

Insulation Layering

At Piping Technology and Products, we recommend multiple layers for cold shoe supports that have a total insulation thickness of four inches or greater.

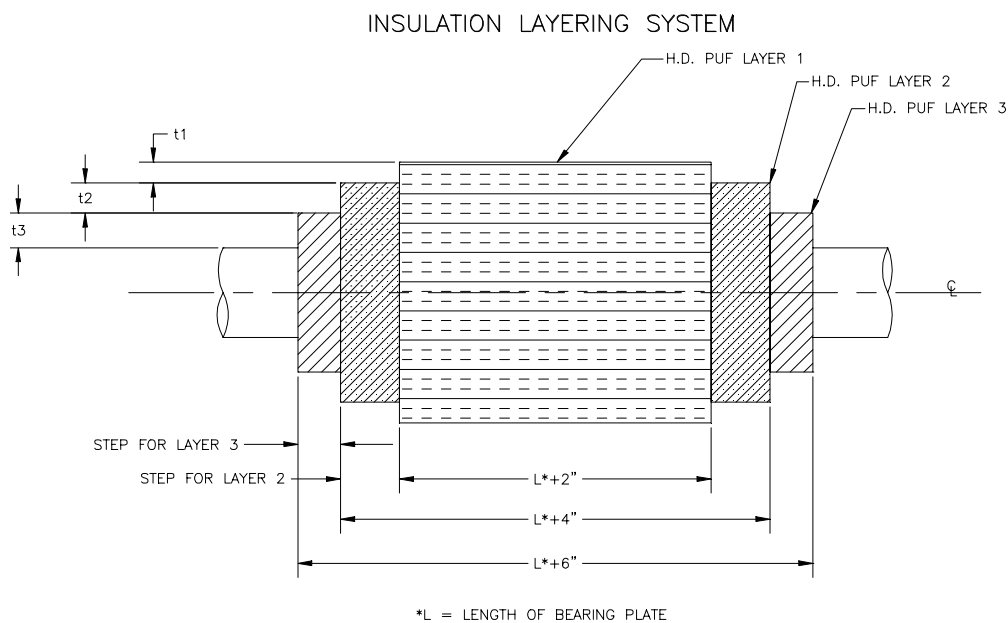
In the field, cold shoes are typically mated with existing pipe insulation. Due to the low temperature of pipe, moisture from the ambient air can be drawn into the pipe through gaps that may exist between the coldshoe and the insulation. At lower temperatures, where thicker insulation is required, there is greater opportunity for moisture to be drawn into the pipe. This is because of the increased single mating surface area between the insulation and the cold shoe.

A solution that eliminates this potential problem is providing multiple mating surfaces between the line insulation and the pipe support. Hence: When insulation thickness is four inches and greater, multiple layers provide an improved moisture seal due to steps between the different layers.

To determine the thickness of each layer, refer to our suggested layering chart on the following page. To use this table, reference the total insulation thickness to determine how many layers are suggested and how thick each layer should be.

Example: A four inch (4") pipe that requires five inches of insulation: Referring to PT&P's suggested layering chart, two layers are required. The first layer (inner layer) thickness is suggested to be 2 2/2" and the second layer (the outer layer) is suggested to be 2 1/2" thick.

Piping Technology and Products can tailor a layering system to meet the customer's requirements. The included layering chart is only a guideline.



Suggested Insulation Layering Chart

NOMINAL			
Insulation Thickness	Layer 1	Layer 2	Layer 3
1"	1"		
1.5"	1.5"		
2"	2"		
2.5"	2.5"		
3"	3"		
3.5"	3.5"		
4"	2"	2"	
4.5"	2"	2.5"	
5"	2.5"	2.5"	
5.5"	2.5"	3"	
6"	2.5"	3.5"	
6.5"	2.5"	2"	2"
7"	2.5"	2.5"	2"
8"	3"	2.5"	2.5"



sting Shoe made of Calcium Silicate for hot service

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POLYURETHANE TECHNICAL INFORMATION

Polyurethane foam is one of the major components of pre-insulated pipe supports manufactured at Piping Technology & Products. Polyurethane is different from most plastic materials in that it can be tailored to meet various load requirements of varying applications.

