호남석유화학주식회사
HONAM PETROCHEMICAL CORP.

ENGINEERING SPECIFICATION
FOR

COLD INSULATION

SPEC. NO. : HPS-G310

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1. GENERAL

1.1 Scope

This specification covers the general requirements for materials and application of thermal insulation to piping, vessels and equipment operating at temperatures below ambient to through -170 °C.

1.2 Documents, Codes, and Industry Standards

All codes and standards as referenced herein shall be a part of this specification and shall be the latest edition, revision, or addendum in effect on the date of order unless specified otherwise on the contract documents.

ASTM, American Society for Testing and Material standards

2. GENERAL DESIGN

2.1 Insulation shall be required to control fluid temperature, surface condensation, noise, and conserve refrigeration.

2.2 Extent of insulation requirements shall be as noted on each P&ID. Thickness of insulation for piping, vessels and equipment shall be determined by reference to operating temperatures and to the applicable Insulation Thickness Charts in paragraph 9.

2.3 Items requiring insulation for cold process reasons and a combination of noise control shall be insulated with an inner layer of fiberglass and an outer layer of cellular glass. The extent and thickness of noise control insulation shall be determined by a noise engineer and so noted on P&ID.

2.4 Items subject to steam-out or other conditions which result in temperatures in excess of 120 °C shall be insulated with an inner layer of 25 mm thick fiberglass in addition to the cellular glass insulation requirements.

3. ACCEPTABLE BASIC MATERIAL OF PIPING, VESSEL AND EQUIPMENT

3.1 General

3.1.1 Insulation materials for austenitic stainless steel piping, vessels and equipment shall contain less than 200 parts per million of leachable chlorides. Materials containing measurable amounts of leachable chlorides shall contain a minimum of 20 parts sodium silicate for each part of leachable chloride.

3.1.2 Materials specified or referenced by manufacturer and designation are not intended to exclude equal or better items offered by other manufacturers. Products of reputable manufacturers and of comparable type, quality and other physical characteristics shall be submitted for HPC approval.

3.2 Pipe Insulation

3.2.1 Sectional pipe covering of cellular glass, nominal 128 kg/m3 (ASTM C552 Type II Grade I)

3.2.2 Sectional pipe covering of polyurethane, nominal 160 kg/m3 (NPS 1/2 thru NPS 8) or nominal 320 kg/m3 (NPS 10 thru NPS 72), for application inside support cradles, hold downs and hanger rods.

3.2.3 Sectional pipe covering of fiberglass, minimum 48 kg/m3, for inner layer on piping requiring multiple layer insulation, noise control and steam-out application.

3.3 Vessel and Equipment Insulation

3.3.1 Cellular glass block, ASTM C552, Type I, nominal 128 kg/m3.

3.3.2 Fiberglass board, minimum 48 kg/m3, for inner layer on vessels and equipment requiring multiple layer insulation, noise control and steam-out application.

3.4 Joint sealer and flashing compound shall be a flexible elastomeric vapor barrier sealant for sealing joints in low temperature insulation.

3.5 Vapor Barrier

3.5.1 Solvent cutback asphalt coating with a water vapor transmission of 0.03 perm-mm with a service temperature range of – 50 °C to 160 °C.

3.5.2 Foil-to-Mylar vapor barrier jacketing composed of 0.025 mm thick aluminum with 0.013 mm thick Mylar polyester film on both sides.

3.5.3 Used for straight run pipe, large smooth areas on equipment and etc.

3.6 Mastic weathercoat shall be an aluminum pigmented, fire resistive, solvent cutback asphalt coating with a water vapor transmission of 0.02 perm-mm with service temperature range of -50 °C to 160 °C.

3.7 Adhesive for sealing Foil-to-Mylar vapor barrier jacketing

3.8 Reinforcing fabric shall be a high strength open mesh nylon 10 x 10 weave for reinforcing fabric in mastic finishes.

3.9 Contraction joint material shall be 16 kg/m^3 fiberglass blanket.

3.10 Securements

3.10.1 19 mm wide glass filament reinforced pressure sensitive tape for base insulation on piping

3.10.2 13 mm wide x 0.4 mm thick, Type 304 stainless steel bands for metal jacket on pipe

3.10.3 9 mm wide x 0.5 mm thick, Type 304 stainless steel bands for base insulation and metal jacket on vessels and equipment

3.10.4 Heavy-duty, Type 304 stainless steel wing type seals

3.11 Metal jacketing shall be aluminum with factory applied polykraft moisture barrier, Alloy 3003 -H14 or 5005 -H14. The aluminum sheeting shall be primed and finished with a light gray baked-on enamel.

3.11.1 0.5 mm thick x 5 mm corrugated for piping.

3.11.2 0.5 mm thick x 5 mm corrugated for all horizontal vessels and equipment shells, vertical vessels and equipment shells 36" diameter and smaller.

3.11.3 0.5 mm thick x 32 mm corrugated for vertical vessels and equipment shells larger than 36" diameter.

3.11.4 0.5 mm thick, flat for vessel and equipment heads, transitions, stiffener rings and flashing rings.

3.12 Breather springs shall be 100 mm long, flat, spiral wound, Type 302 stainless steel.

3.13 S-clips shall be fabricated from 25 mm x 0.8 mm thick, Type 304 stainless steel banding.

4. PROTECTION OF MATERIALS AND WORK

4.1 Insulation and accessory materials subject to damage from dampness and harmful temperature extremes shall be protected from time of delivery until weather protection is applied.

4.1.1 Temporary warehouse facilities will be considered adequate protection during working hours provided the materials are off the ground, out of direct sunlight and are not subjected to damage due to insufficient drainage and/or condensation.

4.1.2 Decking and covering tarps shall not be allowed except in unpredictable emergencies and then only for short periods.

4.2 Insulation removed from storage shall be applied the same day or returned to storage at the end of work.

4.3 Work scheduling shall provide for application of permanent weather protection before the conclusion of each day work. Unfavorable circumstances arise where this is impractical, temporary weather protection shall be provided. Adequacy of such protection shall be the responsibility of the insulation contractor.

4.4 Special care shall be taken to keep aluminum sheets dry prior to application in order to prevent water staining between sheets.

4.5 Special care shall be taken to keep mastics and other coatings at manufacturer recommended temperature to prevent shortening of shelf and pot life.

4.6 Insulation which becomes wet due to lack of or inadequate weather protection, either temporary or permanent, shall be removed and replaced with dry insulation before proceeding with application of metal jacket or weatherproofing compounds. Materials which are inherently water resistant, such as cellular glass and perlite, need not be replaced if exposed to water. However, permanent weather protection shall not be applied until the insulation surface has dried.

5. APPLICATION OF PIPING INSULATION

5.1 General

5.1.1 Piping shall be insulated when indicated on the P&ID in accordance with the thickness chart of this specification unless otherwise noted on the piping drawings. Piping and Instrumentation Diagram, Pipeline List, Piping Plans and Piping Spool Drawings shall be coded as follows;

Insulation Code		Definition
R	:	Insulate to control fluid temperature, surface condensation and conserve refrigeration (Cold)
V	:	Insulate for noise control (Acoustical)
RV	:	Insulate for combination cold and noise control

5.1.2 Application and securement of base insulation on piping larger than 36" diameter shall be the same as described for vessels.

5.1.3 All pipe, valves, flanges and fittings shall be insulated and tightly sealed. Valves shall be insulated up to and including bonnet flanges but not including yoke or packing gland.

5.1.4 Pipe operating at temperatures of -50 °C and lower shall have the insulation applied in not less than two layers. Fittings shall be insulated with single layer cellular glass the full thickness regardless of operating temperature. Exception shall be insulation for steam-out or noise control.

5.1.5 Insulation thickness at flanges shall be in accordance with the insulation thickness chart in paragraph 9 and based on the flange diameter and the line operating temperature.

5.1.6 All attachments, secured to the pipe, that project through the insulation shall be insulated. Projections shall be externally insulated from the point where it projects through the insulation for a distance of four times the thickness of the base insulation, unless otherwise shown on drawings.

5.1.7 All insulation shall be continuous at supports. A metal cradle preformed to the outside diameter of the insulation shall be provided at each support.

5.2 Insulation Application

5.2.1 Insulation materials must be kept dry and shall not be applied wet. If materials become wet after application, they shall be allowed to dry or be replaced before proceeding with application of metal jacketing or weatherproofing compound. Special care shall be taken to keep metal sheets dry prior to application to prevent water stain between sheets. Insulation shall not be applied to any surface where there is any evidence of moisture or frost.

5.2.2 Pressure tests shall, if possible, be completed before insulation is installed. If insulation is applied before testing, all welds, threads, and bolted connections shall be left uninsulated and exposed until completion of testing. Shop welds may be insulated if the piping has been pressure tested in the shop.

5.2.3 Care shall be taken to avoid contact between dissimilar materials which might cause galvanic corrosion.

5.2.4 Single thickness sectional pipe insulation shall be applied in such a manner that all voids are eliminated. The butt edges shall be coated with a 1.6 mm thick layer of joint sealer. In cases of double layer pipe insulation, the inner layer shall be applied without joint sealer. Each layer of insulation shall be secured with pressure sensitive tape or bands on approximately 230 mm centers. Tape or bands shall be placed within 13 mm of end of each section. When applying double layer insulation, stagger or offset outer layer joints from the inner layer joints. Only the outer layer of double layer insulation shall have a vapor barrier. The longitudinal overlaps of the vapor barrier jacketing shall be sealed with an adhesive. All circumferential joints shall be sealed with a Foil-to-Mylar 75 mm wide strip applied over the vapor barrier jacketing.

5.2.5 Insulation contraction joints shall be provided at each weld and equally spaced, not to exceed 3.6 m maximum centers. Joints shall be 40 mm wide, packed with 50 mm of fiberglass blanket. When applying double layer insulation, the contraction joint on the outer layer shall be offset 300 mm from the joint on the inner layer.

5.2.6 Fittings shall be insulated with prefabricated fitting covers or mitered sectional pipe insulation. The butt edges of all segments shall be coated with a 1.6 mm thick layer thickness. Special attention shall be given to seal protrusions, joints or other discontinuities.

