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<div>1.0INTRODUCTION</div> <div>1.1GENERAL</div> <p>This Specification gives the minimum requirements for the thermal and personnel protection insulation of piping and equipment (vessels, heat exchangers, pumps, etc) and method of application.</p> <p>Equipment and piping shall be insulated for the purposes of conservation of heat, maintenance of stabilized process temperatures during atmospheric temperature changes, condensation prevention, burn prevention of personnel or limiting noise levels according to the classification nominated.</p> <div>1.2EXCLUSIONS</div> <p>This Specification does not cover:</p> <ul style="list-style-type: none">Electrical insulation or heat tracingAcoustic insulation of equipmentAcoustic or thermal insulation of HVAC equipment or ductingPassive fire protection insulation for structures <div>1.3CONTRACTOR’S RESPONSIBILITIES</div> <p>This document shall form the basis upon which the EPC Contractor can develop a detailed specification. The document presents the findings of the Definition Engineering Study and as such, should be considered as a general specification. The Contractor should update this document with the detailed design information that is developed during the detailed design phase.</p>				
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<p>Further the contractor shall be responsible for the complete design, selection, supply, installation and inspection of insulation on piping and equipment, including full compliance with all applicable Codes and Standards, including those listed in section 2.0 of this Specification.</p>													
<p>1.4 APPLICATION OF THIS DOCUMENT</p> <p>The scope of this document is limited to this project & associated modifications. This document shall not be used for any other purpose.</p>													
<p>2.0 CODES AND STANDARDS</p>													
<p>2.1 CODES, STANDARDS AND REGULATIONS</p> <p>The insulation covered by this Specification shall be designed, manufactured and tested in accordance with the requirements of this Specification, the attached Data Sheets and the following latest edition of Codes, Standards and Statutory Regulations (where applicable)</p>													
<table><tr><td>ASTM C165</td><td>Test Method for Measuring Compressive Properties of Thermal Insulation</td></tr><tr><td>ASTM C195</td><td>Mineral Fibre Thermal Insulating Cement</td></tr><tr><td>ASTM C303</td><td>Test Method for Density of Preformed Block Type Thermal Insulation</td></tr><tr><td>ASTM C335</td><td>Test Method for Steady-State Heat Transfer Properties</td></tr><tr><td>ASTM C449</td><td>Mineral Fibre Hydraulic Setting Thermal Insulation and Finishing Cement</td></tr></table>				ASTM C165	Test Method for Measuring Compressive Properties of Thermal Insulation	ASTM C195	Mineral Fibre Thermal Insulating Cement	ASTM C303	Test Method for Density of Preformed Block Type Thermal Insulation	ASTM C335	Test Method for Steady-State Heat Transfer Properties	ASTM C449	Mineral Fibre Hydraulic Setting Thermal Insulation and Finishing Cement
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2.2 PROJECT SPECIFICATIONS																													
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<div><div><div>1. Piping fabrication (spec. 2004-C)</div><div>2. Pressure vessel (spec. 2004-D)</div><div>3. Protective coatings (spec. 2005)</div></div><div><div>2.3</div><div>MANDATORY INDIAN STATUTORY REQUIREMENTS</div></div><div><p>This document has been prepared to the international standards detailed within. The EPC Contractor shall ensure that the Scope of Work is executed in accordance with all mandatory Indian Statutory requirements.</p></div><div><div>3.0</div><div>ENVIRONMENTAL DESIGN CRITERIA AND UTILITIES</div></div><div><div>3.1</div><div>DESIGN BASIS CLIMATIC CONDITIONS</div><div><p>The site conditions & climates under which the Equipment & piping will operate is detailed in spec 5006. Designs shall be based on outdoor exposure to the conditions described. Conditions specific to the relevant Equipment Package & process parameters related to piping will be detailed by the contractor on individual Equipment Data Sheets as per approved P&ID's on the basis of process design criteria attached elsewhere in bid package and the same shall be submitted to the company for review.</p></div></div><div><div>3.2</div><div>DESIGN LIFE</div><div><p>The process facilities design life requirement is 25 years.</p></div></div></div>				
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4.0 GENERAL REQUIREMENTS


The Supplier's standard designs (if applicable) which meet the performance requirements and which will operate in the marine environment documented in Section 3.0 for 25 years may be considered with prior approval of Company


4.1 ITEMS REQUIRING INSULATION

- Items shall be insulated for the purpose of conservation of heat, temperature stabilization, personnel protection, condensation prevention (anti-sweat) or limiting noise levels.
- Piping and equipment operating with fluid temperature in excess of 54⁰C or below 10⁰C shall be insulated as burn or freeze protection for personnel to a height of 2.1m above grade and platforms and 0.6m outside the platforms, walkways, etc. with the exception that lines operating above 200⁰C shall be fully insulated.
- Heat transfer equipment in hot services, other than coolers and condensers, shall be completely insulated except for supporting members and flanges. Shell flanges, channel flanges and nozzle necks shall not be insulated. Nozzle necks shall be insulated to the nozzle flanges.
- All piping and equipment operating with fluid temperatures below 27⁰C shall be insulated for condensation prevention ("anti-sweat"). Nozzles, components and appurtenances shall be insulated and covered with vapor barrier and weatherproof cladding.
- All accessories (such as level controllers, level gauges, pipe bridles, etc) which are attached to insulated equipment shall be insulated with equivalent thickness and materials required for the equipment. The insulation shall not obstruct operation or necessary viewing of equipment components, drains, vents and sample points.
- Piping that is considered a potential source of noise should be acoustically insulated. A noise and vibration specification shall be as per spec 5005.