Polyurethane foams are produced by reacting an equal ratio of di- or polyisocyanurates with polyols, in the presence of water, which acts as the blowing agent. Polyisocyanurates are formed when a higher ratio of di- or polyisocyanate are mixed with the polyol. All rigid foams made from polyisocyanurate systems have some form of polyurethane in them and can be called a polyurethane foam. The physical properties differ very little at high densities. Polyisocyanurate foams are used in applications where dimensional stability over 200 deg F is required. However, for cryogenic applications, where your pipeline insulation is not exposed to high temperatures, PUF is an acceptable substitution.

A common method used to obtain a change in load capacity is a change in density. At Piping Technology and Products, we offer 10 lbs. / ft³, 14 lbs. / ft³, and 20 lbs. / ft³ densities.

Density can be varied by changing the amount of blowing agent (water content). The density of polyurethane decreases with increase in water content (See Fig. 1). This relationship can be shown as follow:

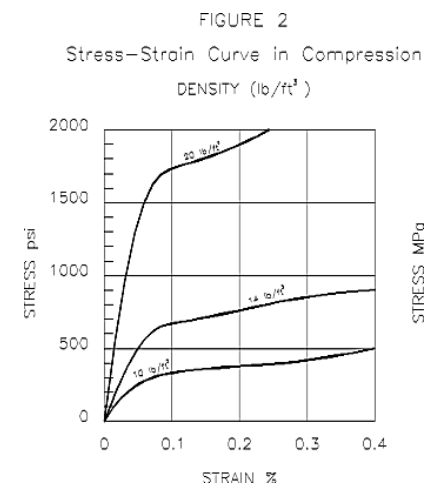
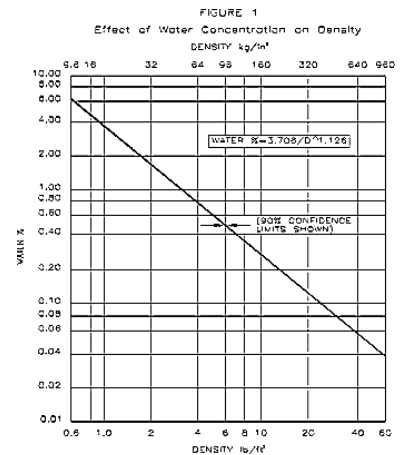
$$W = 3.706 / D^{1.126}$$

Where: W = % of water content
 D = Density of foam (lbs. / ft³.)

In addition to density, the strength of a rigid urethane foam is also influenced by many factors such as catalyst, surfactant, type of mixing, the type of foaming system: base polyol and isocyanate, and the influence of each of these on the foam cell structure.

Rigid urethane foams generally have an elastic region in which stress is nearly proportional to strain. They do not exactly follow Hooke's Law (stress is proportional to strain) because the curve is very slightly "S" shaped. Fig. 2 shows this in detail.

Polyurethane is anisotropic, or polyurethane is stronger in the direction of foam rise. At Piping Technology and Products, the anisotropic character or directional properties of our polyurethane is reduced by overloading the mold used to form the polyurethane.



By overloading the mold, we can control the cell structure and provide uniform physical properties. A relationship between compressive strength and the density of the foam is given in Fig. 3.

Polyurethane is a thermosetting material; however, it does soften slightly with increased temperature and hardens somewhat at very low temperatures. Softening at high temperatures affects the polyurethane in two ways: (a) loss of strength properties and (b) change in foam dimensions (particularly low density foams). Low temperatures generally have very little effect on polyurethane properties other than to make them a little harder and more brittle. See Fig. 4 for these effects.

Rigid polyurethane foams have a relatively large amount of cross-linking as the foam expands. Our suppliers of the raw chemicals control the degree of cross-linking by functionality (higher functionality produces more cross-links) and molecular weight of the components in the blend. The rigid cells provide the poured foam with strength and the interior space provides low thermal conductivity. Water is used as the blowing agent for foam in this 10 to 40 lb-density range.

The relationship between temperature, thermal conductivity and the density of polyurethane foam is shown in Fig. 5.