5.3 Weatherproofing Application

5.3.1 Straight portions of insulated piping shall have the basic insulation covered with metal jacketing, with all joints lapped 50 mm and arranged to shed water. The jacketing shall be secured with bands installed on 300 mm centers.

5.3.2 Fittings shall be weatherproofed with prefabricated metal covers with weatherproof seams. Metal covers shall be secured with bands.

5.3.3 A watertight metal flashing ring shall be installed where pipe insulation terminates.

5.3.4 Heavy fillets of flashing compound shall be applied at all possible sources of moisture penetration.

5.3.5 Irregularly shaped surfaces, which cannot be suitably weatherproofed with metal jacketing, shall be finished with a vapor barrier mastic coating. A tack coat of mastic shall be applied, followed by a layer of reinforcing fabric installed wrinkle-free. Over the reinforcing fabric, a 3.2 mm thick dry coat of mastic weathercoat shall be applied with a smooth finish. This finish shall extend approximately 50 mm under the adjacent pipe jacketing. No porosity shall exist in mastic weathercoating when dry.

6. APPLICATION OF VESSEL AND EQUIPMENT INSULATION

6.1 General

6.1.1 Vessels and equipment shall be insulated when indicated on the P&ID in accordance with the thickness chart of this specification unless otherwise noted on the Vessel or Equipment Drawings.

6.1.2 All attachments secured to the vessel or equipment that project through the insulation shall be insulated. Projections shall be externally insulated from the point where it projects through the insulation for a distance of four times the thickness of the base insulation.

6.1.3 Manhole covers, flanges, nameplates and all other appurtenances shall be insulated. Where periodic maintenance or inspection is required, such as manholes and nameplates, design provisions for removability and replacement without damage to the insulation shall be noticed.

6.1.4 Vessels and equipment operating at temperatures of -45 °C and lower shall have the insulation applied in not less than two layers.

6.1.5 Vertical vessels which have a significant difference in operating temperature from top to bottom may have the lower half of the vessel insulated for the bottom operating temperature and upper half insulated for the vessel's overall average operating temperature. Applicable thicknesses shall be as indicated on the vessel drawing, and/or the Piping and Instrumentation Diagram.

6.1.6 For vessels and tubular equipment 36" diameter and smaller, preformed pipe insulation shall be used where applicable.

6.2 Insulation Application

6.2.1 Insulation materials must be kept dry and shall not be applied wet. If materials become wet after application, they shall be allowed to dry or be replaced before proceeding with application of metal jacketing or weatherproofing compound. Special care shall be taken to keep metal sheets dry prior to application to prevent water stain between sheets. Insulation shall not be applied to any surface where there is any evidence of moisture or frost.

6.2.2 Pressure tests shall, if possible, be completed before insulation is installed. If insulation is applied before testing, all welds and threads shall be left uninsulated and exposed until completion of testing. Vessel, exchanger and equipment welds may be insulated if the item has been pressure tested in the shop.

6.2.3 Care shall be taken to avoid contact between dissimilar materials which might cause galvanic corrosion.

6.2.4 Block insulation on vessels and equipment shall be applied with stagger joint arrangement. The butt edges shall be coated with a 1.6 mm thick layer of joint sealer. In cases of double layer insulation, the inner layer shall be applied without joint sealer. Each layer of insulation shall be secured with bands on 300 mm centers. When applying double layer insulation, stagger or offset outer layer joints from the inner layer joints. Only the outer layer of double layer insulation shall have a vapor barrier. All joints shall be sealed with a Foil-to-Mylar 75 mm wide strip applied over the vapor barrier jacketing.

6.2.5 Insulation contraction joints shall be provided on 3.6 m maximum centers. Joints shall be 40 mm wide, packed with 50 mm of fiberglass blanket. Joints shall be sealed with a Foil-to-Mylar strip to serve as a vapor barrier.

6.2.6 Heads shall have the blocks shaped so that all sections closely fit the contour of the head. The butt edges shall be coated with a 1.6 mm thick layer of joint sealer. In cases of multiple layers, only the outermost layer shall be sealed. Insulation for exposed heads shall be secured with bands attached to a floating ring on the top and to a circumferential band at the tangent line of the vessel head. Band spacing shall be on 300 mm maximum center at the tangent line. For unexposed heads, the bands shall be fastened to the attachments provided by the vessel manufacturer.

6.2.7 Vessel transitions shall have the block insulation shaped so that all sections closely fit the contour of the shell. The butt edges shall be coated with a 1.6 mm thick layer of joint sealer. The insulation shall be secured in place with bands.

6.2.8 Stiffener rings shall be enclosed in block insulation. Butt edges of all insulation shall be coated with a 1.6 mm thick layer of joint sealer. The insulation shall be secured in place with a band in the center of each stiffener ring.

6.2.9 Pumps and compressors shall be enclosed in block insulation. Butt edges of all insulation shall be coated with a 1.6 mm thick layer of joint sealer. The insulation shall be secured in place with bands.

6.2.10 A vapor barrier coating shall be applied at 1.6 mm dry thickness to seal protrusions, joints or other discontinuities in the vapor barrier jacketing.

6.3 Weatherproofing Application

6.3.1 Vessel and tubular equipment shells shall be finished with metal jacketing.

6.3.2 On vertical vessels and equipment, the metal jacketing shall be supported on S-clips. The metal jacketing shall be secured with bands spaced on 300 mm centers with one band at each circumferential overlap. Each band shall be equipped with one breather spring.

6.3.3 On horizontal vessels and tubular equipment, the metal jacketing shall be secured with bands spaced on 300 mm centers with one band at each circumferential overlap. Each band shall be equipped with one breather spring.

6.3.4 Longitudinal laps on 32 mm corrugated metal jacketing shall be one and one-half corrugations. Longitudinal laps on 5 mm corrugated metal jacketing shall be a minimum of 50 mm. All circumferential laps shall be a minimum of 75 mm.

6.3.5 Top heads on vertical vessels and tubular equipment shall be finished with metal jacketing, with a minimum of 150 mm turned down on the straight side of the vessel as an overlap. The metal head cover shall be secured in place at the circumferential overlap with a band equipped with a breather spring. All metal joints shall have weatherproof seams.

6.3.6 Heads on horizontal vessels and tubular equipment and bottom exposed heads on vertical vessels shall be finished with metal jacketing with a minimum of 150 mm turned under the shell metal jacketing. The metal head cover shall be secured in place at the circumferential over-lap with a band equipped with a breather spring. All metal joints shall have weatherproof seams.

6.3.7 Transitions and stiffener rings shall be finished with metal jacketing with weatherproof seams. The jacketing shall extend under the upper shell jacketing a minimum of 150 mm and down over the lower shell jacketing a minimum of 150 mm. The metal covers shall be secured in place at the circumferential overlaps with a band equipped with a breather spring.

6.3.8 Pumps, turbines and irregularly shaped surfaces which cannot be suitably weatherproofed with metal jacketing shall be finished with a tack coat of vapor barrier mastic applied over the vapor barrier, followed by a layer of reinforcing fabric installed wrinkle-free. Over the reinforcing fabric, a 3.2 mm thick dry coat of mastic weathercoat shall be applied with a smooth finish. The finish shall extend approximately 150 mm beyond the insulation at all metal projections to assure a good seal.

6.3.9 Heavy fillets of flashing compound shall be applied as flashing at all possible sources of moisture penetration such as nozzles and other protrusions through the metal surface.

7. APPLICATION OF INSTRUMENT INSULATION

7.1 General

7.1.1 Instruments, including components, valves, tubing and piping shall be insulated when indicated on the P&ID.

7.1.2 In cases where installed lengths of tubing or piping are field routed, actual field measurements shall be required to determine dimensions.

7.1.3 Flanges and unions shall be insulated in instrument lines unless otherwise noted on the drawings.

7.1.4 Pressure tests shall, if possible, be completed before insulation is installed. If insulation is applied before testing, all connections, including welds shall be left uninsulated and exposed until completion of testing.

7.2 Insulation Application

7.2.1 Insulation materials and application shall be in accordance with Paragraphs 5 and 6 of this specification.

7.2.2 Special applications shall be in accordance with details and drawings prepared for a specific project.

7.3 In-Line Instruments

7.3.1 In-Line instruments are defined as those which are an integral part of the piping system, i.e., cannot be removed without affecting normal process flow.

7.3.2 In-Line instruments shall be insulated with the same material and thickness as that specified for the adjoining pipe.

7.4 Level Instruments

7.4.1 Level glasses and displacer type level controllers shall be insulated as specified by the vessel trim line number.

7.5 Differential type level controllers shall be insulated in accordance with paragraph 12.2.

7.6 Remote Instruments

7.6.1 Remote instruments are defined as those which are not an integral part of a piping system, i.e., can be removed without affecting normal process flow.

7.6.2 Normally, remote instruments that require insulation are installed in prefabricated insulated houses and the lead lines are insulated in the normal manner after installation.

7.6.3 Insulation requirements for analyzer lead lines must be determined for each installation by Instrument engineering.

8. INSPECTION

8.1 Witness Inspection

Witness inspection shall be performed by HPC personnel in charge or his designated representative.

8.2 Inspection and Test Records

The records of the following inspection and tests shall be submitted.

8.2.1 Materials Certificate

8.2.2 Inspection Records of Dimensional Check

8.3 Inspection Method and Acceptance Standard

Items, methods and acceptance standard of tests and inspection shall be as follows.

Item	Methods and Acceptance Standard
Surface preparation	The surface shall be inspected visually. There shall be no adhesion of rust, oil, soil/sand, rain water or other foreign matter.

Materials inspection	The following items shall be checked for materials to be used. (a) Material specification: materials to be used (insulation materials, jacket plates, wires, bands and etc.) shall be checked. (b) Thickness measurement: Thickness shall be measured with measuring tools. This shall be as required in the Specification. (c) Appearance: Appearance of materials to be used shall be checked visually. These shall be no crack, injury, deformation or moisture absorption.
Inspection during the work	The followings shall be checked visually and with measuring tools, in accordance with the specifications and drawings. (a) Procedure: The procedure of insulation work shall be in accordance with engineering specifications. (b) Thickness: Insulating thickness shall be in accordance with the specifications and drawings. (c) Binding: Insulation materials shall be bound securely and firmly. (d) Caulking at joint: Caulking of joint part or insulation material shall be sufficient to leave no gap. (e) Expansion (and Contraction) countermeasure: Countermeasure for contraction shall be provided. (f) Staggering of joint: When 2 or more layers are stacked, joints of insulation material shall be staggered. (g) Fixing wire: Material and size of steel wire shall be in conformity with the specification. (h) Lap length: For work using moisture-proofing sheet, its lap length at longitudinal and circumferential joints shall be 30 mm or more. (i) Jacketing material: Material and thickness of jacketing sheet shall be in conformity with the specification. (j) “z” joint and lap length of jacket: Position of “z” joint and lap length shall be as specified.

