requirements.
- 5.3.3 Pipe covering, and curved shapes shall be fabricated in accordance with ASTM C450 and C585 with minimum number of through joints.

5.3.3.1 Where multi-layer pipe covering is required, each layer shall be minimum 1" thickness.

5.3.4 The fittings (valves, flanges, 90 and 45 elbows) shall be two-piece prefabricated fly-cut or routed for 9 5/8" outside diameter and smaller.

5.3.5 Larger diameters shall be two pieces mitered for 10-3/4" outside diameter and/or 4" IPS or larger, in accordance with ASTM C450 and C585. Larger OD valves and flanges may be fabricated as oversized and cavities may be filled with two component urethanes spray foam after covering with polyethylene.

5.3.6 Flat boards shall be fabricated in accordance with ASTM C 450.

5.3.7 Vessel heads segments, flat insert type, fabricated per ASTM C 450). Use two component urethane spray foam to fill voids in dome.

5.3.8 Curved segments shall be fabricated per ASTM C450, to fit the contour of the surface in equal pieces to go around vessel with minimum number of through joints. Cutting in the field shall be minimized.

#### 5.4 Joint Sealer

5.4.1 Joint sealer for sealing all joints of insulation and PCV slip joints shall be vapor barrier type, moisture and water resistant, 97% solids by weight, non-hardening, flexible with the service temperature range from -50 °F to +180°F, TACC 622 or Childers CP-70, or approved equal.

#### 5.5 Fitting Vapor Barrier

5.5.1 The vapor barrier used to seal all fittings, valves, heads and equipment insulation prior to application of outer covering shall be Permacast Fitting Seal. The Permacast Fitting Seal will have the following minimum requirements:

	<b>Test Method</b>	<b>Values</b>
Water Vapor Transmission	E-96	1.64

5.5.2 Prior to delivery of pipe and vessel insulation to the Project,

Compressive 10% Deformation	33-12
Flexural	71.1
Tensile	23-27
Shear	33-37
Shear Modulus	600-640
Modulus of Elasticity	460-500

5.5.3 Vapor Barrier



5.5.3.1 Vapor barrier shall be manufactured by PermaTherm, Inc., Monticello, GA 31064, or equal. Vapor barrier shall have the following physical properties:

Construction:

Aluminum Foil	0.1 mil
Film	0.1 mil
Adhesive	Flame Retardant

Physical Properties:

Permeance (MVTR)	ASTM E-96 perms .0000
Service Temp. Range	-100°F to + 300°F
Tensile Strength	20,000 psi
Bursting Strength	95 psi
Flame Spread E-84 & UL 723	10
Smoke generation E-84 & UL 723	25

5.5.4 Pipe and Hanger Supports

5.5.4.1 Pipe insulation supports shall be fabricated from galvanized sheet metal as indicated on the drawings. All supports must be outside the insulation. There shall be no protrusions through insulation to pipe.

5.5.5 PVC Jacketing

5.5.5.1 PVC jacketing (for indoor use only) shall have the following physical properties:

<u>Property:</u>	<u>Thickness:</u>	<u>Values:</u>
Tensile Strength at Yield	0.030	6,500psi
Elongation at yield	0.030	4%
Tensile Module	0.030	380,000 psi
Coefficient of linear	0.030	3.6 in./in.
Thermal Expansion	0.030	Fx10-5
Flame Spread	0.030	50
Smoke generation	0.030	25
Perm Rating	0.030	.002 perm in.

5.5.5.2 Aluminum Jacketing (for Outdoor Use Only)

5.5.5.2.1 The metal cladding weather barrier to provide protection from weather, mechanical wear or other damage shall be aluminum alloys 3003, 1100, or 3150 meeting ASTM B209 with H-14 temper, 0.016” thick with 40# poly-kraft paper moisture barrier on the back side. The metal jacketing shall be Pabco, Childers Prod., or approved equal. All cold piping must have a vapor barrier installed before Aluminum cladding.

5.5.5.2.2 Metal cladding shall be stucco embossed or smooth finish.

5.5.5.3 Fastening Accessories (Tape, Strapping, ect.)

5.5.5.3.1 Tape for fastening pipe insulation shall be 3/4" Fiberglass reinforced strapping tape made by National Tape Co. or approved equal.

5.5.5.3.2 Stainless-steel strapping for fastening aluminum jacketing outdoors and outer layer of vessel and/or large diameter (above 16" OD) pipe insulation shall be 1/2" x 0.020" thick with wing seal made by Gerrard or approved equal.

5.5.5.4 Caulking

5.5.5.4.1 Caulking compound for sealing laps and penetrations on all cladding (Metal: color-grey and PVC: color clear or white) to prevent entry of water shall be USDA approved, weather resistant clear, silicone caulking compound. Boss 368 butyl caulking, may be used for sealing laps on metal.

5.5.5.5 Construction Joints

5.5.5.5.1 Expansion/contraction joint material shall be one lb./ft<sup>3</sup> density fiberglass blanket and shall be packed to twice its original density.

## 6.0 INSTALLATION

### 6.1 Application of Insulation (All Services)

#### 6.1.1 General

6.1.1.1 The design requirements of this specification are general and where it is not specific, pipe fittings, flange valve insulation and curved segments shall be fabricated in compliance with ASTM C450 and ASTM C585.

6.1.1.2 Prior to installation of installation of insulating material, its thickness shall be verified in accordance with the operating temperature and diameter of pipe and equipment. If thickness or material do not verify, Subcontractor shall contact Contractor to resolve the conflict. The Subcontractor shall not in any case establish a new thickness or select different material without written approval.