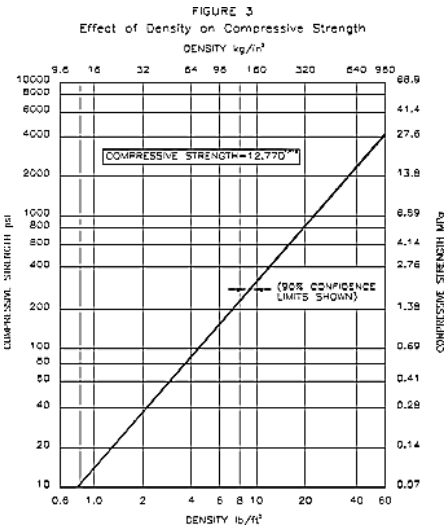


FIGURE 4
Effect of Temperature on Compressive Strength

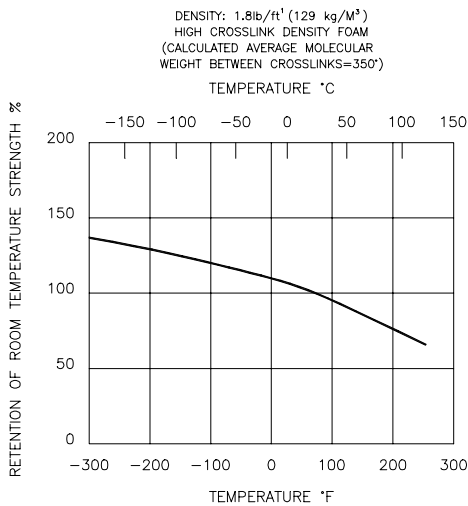
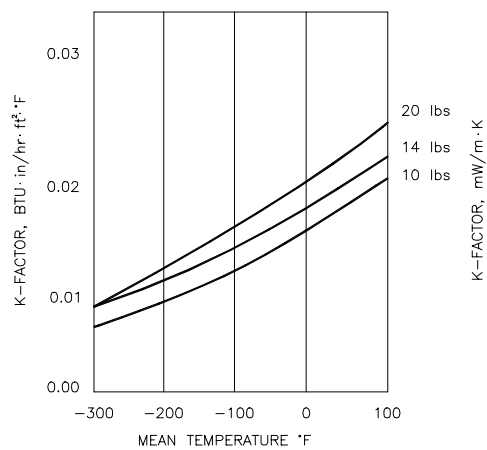


FIGURE 5
Effect of Temperature on Thermal Conductivity
(Foam Blown with Water)



The relationships of foam's density with its Elastic Modules in Compression, Tensile Strength, Elastic Modules in Tension, and Shear Strength are given in Figs. 6 through 9 respectively. Please see the following for the respective curves.

Piping Technology & Products has a complete manufacturing facility for production of polyurethane required for pipe supports. We invite our customers to visit our facility and observe the fabrication of insulated pipe supports of all types.

DENSITY	COMPRESSIVE STRENGTH	FLEXURAL STRENGTH (flatwise with grain) (psi)	TENSILE STRENGTH (with grain) (psi)	MODULUS OF ELASTICITY (psi)	CLOSED CELL CONTENT (%)	TEMPERATURE (F) CONTINUOUS OPERATION	K-FACTOR	THERMAL CONDUCTIVITY (btu/hr m ² of)	SHEAR (flatwise) (1/8" thk.) (psi)	DENSITY (lb/in ³)	WATER ABSORPTION (%)
PUF (10 pcf)	200.00	400.00	300.00	6,000.00	95.00	-300.00	0.08	0.1600	180.00	0.0057	0.22
PUF (14pcf)	300.00	600.00	500.00	11,000.00	95.00	-300.00	0.12	0.2000	200.00	0.0081	0.18
PUF (20pcf)	500.00	1,100.00	600.00	20,000.00	95.00	-300.00	0.14	0.2500	400.00	0.0115	0.13