Inspection after completion of works	The followings shall be checked visually and with measuring tools, according to the Specifications and Drawings. (a) Penetrated part of insulating material: Water-proofing shall be enough there. (b) Insulation around flanges, valves and etc.: Insulation material with suitable water-proofing shall be applied correctly around them. (c) Insulation thickness: The thickness tolerance shall be within -3 mm of design thickness. (d) Appearance of jacketing: There shall be no loose part, no extreme cave-in or injury. (e) Termination treatment: Water-proofing shall be enough, particularly check whether enough length of insulation at skirt or support is taken or not. Disposal of left-over material and cleaning: Left-over materials shall be brought together at the designated place and kept in orderly manner. The work place shall be cleaned enough after completion of work.

9. INSULATION THICKNESS CHART OF COLD INSULATION

Temperatures in following charts are minimum operating temperatures for given thickness. The charts are based on ambient temperature of 21 °C at 80 % relative humidity, emissivity of 0.85 and wind speed of 4.83 km/hr. The “K” values are calculated in accordance with ASTM-C680.

Piping, Vessels and Equipment above 36" Diameter

(°C)

Pipe Size	Insulation Thickness (mm)										
	25	40	50	65	75	90	100	115	125	140	150
1/2"	4	-12	-34	-59	-87	-121	-171				
3/4"	7	-9	-29	-54	-79	-109	-143	-159			
1"	7	-7	-26	-46	-70	-96	-118	-159	-184		
1-1/2"	10	-4	-18	-37	-57	-96	-107	-121	-146	-179	
2"	10	-1	-15	-32	-48	-68	-90	-98	-143	-179	
3"	13	2	-12	-26	-40	-57	-76	-96	-115	-148	-179
4"	13	4	-9	-21	-34	-51	-68	-87	-107	-132	-159
6"	16	4	-4	-15	-29	-43	-57	-73	-90	-107	-126
8"		7	-4	-12	-26	-37	-51	-65	-82	-98	-115
10"		7	-1	-12	-23	-34	-46	-59	-73	-90	-101
12"		7	-1	-9	-21	-32	-43	-54	-68	-84	-98
14"		7	-1	-9	-18	-29	-40	-54	-65	-79	-96
16"		7	-1	-9	-18	-29	-40	-51	-62	-76	-90
18"		10	2	-9	-18	-26	-37	-48	-59	-73	-87
20"		10	2	-9	-18	-26	-37	-46	-59	-70	-84
24"		10	2	-9	-15	-23	-34	-46	-54	-68	-79
28"		10	2	-9	-15	-23	-32	-43	-54	-65	-76
32"		10	2	-9	-12	-23	-29	-40	-51	-62	-73
36"		10	2	-4	-12	-21	-29	-40	-48	-59	-70

Single Layer → ← Double Layer

Piping, Vessels and Equipment above 36" Diameter

(°C)

Pipe Size	Insulation Thickness (mm)												
	40	50	65	75	90	100	115	125	140	150	165	175	190
42"	10	2	-4	-12	-21	-29	-37	-48	-57	-68	-79	-96	-93
48"	10	4	-4	-12	-21	-29	-37	-46	-57	-65	-76	-87	-93
54"	10	4	-4	-12	-21	-26	-37	-46	-54	-65	-73	-84	-93
60"	10	4	-4	-12	-18	-26	-34	-43	-54	-62	-73	-84	-93
66"	10	4	-4	-9	-18	-26	-34	-43	-51	-62	-70	-82	-93
72"	10	4	-4	-9	-18	-26	-34	-43	-51	-59	-70	-82	-93
78"	10	4	-4	-9	-18	-26	-34	-43	-51	-59	-70	-79	-90
96"	10	4	-1	-9	-18	-23	-32	-40	-48	-57	-68	-76	-87
120"	10	4	-1	-9	-15	-23	-32	-40	-48	-57	-65	-73	-84
144"	10	4	-1	-9	-15	-23	-32	-37	-46	-54	-65	-73	-82

Single Layer → ← Double Layer

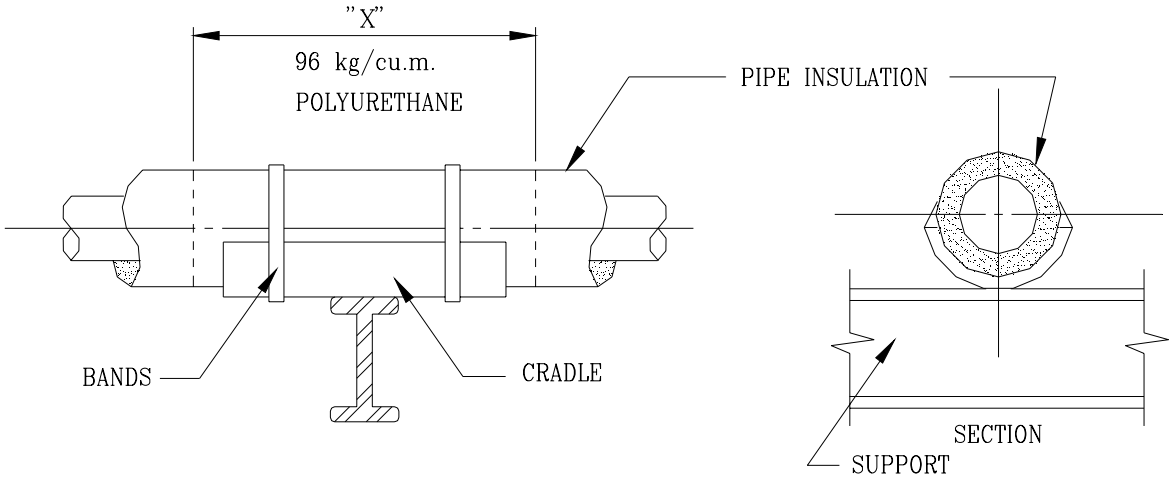
THICKNESS OF INSULATION IN mm FOR (R) REFRIGERATION REQUIREMENT 0°C AND LOWER AND (D) ANTI-SWEAT REQUIREMENT 0°C AND LOWER POINT (MATERIAL : AEROGEL - CRYOGEL)

Nominal Pipe Size or Vessel Dia. (inches)	OPERATING TEMPERATURE °C						
	14 to -10	-11 to -35	-36 to -60	-61 to -85	-86 to -110	-111 to -135	-136 to -150
1/2	10	15	20	20	25	25	30
3/4	15	15	20	25	25	30	35
1	15	15	20	25	25	30	35
1-1/2	15	20	25	30	30	35	45
2	15	20	25	30	30	35	45
3	15	20	25	30	35	45	45
4	15	25	30	35	45	45	55
6	20	25	30	45	45	55	55
8	20	30	35	45	55	55	65
10	20	30	35	45	55	65	**65**
12	20	30	45	45	55	65	75
14	20	30	45	55	55	65	75
16	25	30	45	55	65	65	75
18	25	35	45	55	65	75	75
20	25	35	45	55	65	75	85
24	25	35	45	55	65	75	85
30	25	35	55	65	75	75	85
Flat	45	65	85	105	125	145	165

Note 1 : Thickness of based ambient temperature 14°C, 85% relative humidity. 2.5m/s wind velocity, dew point 27.8°C and will keep surface temperature Above 29°C