6.1.1.3 The multi-layer schedule shall be in accordance with Attachment II.

6.1.1.4 The insulation shall be protected from moisture and weather before and during application.



- 6.1.1.5 All insulation and surfaces to be insulated shall be dry and free from moisture prior to application of insulation and vapor barrier.
- 6.1.1.6 Piping with 16" outside diameter and less shall be insulated with 2-piece "sectional" pipe insulation. Above 16" OD, sectional pipe covering, or prefabricated curved sidewall segments may be used.
- 6.1.1.7 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.
- 6.1.1.8 Insulation ends shall be rubbed against each other to achieve tight fit.
- 6.1.2 Application of Joint Sealer
  - 6.1.2.1 A vapor sealing joint sealer shall be applied to all circumferential and longitudinal joints of single layer insulation.
  - 6.1.2.2 Joint sealer is required on all indoor and outdoor insulation.
  - 6.1.2.3 Layers of insulation shall not be bonded to each other. Excessive sealer in the joints should be avoided during application. Do not feather edge.
- 6.1.3 Application of Tape and Banding
  - 6.1.3.1 Insulation shall be fastened circumferentially with ¾" wide tape.
  - 6.1.3.2 Tape shall be applied 9" on center. The tape shall be pulled tight to seal all joints. Bands shall be used above 16" OD and on all curved wall segments where tapes do not close insulation joints tightly. Bands shall be 12" on center.
  - 6.1.3.3 All tapes shall be taped at least 50% on itself.
  - 6.1.3.4 Tightening of tapes or bands shall not crush or crack the insulation. Cracked or broken insulation shall be replaced.
- 6.1.4 Application of Multiple Layers
  - 6.1.4.1 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. Minimum overlap shall be as shown on the insulation details.
  - 6.1.4.2 Openings through the insulation shall be sealed vapor tight by applying joint sealer between protrusion and insulation.
- 6.2 Vapor Barrier and Jacketing (Indoor Service)
  - 6.2.1 Application of Vapor Barrier Jacket
    - 6.2.1.1 PermaTherm's pressure sensitive tape shall be 1-1/4" min. width with equal tape coverage at each side of joint. Firm pressure by roller shall be applied on sealed joints.



- 6.2.1.2 PermaTherm's Vapor Barrier shall cover all outer surfaces of straight insulation.
- 6.2.1.3 Irregular surfaces, contraction joints and fittings shall be vapor sealed with PermaTherm's Permacast Fitting Seal.
- 6.2.2 Application of PVC Jacketing
  - 6.2.2.1 All indoor PCV Jacketing shall provide a vapor barrier and abuse protection.
  - 6.2.2.2 All covering flanges, valves and fittings shall be covered with PCV heavy gauge fitting covers. Minimum .028" thick.
  - 6.2.2.3 All longitudinal and circumferential laps shall be seal welded with PVC solvent welding adhesive. Apply tension to all joints using elastic cord or tape to ensure even spread of welding adhesive. Then apply a band of welding adhesive 1/8" diameter under all overlapping joints and to the outside of overlaps and feather the edge. Overlap adjacent jacketing, fitting covers, and weld all longitudinal and circumferential seams with welding adhesive. Insulation Contractor shall provide for thermal expansion of PVC in accordance with manufacturers recommendations.
  - 6.2.2.4 All circumferential and butt joints shall overlap a minimum of 1-1/2". Laps shall be located at 10 o'clock or 2 o'clock positions.
- 6.3 Vapor Barrier and Jacketing (Outdoor Service)
  - 6.3.1 General
    - 6.3.1.1 All insulated surfaces shall be covered with PMZ Vapor Barrier and metal weatherproofing shall be installed as soon as practical after the insulation work has been completed. Vapor barrier shall be continuous on all surfaces including contraction joints, valves, flanges, ect.
    - 6.3.1.2 All materials applied in one day shall have the vapor barrier applied the same day. Any exposed insulation shall be temporarily protected with a combination moisture and/or UV barrier such as black polyethylene film to keep rainwater out. The film shall be sealed to pipe or equipment.
  - 6.3.2 Application of Metal Jacketing for Fittings
    - 6.3.2.1 Pre-formed aluminum metal elbows shall be used for diameter up to 12".
    - 6.3.2.2 Smooth metal jacketing Beauty Bands with beaded ends shall be used over flanges and flanged fittings.
    - 6.3.2.3 Stainless bands shall be used for securing metal jacketing on gored and preformed elbow covers. Metal jacket shall have raised bead for proper closed of gores.
  - 6.3.3 Application of Metal Jacketing for Equipment

- 6.3.3.1 Aluminum shall be used for all horizontal equipment, vessel heads, manways, nozzles and flashing.
- 6.3.3.2 Jacketing for horizontal and vertical cylindrical surfaces shall be applied with 3" circumferential and longitudinal laps.
- 6.3.3.3 Metal jacketing for vessel heads shall be fitted to the insulation or a single flat sheet bent at the edges for small diameter vessels. Head covers shall overlap the shell jackets by 4", head jacketing shall be fastened by means of 1/2" x 0.020 stainless-steel band, one for every gore. An additional metal band, minimum 4" wide shall be installed over the overlap and secured with stainless-steel bands.
- 6.3.3.4 Metal jacketing on horizontal and vertical vessels shall be secured with 1/2" wide x 0.020 thick stainless T-304 bands spaced on 12" centers.
- 6.3.3.5 Metal screws, pop rivets, ect. Shall not be used to secure metal jacketing.
- 6.3.3.6 Metal jacketing on vertical equipment shall be supported by "S" clips on 12" centers.
- 6.3.3.7 Circumferential lap shall have one band on overlap and intermediate bands shall be installed on 12" centers.