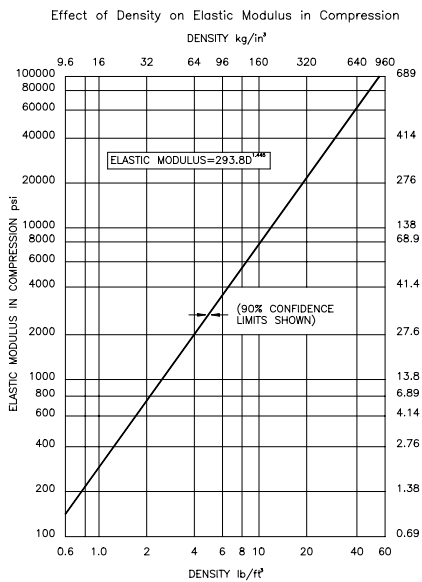


FIGURE 8

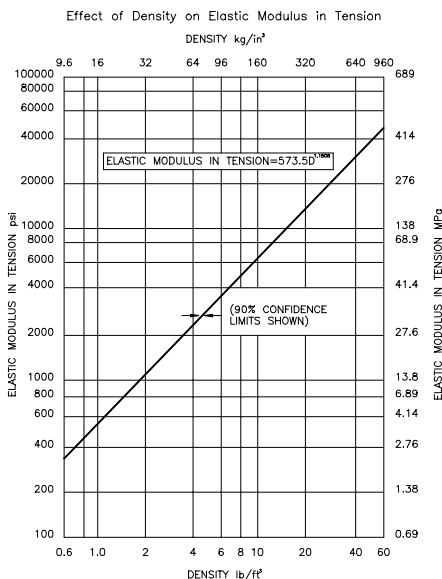


FIGURE 7

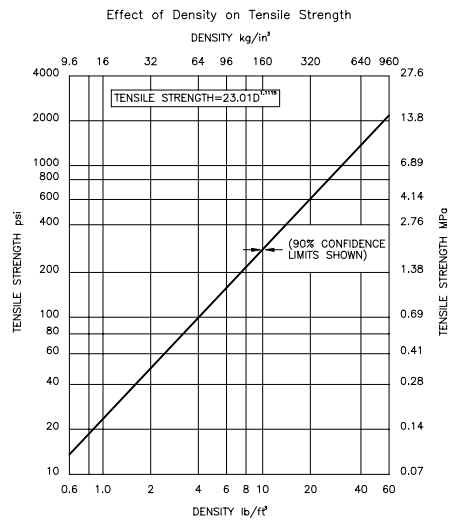
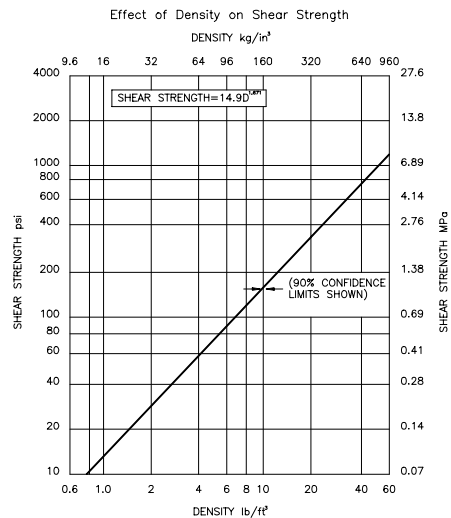