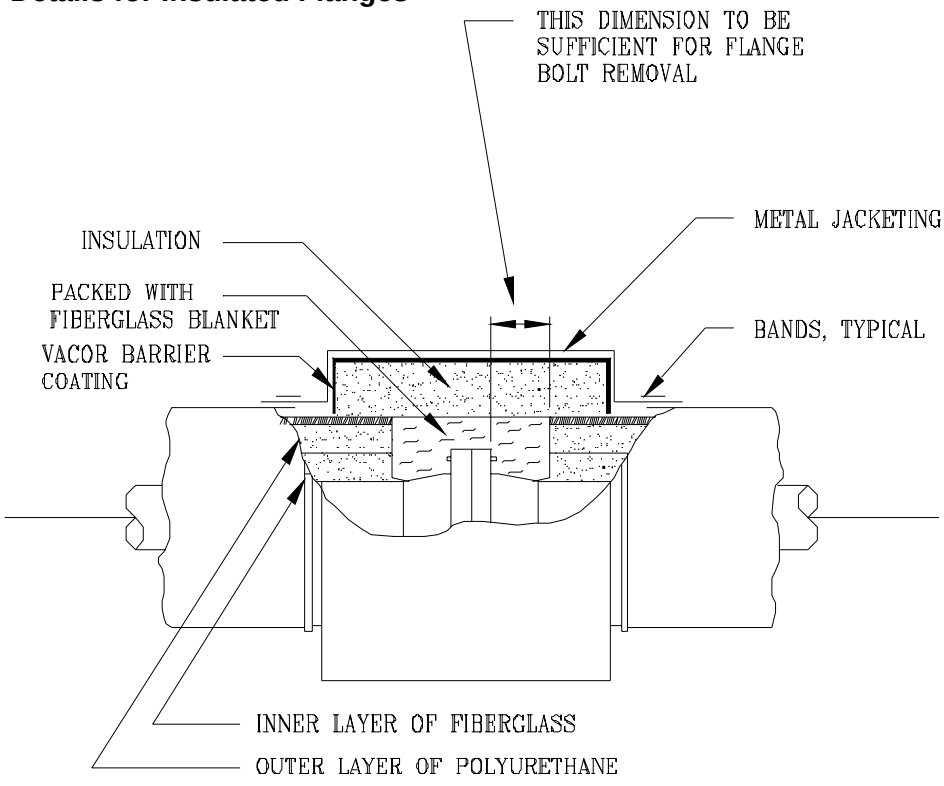
PIPING INSULATION DETAILS

9.1 Typical Details for Support Cradle

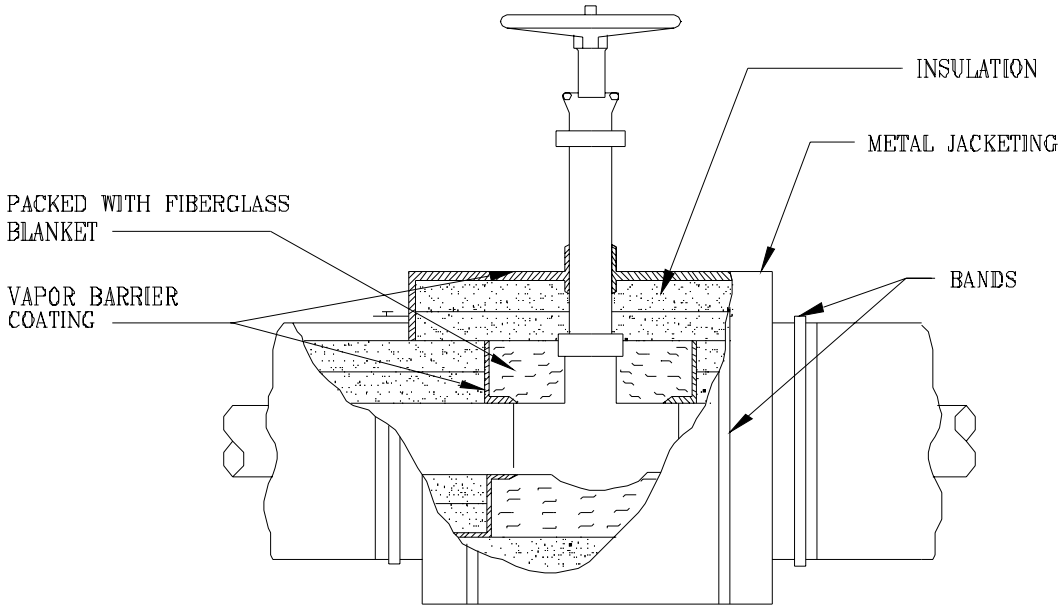


NOTE :
"X" DIMENSION SHALL EXTEND A MINIMUM OF 25mm BEYOND THE ENDS OF THE SUPPORT CRADLE.

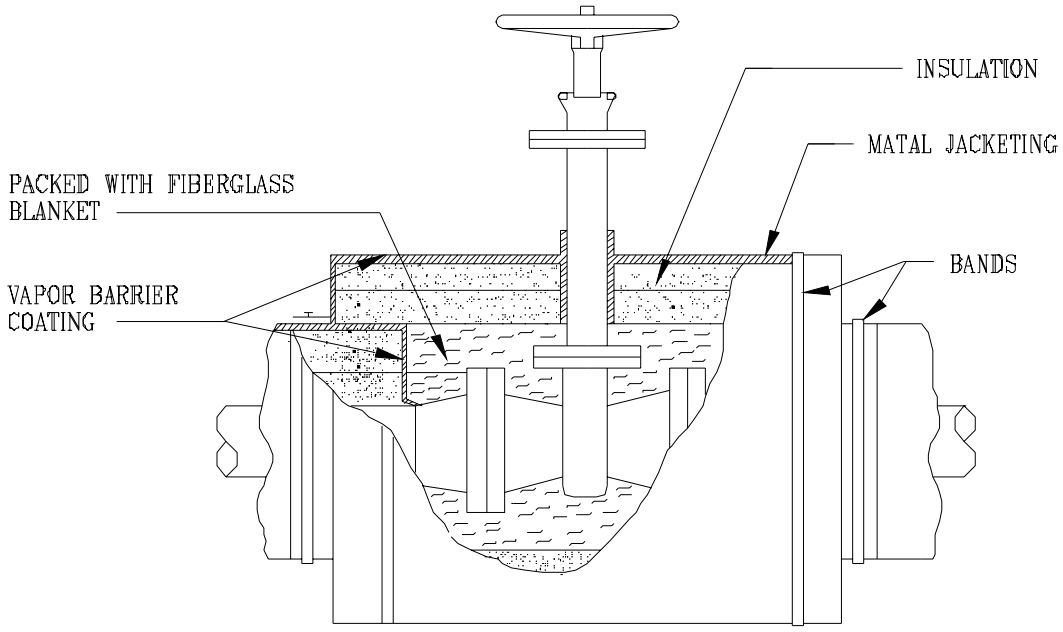
9.2 Typical Details for Insulated Flanges



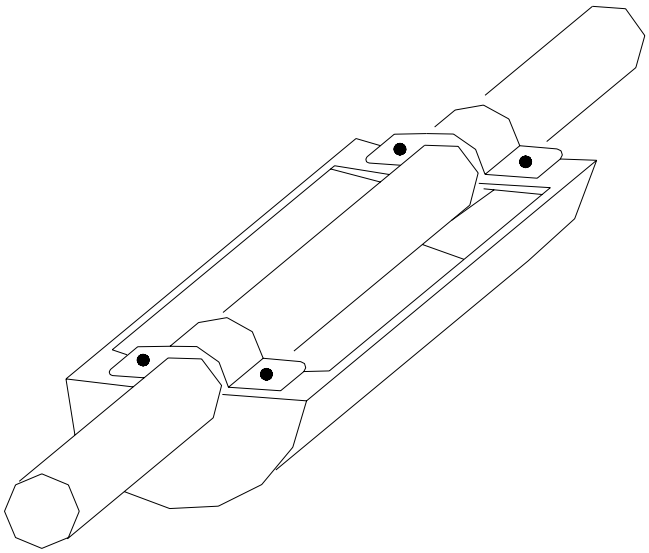
9.3 Typical Details for Socket or Buttwelded Valves



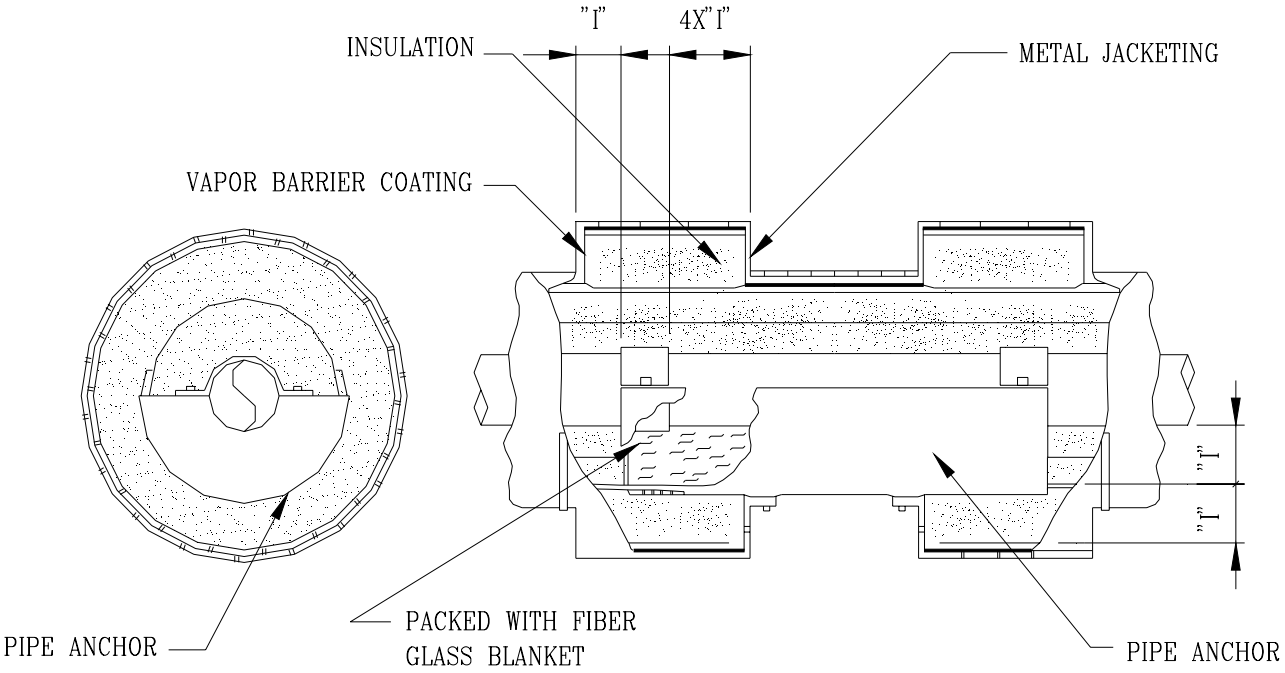
9.4 Typical Details for Flanged Valves



9.5 Typical Details for Pipe Anchor

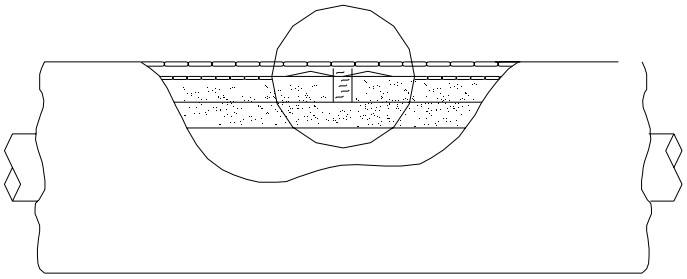


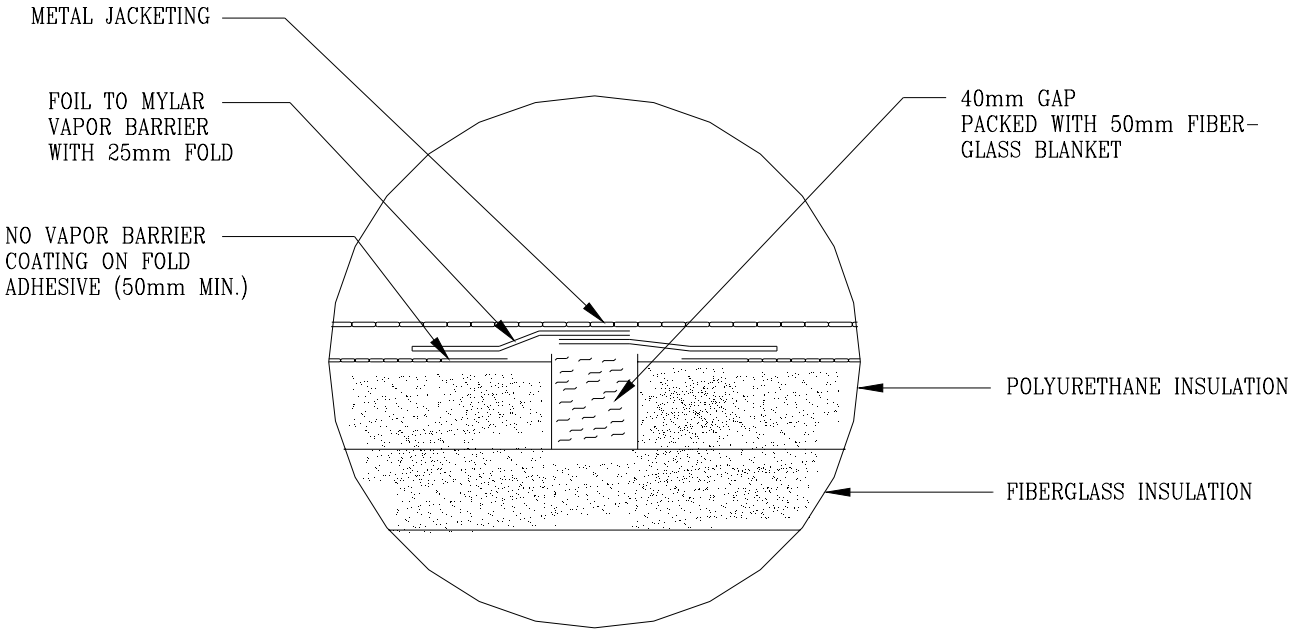
9.6 Typical Details for Insulated Pipe Anchor



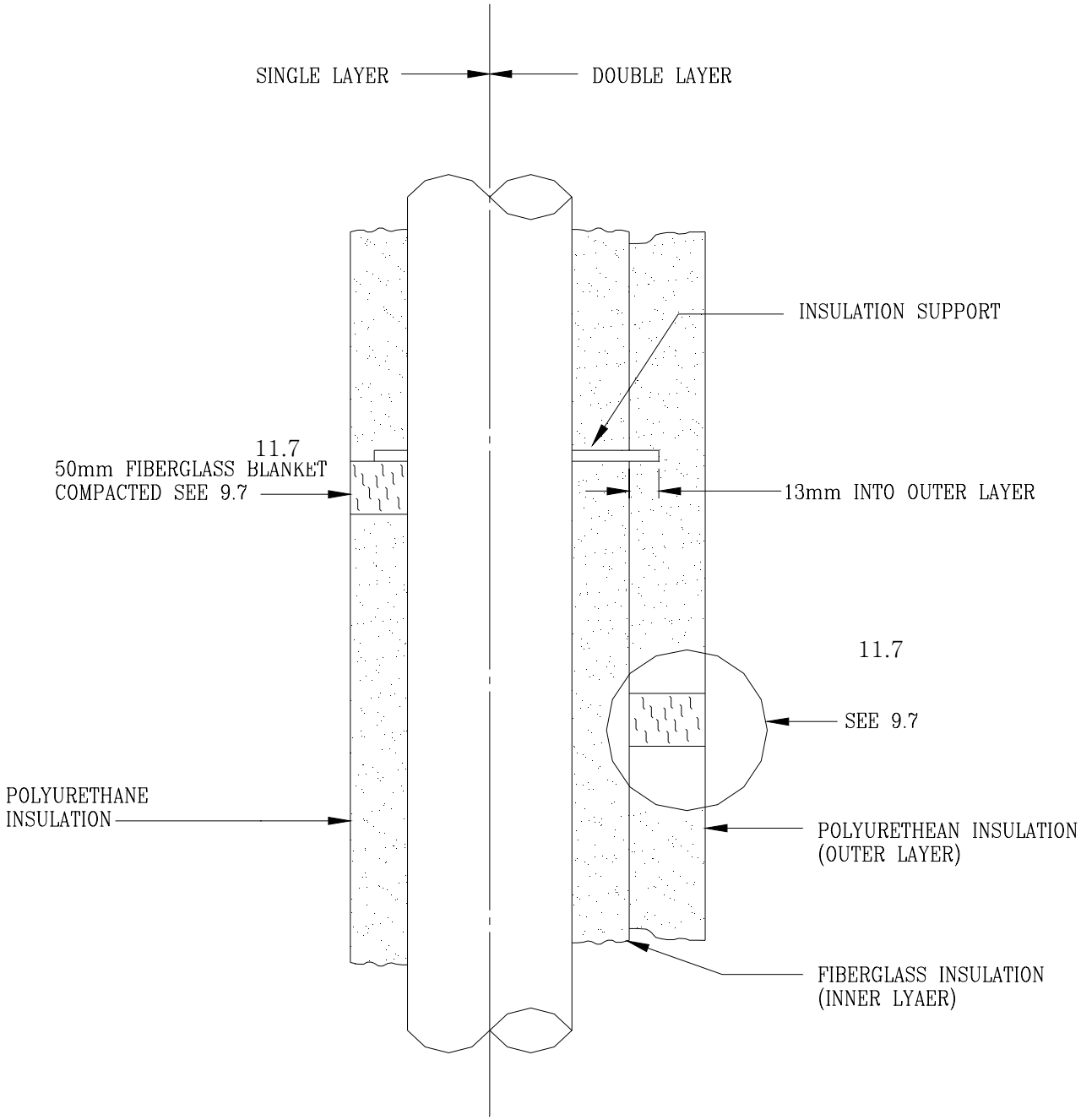
"I" = INSULATION THICKNESS IN ACCORDANCE WITH THE COLD INSULATION THICKNESS CHART, BASED ON THE LINE SIZE AND OPERATING TEMPERATURE.