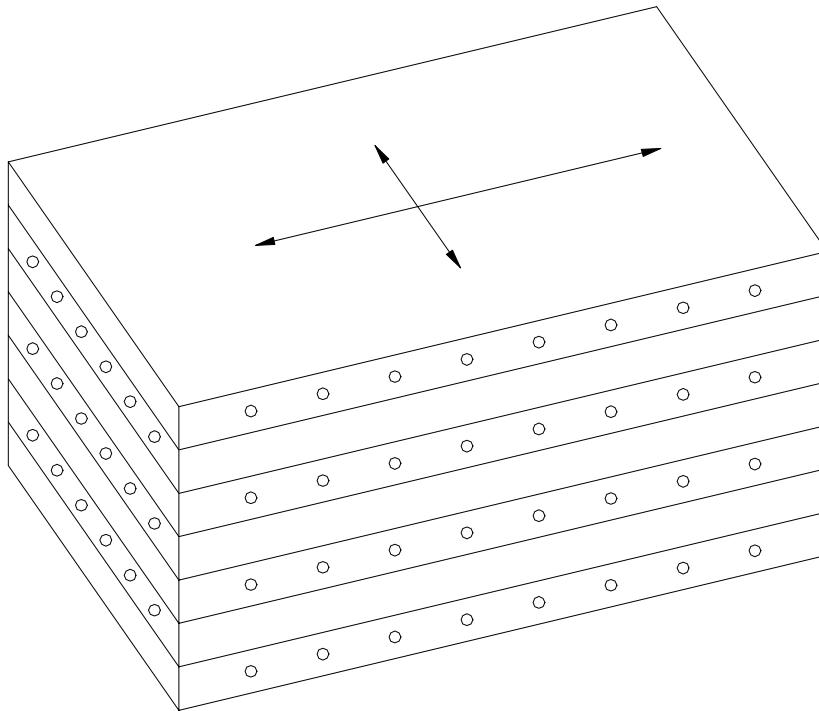
FIGURE 9



Laminated Beechwood Technical Information

Permali® or Insulam® is an insulating material used in applications which require high tensile and compressive strength (see table below). In addition, due to its exceptional resistance to moisture, it serves as a suitable insulator where the support (LNG lines, flare lines & dummy legs) is exposed to harsh environmental elements.

Permali® or Insulam® is a phenolic laminate (densified, impregnated wood) product made from carefully selected thin beechwood veneers. These wood layers are impregnated under vacuum conditions with a special synthetic resin and then densified through the application of heat and pressure. The result is a homogenous material that combines the great strength and toughness of wood fibers with the excellent stability and dielectric properties of the most advanced thermosetting. The phenolic laminated block material is furnished with cross-directional fibers as shown in Figure 10 below.



Cross laminated
For components in compression or for
parts stressed in more than one direction
Sizes to suit most applications

DENSITY	COMPRESSIVE STRENGTH	FLEXURAL STRENGTH (flatwise with grain) (psi)	TENSILE STRENGTH (with grain) (psi)	MODULUS OF ELASTICITY (psi)	CLOSED CELL CONTENT (%)	TEMPERATURE (F) CONTINUOUS OPERATION	K-FACTOR	THERMAL CONDUCTIVITY (btu/hr m ² of)	SHEAR (flatwise) (1/8" thk.) (psi)	DENSITY (lb/in ³)	WATER ABSORPTION (%)
PERMALI	30000.00	15000.00	15000.00	2.0 10 ⁶	N/A	221.00	N/A	0.0018	7200.00	0.0469	0.75

FOAMGLAS® TECHNICAL INFORMATION

Foamglas® insulation is a light weight, rigid insulation composed of millions of completely sealed glass cells. Each cell serves as an insulating agent. Foamglas® is widely used in the cryogenic and hot pipe supports and is fabricated in various shapes, thickness, and sizes to meet the particular requirements of an application.

One unique advantage that Foamglas® has is its very low moisture absorption. Since Foamglas® insulation is full of closed glass cells, it resists moisture in both liquid and vapor form. This guarantees the long term performance of the insulation. Foamglas® insulation's resistance to moisture ensures that, properly installed, it retains its original thermal efficiency.

The major advantages and applications of Foamglas® insulation are listed below. For details about the physical and mechanical properties of the Foamglas® material, please refer to the table below.

Major Advantages:-

- i. Constant Insulating Efficiency.
- ii. Fire Protection.
- iii. Corrosion Resistance.
- iv. Long Term Dimensional Stability.
- v. Physical Strength.

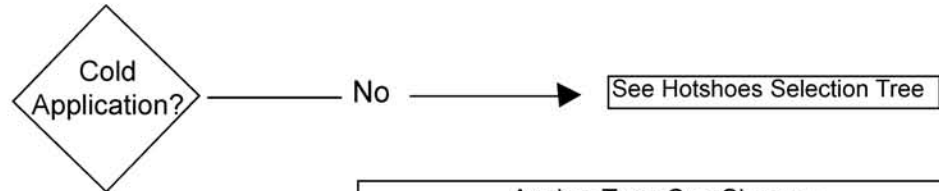
Major Applications:-



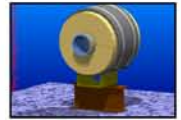

- i. Cryogenic and Hot Pipe Supports.
- ii. Cryogenic Tanks and Vessels.
- iii. Chilled and Hot Water Service Lines.
- iv. Over-fit and Revitalize the Old Insulation.
- v. Composite Insulation Systems for Special Conditions.