9.7 Typical Detail for Insulated Contraction Joints



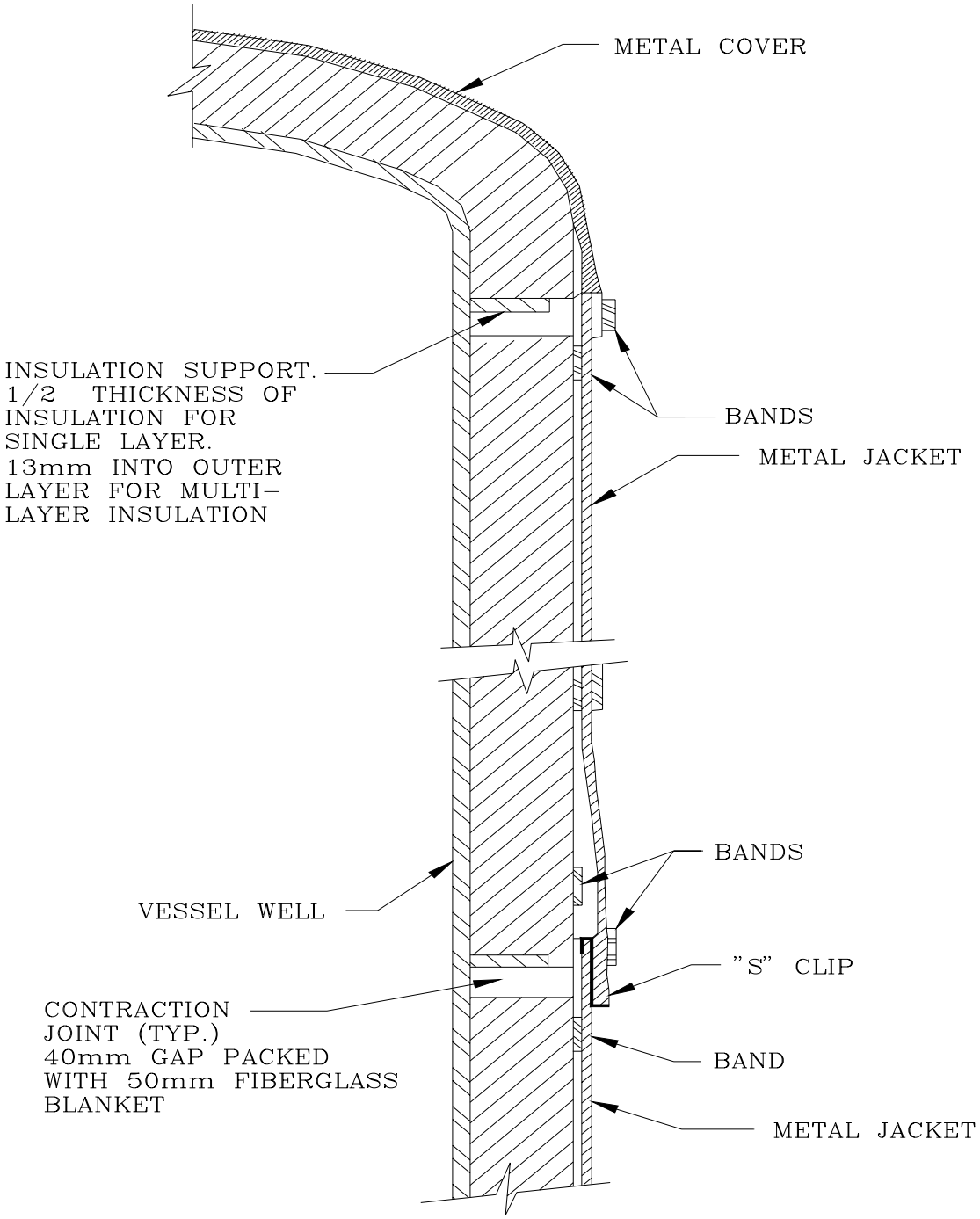


9.8 Typical Vertical Contraction Joint Detail

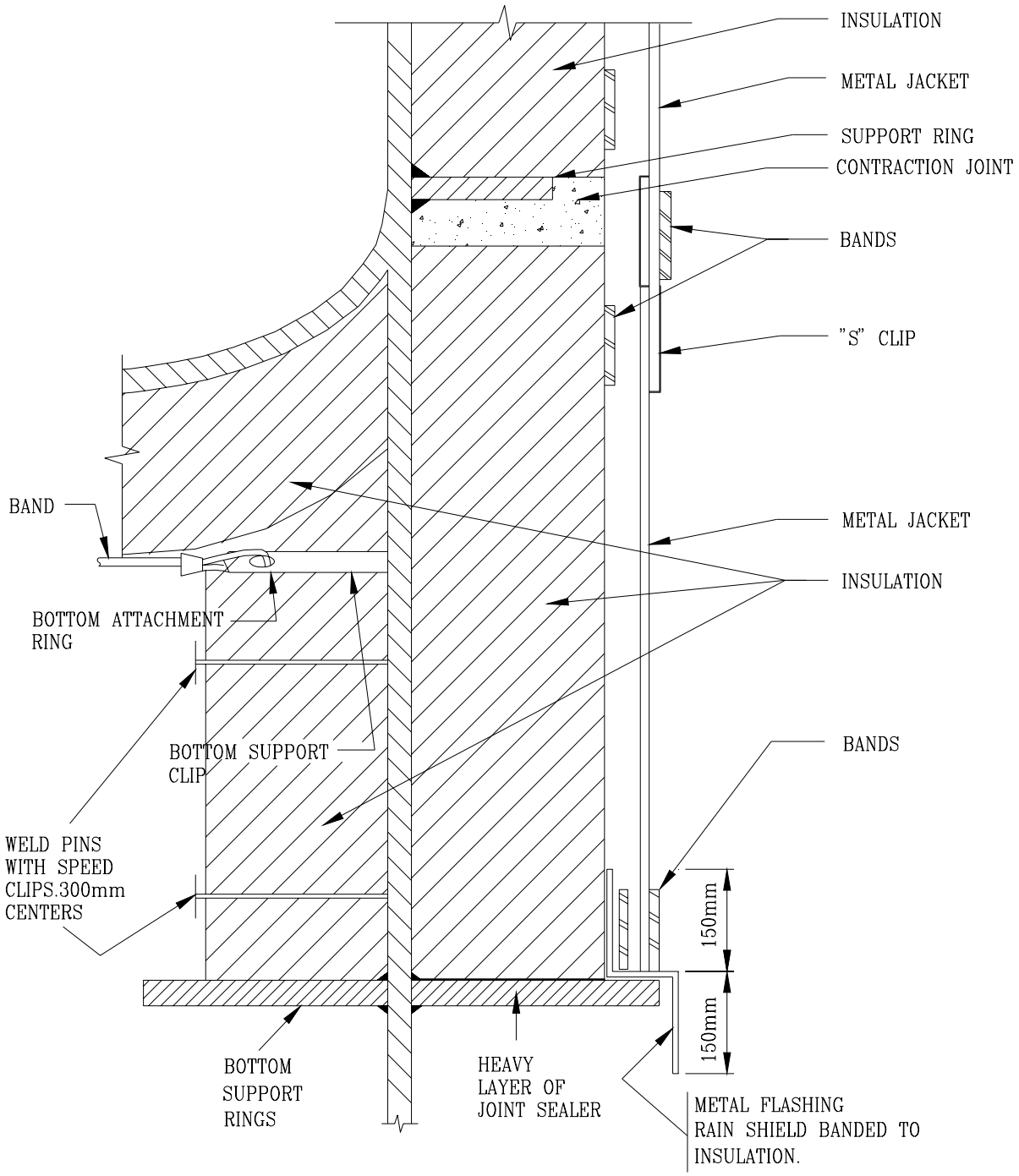


10. VESSEL AND EQUIPMENT INSULATION DETAILS

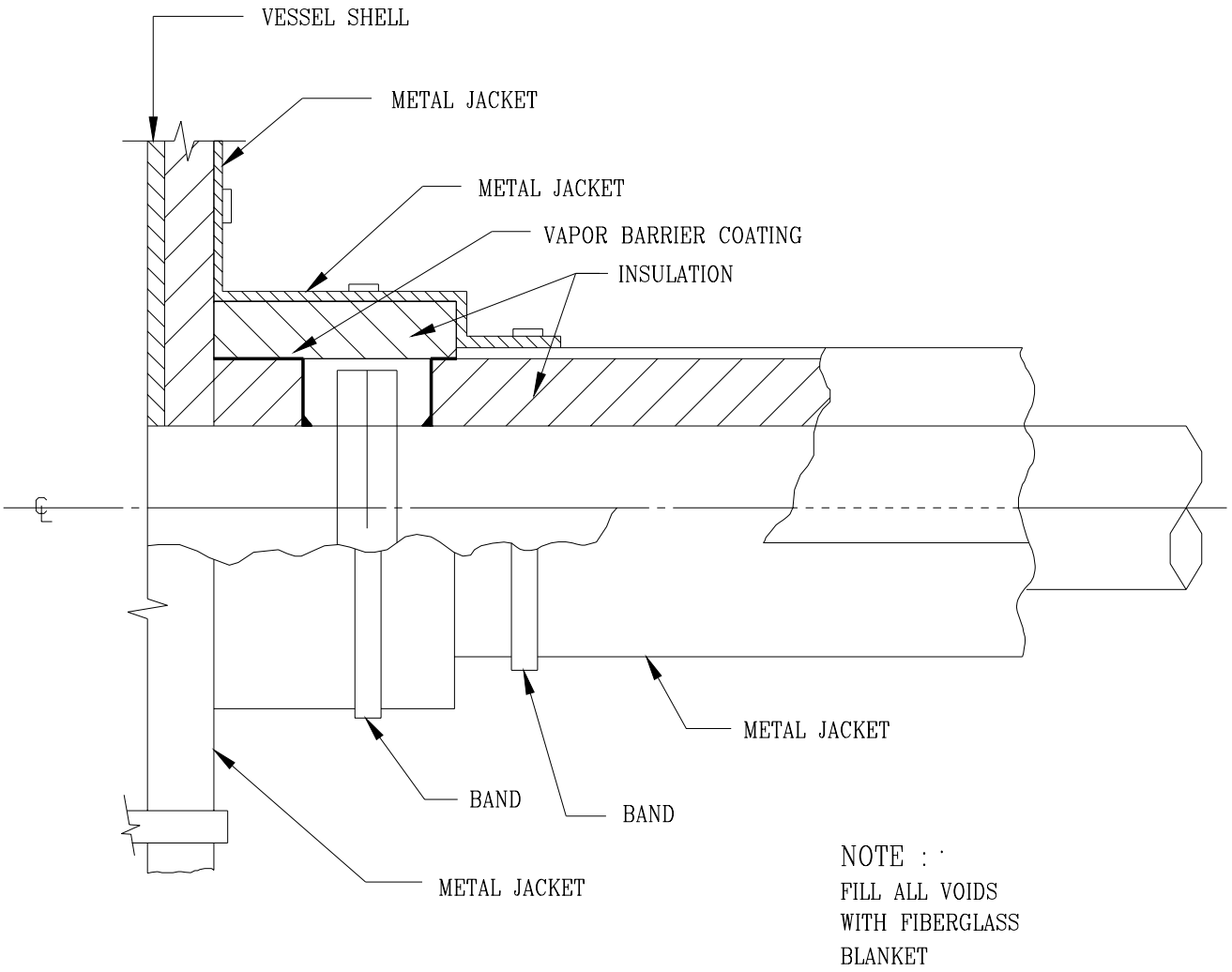
10.1 Vessel Support and Weatherproofing Details