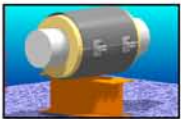



DENSITY	COMPRESSIVE STRENGTH	FLEXURAL STRENGTH (flatwise with grain) (psi)	TENSILE STRENGTH (with grain) (psi)	MODULUS OF ELASTICITY (psi)	CLOSED CELL CONTENT (%)	TEMPERATURE (F) CONTINUOUS OPERATION	K-FACTOR	THERMAL CONDUCTIVITY (btu/hr m ² of)	SHEAR (flatwise) (1/8" thk.) (psi)	DENSITY (lb/in ³)	WATER ABSORPTION (%)
FOAMGLAS® (8pcf)	400.00	80.00	N/A	1.3 10 ⁶	N/A	500 max.	N/A	0.7000	N/A	0.0046	0.70








PT&P PRODUCT SELECTION TREE - CRYOSHOES™

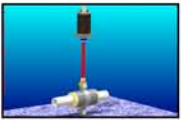

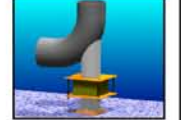

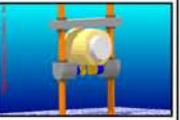
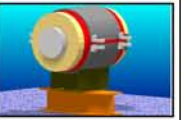
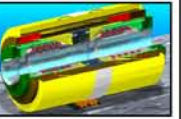


Resting CyroShoes™			
Without Base	Split T-Base	U-Type Base	Double-T Base
			
CS-1000 P, 22 CS-1001 P, 24	CS-1010 P, 26 CS-1011 P, 28	CS-1020 P, 30 CS-1021 P, 32	CS-1030 P, 34 CS-1031 P, 36

Guided Cryoshoes™			
Without Base	Split T-Base	U-Type Base	Double-T Base
			
CS-4001 P, 78	CS-4010 P, 80 CS-4011 P, 82	CS-4020 P, 84 CS-4021 P, 86	CS-4030 P, 88 CS-4031 P, 90

Anchor Type CryoShoes™		
Split-T Base	U-Type Base	Double-T Base
		
CS-2010 P, 38 CS-2011 P, 40 CS-2012 P, 42	CS-2020 P, 44 CS-2021 P, 46 CS-2023 P, 48	CS-2030 P, 50 CS-2031 P, 52 CS-2032 P, 54 CS-2033 P, 56

Sliding CryoShoes™		
Split-T Base	U-Type Base	Double-T Base
		
CS-3011 P, 58 CS-3013 P, 60	CS-3020 P, 62 CS-3021 P, 64 CS-3022 P, 66 CS-3023 P, 68	CS-3030 P, 70 CS-3031 P, 72 CS-3032 P, 74 CS-3033 P, 76

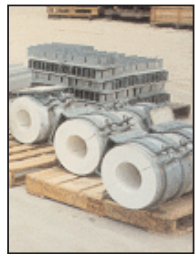
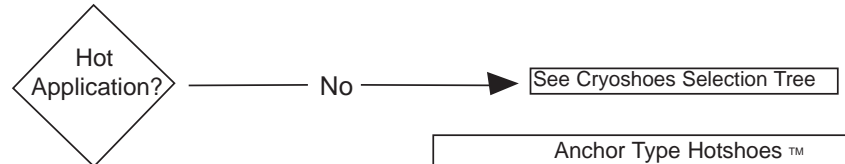
Misc. Cryoshoes™						
Pre-insulated Hanger Support	Double Clamp Phenolic Support	Dummy Leg, Phenolic Block	Roller Type	Hanging Roller	FoamGlass-Polyurethane Hybrid Shoe	LNG Line Anchor
						