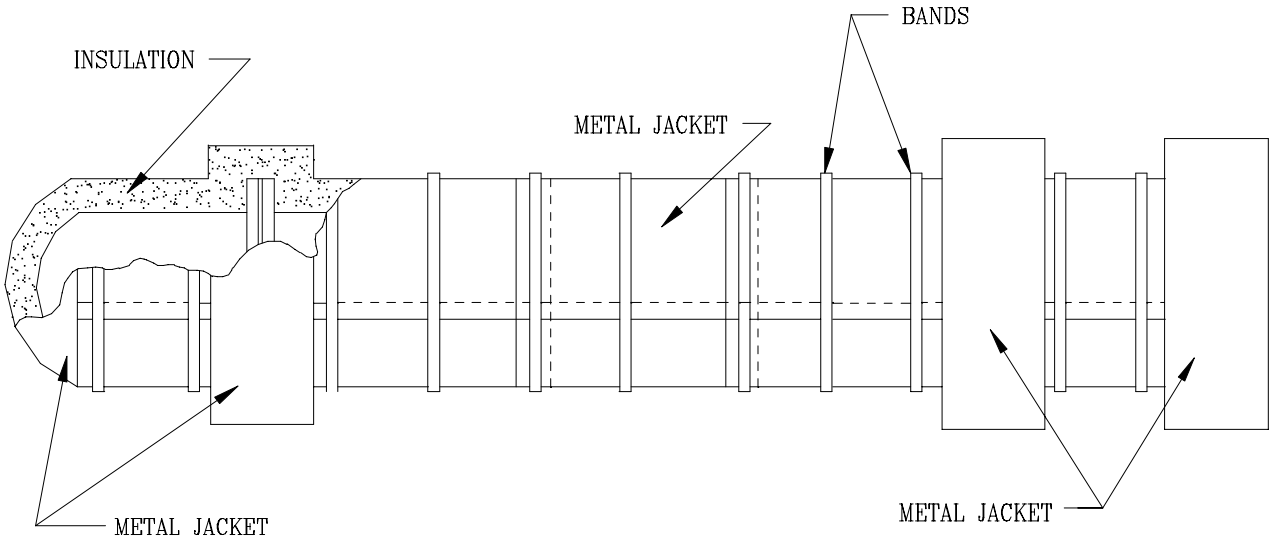
10.2 Insulation Support Ring Detail



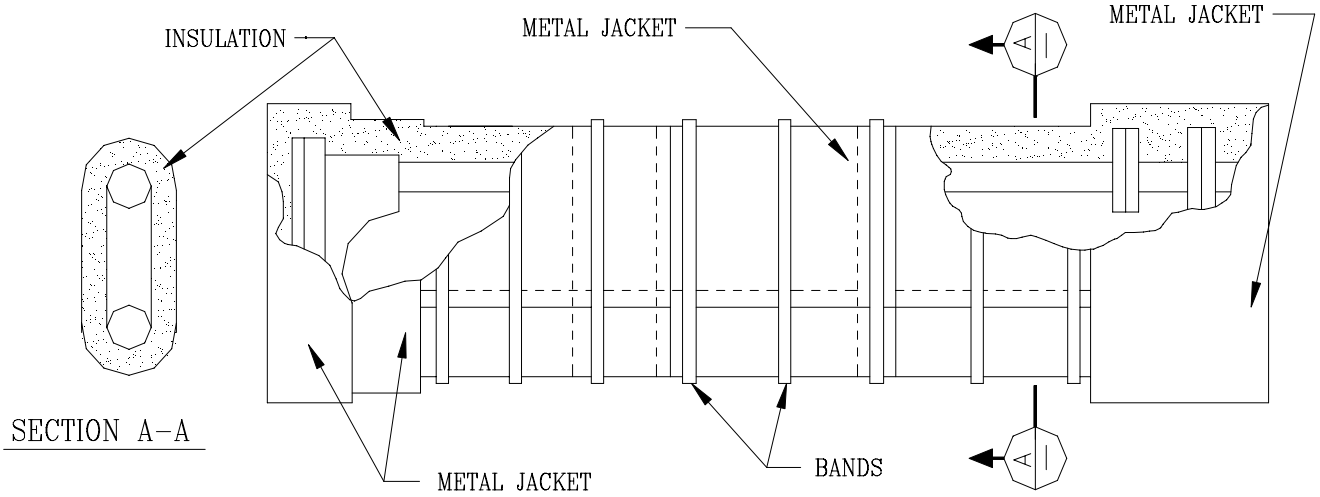
10.3 Typical Detail for Insulating Vessel Nozzle



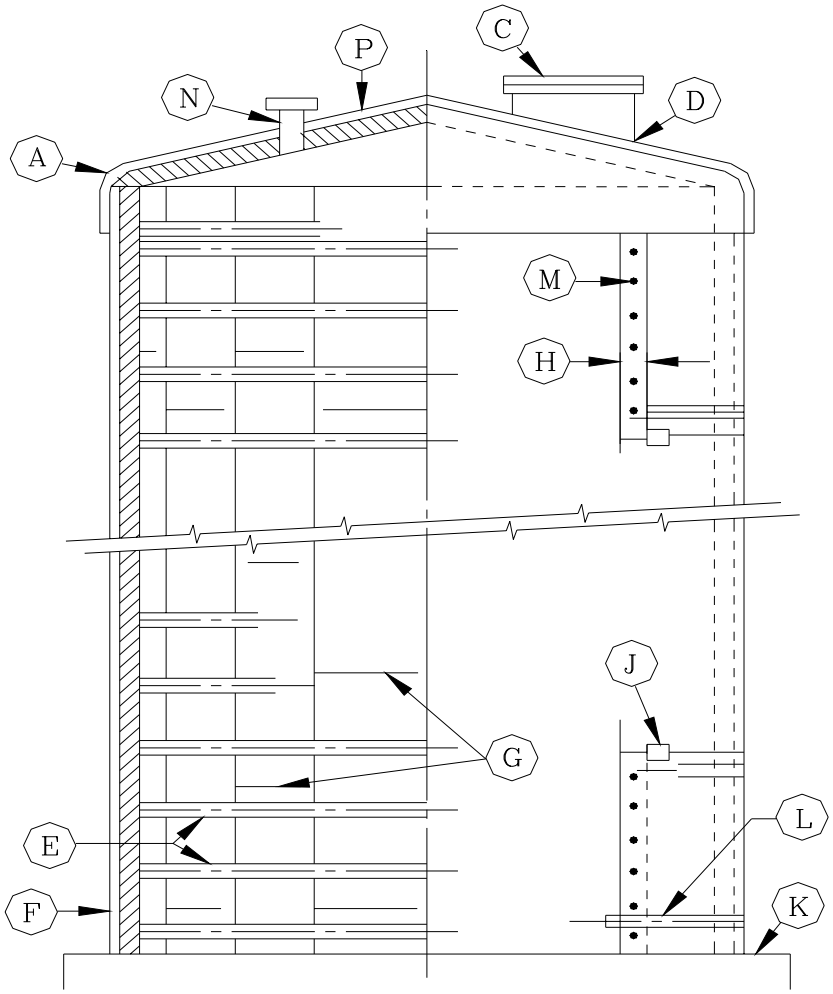
10.4 Typical Detail for Shell and Tube Exchanger



10.5 Typical Detail for Double Pipe Exchanger



10.6 Insulation Details for Storage Tank in Cold Service



A. Over roof insulation apply a tack coat of vapor barrier mastic to dry insulation. While still wet, embed a layer of 5 x 5 glass fabric into the mastic. Overlap cloth at least 75 mm (3"). Before surface dries, a second coat of mastic shall be applied over the glass cloth to a uniform thickness of not less than 1.6 mm(1/16")(wet).

B. -

C. Manholes shall be protected with built up removable covers (not metal jacketed).

D. Provide Type 302 stainless steel floating ring at manholes, attachments and etc., where required to secure straps.

E. Stainless steel straps and seals on 225 mm (9") centers.

F. For type and thickness of insulation, see vendor's datasheet.

G. Use staggered joint construction.

H. Over shell insulation apply metal jacket. Laps in jacket shall be 100 mm (4") on vertical seams or 75 mm (3") on horizontal seams. Corrugations are (32 mm) 1-1/4".

I. -

J. Seal with flashing sealer.

K. Stainless steel insulation straps and seals at horizontal seams and not over 610 mm (24") apart.

L. Pop rivet, on 150 mm (6") centers, all vertical and horizontal joints.

M. Nozzle to be insulated per piping insulation

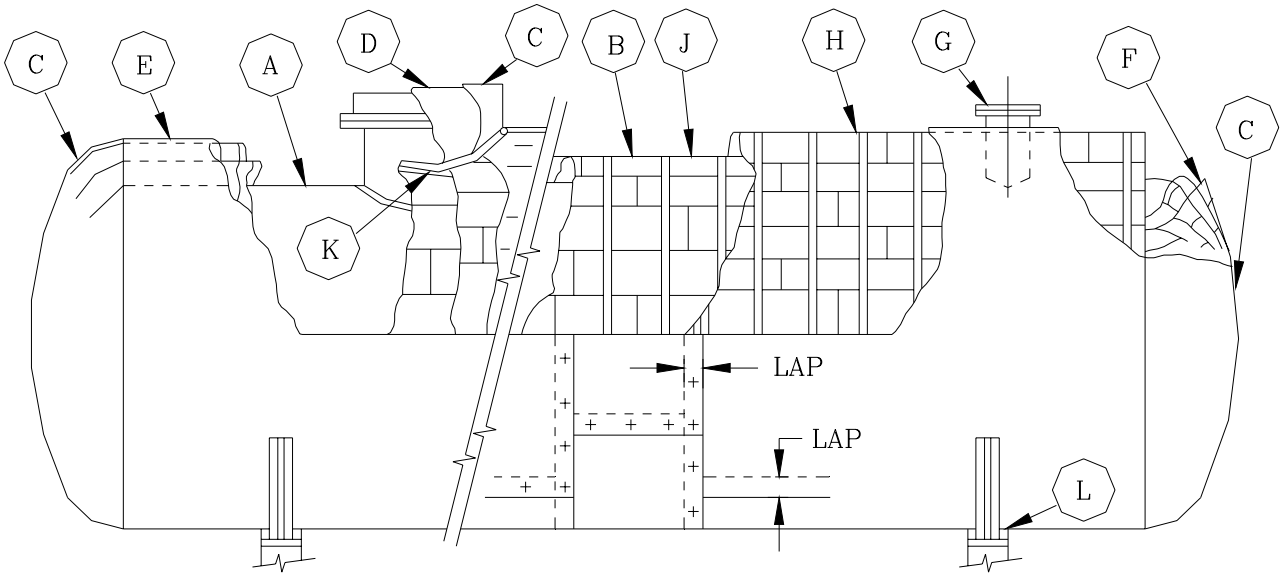
Notes :

1) Surfaces to be insulated shall be clean, dry and free from frost, rust and etc. All metal surfaces shall be primed with a brush coat of rust inhibiting primer (if not already painted). Allow primer to dry thoroughly before applying insulation.

2) For number and size of nozzles, see piping drawings.

3) Fit metal jacket as closely as possible around all projections and seal with flashing sealant. Projections shall be insulated for a distance equal to four times the thickness of insulation where possible.

10.7 Insulation Details for Horizontal Tanks Over 762 mm(30") in Cold Service



A. Surfaces to be insulated shall be clean, dry and free from frost, rust and etc. Prime all metal surfaces with a brush coat of rust inhibiting primer(if not already painted).

B. When paint is dry, lay up cold insulation blocks using joint sealer on all butt edges and ends of outer layer or single layer. Stagger joints. Use gobs of sealer as temporary.

C. Weatherproofing heads and manholes. Over insulation apply a tack coat of vapor barrier mastic. While still wet, embed a layer of 5 x 5 mesh glass cloth in the mastic coating, overlapping cloth at least 75 mm (3"). Before surface dries, apply a second coat of mastic to a uniform thickness of not less than 1.6 mm (1/16") (wet)

D. Manholes shall be protected with built up removable covers same thickness as specified for tank(Not metal jacketed).

E. Weatherproofing shell. Over shell insulation, apply metal jacketing. Laps in jacket shall be 100mm (4") on vertical seams and 75 mm (3") on horizontal seams. Use No. 8 x 13 mm (1/2") long stainless steel sheet metal screws spaced 150 mm (6") apart on horizontal laps urethane - space straps on 225 mm (9") centers.