CS-6010 P, 98	CS-6020 P, 100	CS-6030 P, 102	CS-6040 P, 104	CS-6050 P, 106	CS-6060 P, 108	CS-6070 P, 111





Base Insulated CryoShoes		
90 insulation	180 insulation	360 insulation
		
CS-5010 P, 92	CS-5020 P, 94	CS-5030 P, 96






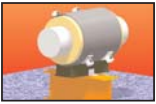


PT&P PRODUCT SELECTION TREE - HOTSHOES



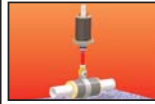





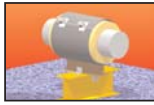


Resting Hotshoes			
Without Base	Split T-Base	U-Type Base	Double-T Base
			
HS-1000 P, 120 HS-1001 P, 122	HS-1010 P, 124 HS-1011 P, 126	HS-1020 P, 128 HS-1021 P, 130	HS-1030 P, 132 HS-1031 P, 134



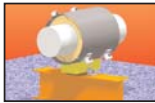


Guided Hotshoes™			
Without Base	Split T-Base	U-Type Base	Double-T Base
			
HS-4001 P, 176	HS-4010 P, 178 HS-4011 P, 180	HS-4020 P, 182 HS-4021 P, 184	HS-4030 P, 186 HS-4031 P, 188



Misc. Hotshoes					
Pre-insulated Hanger Support	Double Clamp Phenolic Support	Dummy Leg Phenolic Block	Roller Type	Hanging Roller	FoamGlass-Polyurethane Hybrid Shoe
					
HS-6010 P, 190	HS-6020 P, 192	HS-6030 P, 194	HS-6040 P, 196	HS-6050 P, 198	HS-6060 P, 200

Anchor Type Hotshoes™		
Split-T Base	U-Type Base	Double-T Base
		
HS-2010 P, 136 HS-2011 P, 138 HS-2012 P, 140	HS-2020 P, 142 HS-2021 P, 144 HS-2023 P, 146	HS-2030 P, 148 HS-2031 P, 150 HS-2032 P, 152 HS-2033 P, 154

Sliding Hotshoes™		
Split-T Base	U-Type Base	Double-T Base
		
HS-3011 P, 156 HS-3013 P, 158	HS-3020 P, 160 HS-3021 P, 162 HS-3022 P, 164 HS-3023 P, 166	HS-3030 P, 168 HS-3031 P, 170 HS-3032 P, 172 HS-3033 P, 174

Low Temperature Support Specifications

1.0 Scope

This specification covers the requirements for the design, fabrication and use of our pre-insulated low temperature pipe supports. These supports are for pipes having surface temperature ranges of -460°F (-273°C) to 280°F (138°C).

2.0 General Requirements

- 2.1 All insulated pipes shall be supported with pre-insulated pipe supports.
- 2.2 Insulated pipe supports shall comply with the following standards:
 - ANSI/ASME B31.1 & B31.3
 - Manufacturers Standardization Society SP-58, 69, & 89.
- 2.3 The following criteria shall be considered in the selection of low temperature insulated supports:
 - A. Vertical, lateral and axial support design load limits.
 - B. Vertical, lateral, and axial support design travel limits.
 - C. Temperature of the support, at the pipe surface, and ambient conditions.
 - D. All test or pre-operational loads that may exceed normal operating conditions.
 - E. Any dimensional clearances needed during installation and operation should be specified.
 - F. Material for any items that will be welded directly to the pipe.
 - G. All loading and displacements caused by seismic, hydraulic surge, or other disturbances.
 - H. Temperature at the support steel.
- 2.4 Upon request by the purchaser or the end user, design calculations of supports will be made available for review.
- 2.5 Upon request by the purchaser or the end user, localized stress calculations for lugs and other welded attachments will be made available for review.
- 2.6 Prior to placing an order, all special requirements such as mill test reports, material certification or non-standard materials must be specified.

3.0 Design Criteria

- 3.1 The load bearing insulating materials used in the support shall be the same material that was used to rate the support.
- 3.2 At the request of the end user or the purchaser, we will make available compressive strength and thermal conductivity testing results of the high density polyurethane in the format provided by MSS SP-89. Testing will be done at the maximum temperature of -196°C .
- 3.3 A description of the quantity of load that can be applied to the support shall be provided for evaluation upon request. A minimum safety factor of 5 at the system design temperature shall be used to determine the maximum load.
- 3.4 Testing for compressive strength properties shall comply with ASTM D1621, the standard testing method for compressive properties of Rigid Cellular Plastics.
- 3.5 Testing for thermal conductivity shall comply with ASTM C177, Steady State Heat Flux Measurements and Thermal Transmission Properties by means of the *Guarded Hot Plate Apparatus*.

- 3.6 Load bearing element capacity shall be demonstrated at the system design temperature and load.
- 3.7 The insulated pipe support assembly shall exert enough clamping force to assure that the support will move axially with the pipe and will not slip when under design conditions.
- 3.8 All slide plate surfaces shall be designed so that the coefficient of friction will be limited to .1 for the design life without requiring lubrication. Any friction reducing material that requires bonding shall be bonded to a backing structure prior to shipment.
- 3.9 High density polyurethane shall have the following maximum thermal conductivity:
 - A. 10 lb./cu.ft. foam - .114 BTU-in/hr-ft² – °F (.0164 W/m- °K)
 - B. 14 lb./cu.ft. foam - .12 BTU-in/hr-ft² – °F (.0173 W/m- °K)
 - C. 20 lb./cu.ft. foam - .22 BTU-in/hr-ft² – °F (.0320 W/m- °K)
- 3.10 CFC's shall not be used in the manufacture of high-density polyurethane foam.

4.0 Fabrication

- 4.1 All polyurethane foam shall be monolithic and molded oversized so that excess material shall be removed by cutting to achieve the final finished dimensions, the outer skin shall be removed.
- 4.2 The insulated pipe support shall:
 - A. Come pre-assembled with sufficient insulation extending past the outer metal jacket allowing the pipe insulator to butt the line insulation against it.
 - B. All exposed surfaces will be coated with mastic to protect the foam from moisture and UV degradation. The mastic will have a minimum perm rating of .02 (ASTM E-96).
 - C. The vapor barrier between the metallic jacket and the insulating material will also have a perm rating of .02.
 - D. The ID and OD dimensions of the insulation shall conform to ASTM specification C585 unless otherwise specified.
- 4.3 Designs having sliding surfaces shall incorporate two slide plates at each surface. Each slide plate will be made of 3/32" thick glass filled reinforced Teflon bonded to a 10GA carbon steel backing plate. The Teflon will be recessed 1/4" from the edge of the plate.
- 4.4 All welding shall comply with B31.3 and B31.1 Piping Code and AWS D1.1
- 4.5 The following items unless otherwise noted on contract drawings shall be in accordance with the following:
 - A. Structure shapes and plate: ASTM A-36
 - B. Bolts and studs: ASTM A-307
 - C. Nuts: A563

5.0 Shipping and Handling

- 5.1 Each insulated support assembly shall be clearly and permanently marked with the support identification number.
- 5.2 The support marking shall be visible prior to and after installation.
- 5.3 Unless otherwise specified, supports are to be shipped on pallets, wrapped in black plastic, and shrink wrapped to prevent moisture and UV damage.

5.4 A packing list will be included with each shipment.

5.5 These supports must be stored in a dry area and protected from exposure to sunlight, rain and moisture.

6.0 Extent of Work

6.1 Work Included:

Furnish the insulated pipe support assembly that includes the insulation inserts, the metallic jacket, the steel bridle, the guide clips, and any other necessary hardware which requires complete assembly.

6.2 Work Not Included:

- A. Providing structural steel that is not an integral part of the support.
- B. Receiving, unloading, and installing of support.

7.0 Quotation

7.1 Quotations shall be submitted to the Quotation Manager by fax, writing, or e-mail.

7.2 Bidder shall quote on all equipment specified in the quotation. Manufacturer shall be Piping Technology and Products, Inc.

7.3 Bidder shall provide a unit and extended price list for each assembly. Bidder shall total all pricing on bid.

8.0 Information to be Furnished After Award but Prior to Shipping

The supplier shall furnish installation instructions necessary for the proper installation of support.

9.0 Correspondence

9.1 All correspondence, drawings, and other submittals shall bear reference to the purchase order number and product ID.

9.2 Correspondence concerning technical data, shipping information, changes to the purchase order or specification not covered in the purchase order shall be sent to the Project Engineer.

9.3 Correspondence regarding purchasing shall be sent to the Quotation Manager or the Project Engineer.

10.0 Guarantees

The supplier shall guarantee that the performance and design of the equipment is in strict accordance with specifications.

11.0 Delivery

11.1 All insulated supports are to be delivered to the project site according to the terms agreed to in the purchase order.

11.2 Job site location is Piping Technology and Products, Inc.