F. Shape and fit blocks to the contour of surface to be insulated.

G. Nozzles to be insulated per piping insulation thickness schedule.

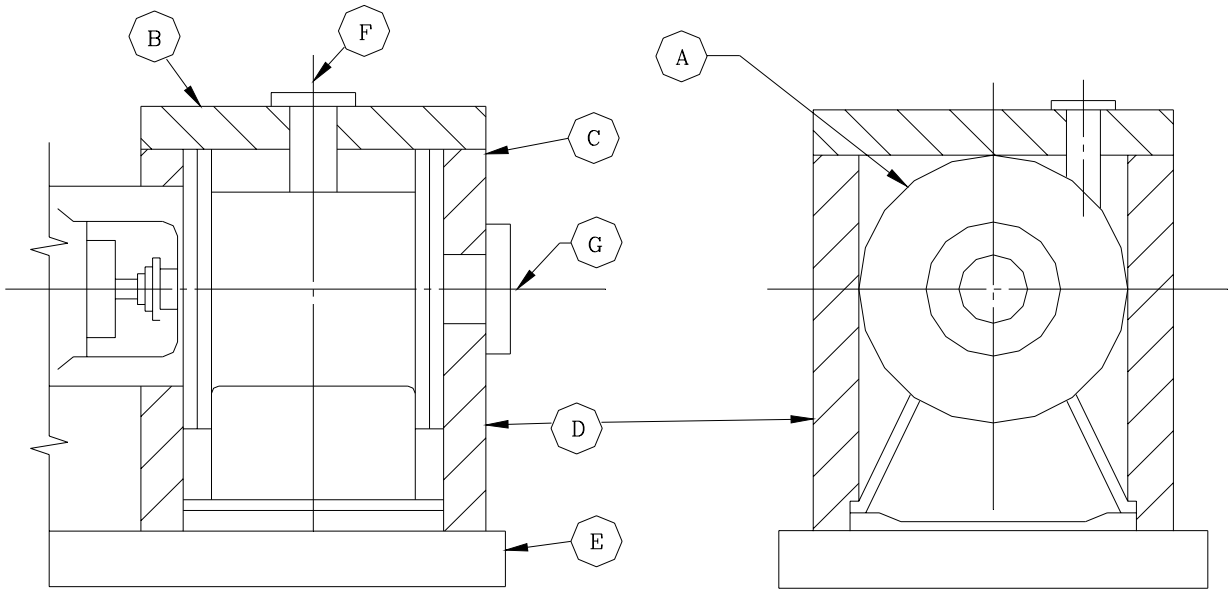
H. Stainless steel straps and seals spaced 225 mm (9") on centers shall be used to secure each course.

I. -

J. Provided Type 302 stainless steel floating rings at manholes and etc., where required to secure straps.

K. Insulated and sealed at all projections and attachments.

10.8 Details of Cold Pump Insulation (No Scale)



A. Surfaces to be insulated shall be clean, dry and free from frost, rust and etc.

B. For type and thickness of insulation, see vendor's datasheet.

C. Lay up insulation material blocks coating all butt edges and ends of blocks with a buttered layer of joint sealer.

Band blocks in place with stainless steel bands and seals 225 mm (9") on center.

D. Over insulation apply a tack coat of vapor barrier mastic. Into this a layer of 10 x 10 glass cloth shall be embedded, and a final coating of mastic shall be applied to give 1.6 mm (1/16") wet film thickness. Laps in glass fabric shall be at least 75 mm (3").

E. Baseplate not insulated

F. Centerline of discharge

G. Centerline of suction

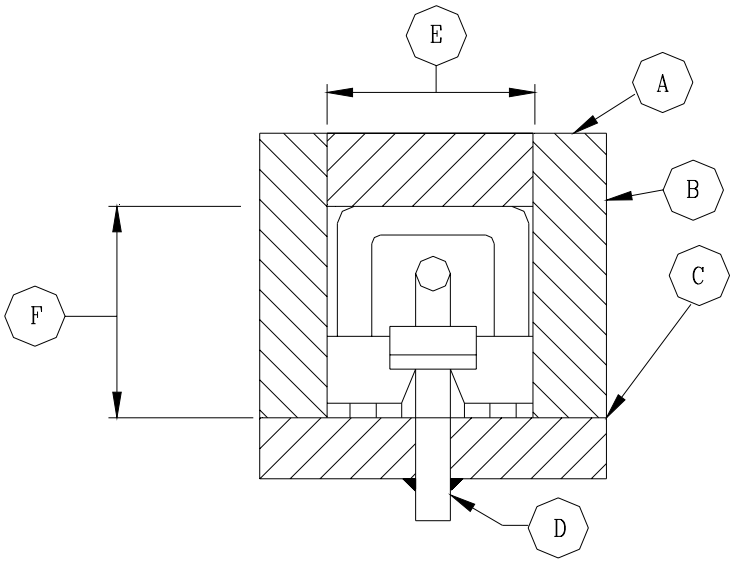
Notes :

1) Details shown represent typical fixed insulation detail.

2) Where removable type insulation is required, it shall be listed in equipment datasheets, and applicable detail sheets shall be part of this specification.

11. INSTRUMENT INSULATION DETAILS

11.1 Insulation Detail for Level Gages



SECTION THROUGH REFLEX OR "R" LEVEL GAGE
WITH NONFROSTING EXTENSION

A. BLOCK INSUIATION CUT TO FIT.

B. INSULATION TO BE WIRED ON, USING #16 GAUGE STAINLESS STEEL TIE WIRES.

C. SEAL ALL JOINTS AND WEATHERPROOF SAME AS ADJACENT EQUIPMENT

D. SEAL THOROUGHLY WTIH JIONT SEALER WHERE NONFROSTING EXTENSION PROJECTS THROUGH INSULATION.

E. 80mm

F. 90mm

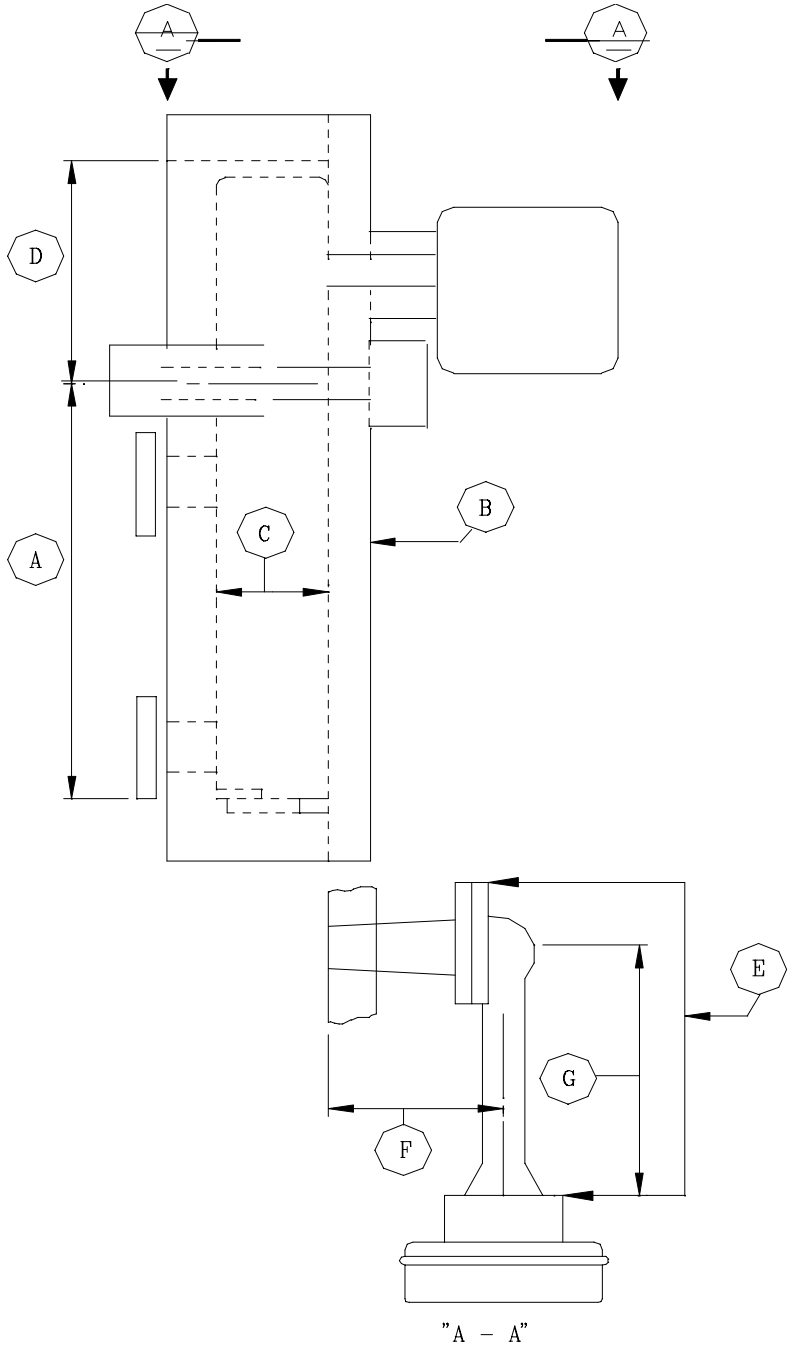
NOTES

(1) LEVEL GAUGES SHALL BE INSULATED COMPLETELY, INCLUDING TOP AND BOTTOM AND CONNECTING PIPING.

(2) SEE SCHEDULE OF LEVEL GAGES.

(3) PROTECT FACE WITH MASKING TAPE WHILE INSULATION AND WEATHERPROOFING ARE BEING APPLIED.

11.2 Insulation Details for Level Controllers



A. DIMENSION "A"

B. FOR THCKNESS OF INSULATION, SEE SCHEDULE OF LEVEL CONTROLLERS.

C. 115mm OUTSIDE DIAMETER.

D. 280mm

E. INSULATE COMPLETELY, UP TO CONTROL BOX.

F. 145mm

G. 280mm

NOTES:

(1) LEVEL CONTROLLERS WHERE INSULATION IS INDICATED SHALL BE INSULATED COMPLETELY, INCLUDING BONNET, FLANGES TORQUE TUBE, AND CONNECTING PIPING

(2) APPLY INSULATION AND WEATHERPROOFING AS DESCRIBED FOR PIPING.

(3) SEAL JIONTS WITH JIONT SEALER.

(4) PIPING BETWEEN LEVEL CONTROLLER AND VESSEL SHALL BE INSULATED

(5) FOR PIPING CONNECTIONS, SEE PIPPING DRAWINGS.