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<div>4.2EXCLUSIONS</div> <p>The following hot parts shall not be insulated, except for burn protection :</p> <ul style="list-style-type: none">Man ways, manholes and inspection openings on hot vessels.Code inspection plates and nameplatesConnectors and tube unions on fin-tube heat exchangersFlanges of piping and equipment in hot serviceExpansion and rotating joints <div>5.0MATERIALS</div> <div>5.1GENERAL</div> <p>All new materials shall be used. Materials showing any evidence of containing contamination or moisture shall not be used.</p> <p>Insulation materials for equipment and piping shall be suitable for the application, operation, and temperature and be compatible with the contained fluids.</p> <p>Insulation materials shall have the following properties:</p> <ul style="list-style-type: none">Completely free from all forms of asbestos.Water-soluble chloride and fluoride ion concentrations as low as possible, 20ppm by mass maximum.Chemically neutral, with pH preferably between 7 and 8 in the wet condition.Non-combustible and odorless at operating temperatures.				
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<ul style="list-style-type: none">Have sufficient compressive strength that the method of fixing and finish shall not damage the insulation. <p>Phenolic and polyisocyanurate (polyurethane) foams shall not be used for services, which may exceed 100⁰C because these produce toxic smoke when burning.</p> <p>Any wire mesh reinforcement shall be stainless steel grade 316L.</p> <p>Any required painting, protective coatings and the procedures used for the preparation of surfaces shall be as specified in the Project Specification for Protective Coatings spec. 2005.</p> <h2>5.2 CLASSIFICATIONS</h2> <p>The Line schedule and the Piping and Instrument Diagrams shall indicate the thickness and insulation classification required.</p> <p>The following insulation classifications are described in this Specification:</p> <ul style="list-style-type: none">C Low temperature insulation designated for processes with operating temperatures below 21⁰C where heat gain is undesirable, or for the prevention of condensation on pipes and equipment with operating temperatures below 27⁰C.H Heat conservation insulation designated for all processes (except heat transfer fluids) with operating temperatures at or above 25⁰C.PP Personal protection insulation designated for equipment and vessels with operating temperatures in excess of 54⁰C or below 10⁰C.				
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5.3 MATERIALS FOR LOW TEMPERATURE SERVICES (CLASS C)

The following materials shall be used for piping and vessel insulation for Class C:

- Preformed or foamed-in-place polyurethane for piping up to and including DN900.
- Polyurethane blocks, segments or foamed in place sections for piping and vessels greater than DN900.


Polyurethane foam shall conform to ASTM C591, Type 11, with a flame spread rating not exceeding 25 in accordance with ASTM E84. Higher density and higher strength foam may be used as load bearing insulation if the properties are approved.


Insulating material used on austenitic steel surfaces shall contain less than 20ppm leachable chlorides and a minimum of 20ppm sodium silicate for each part per million of leachable chlorides.

Foamed in place polyurethane foam shall, as a minimum, conform to the following:

- Density of the core shall be between 30 and 35kg/m³.
- Thermal Conductivity shall not exceed 0.019 W/mK when the foam is new and cured. This value shall be based on a mean temperature of 25⁰C as determined in accordance with ASTM C518.
- Flammability shall be guaranteed to have a flame spread classification not exceeding 75 in accordance with ASTM E84.
- Compressive Strength in accordance with ASTM D1621 shall be not less than 170kN/m.

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<ul style="list-style-type: none">• Closed Cell Content shall not be less than 90%. The cell structure shall be uniform throughout the core and the average cell size shall be no more than 0.40mm. Elongated cells shall be no longer than three times the smallest dimension. These requirements are to be verified in accordance with ASTM D2856, Procedure A.• Dimensional Stability :the maximum volumetric change shall not be more than 6% after 7 days exposure at 75+3⁰C and 100+0/-3% relative humidity in accordance with ASTM D2126.• The permeability shall not exceed 2.5perm in accordance with ASTM C335.• Friability: A 6mm cube, when properly cured, shall not powder when crushed.• Vapor barrier coatings shall cover insulation completely before weatherproofing is installed and have the following characteristics:• They must be compatible with the process piping insulation• They must be flexible at the lowest temperature to which they are exposed• Permeability shall not exceed 0.03 perm in accordance with Procedure E of ASTM E96 for the thickness used.• Minimum dry film thickness shall equal or exceed 0.76mm• Flame spread rating shall not exceed 30 in accordance with ASTM E84.• They shall be weatherproof and non-absorbent and shall constitute a vapor barrier.				
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5.4 MATERIAL FOR HEAT CONSERVATION INSULATION (CLASS H)

Thickness shall be in accordance with Section 6 of this specification.


The following materials shall be used for piping and equipment insulation for Class H:


- For equipment and piping which is to be operated intermittently or continuously at temperatures not exceeding 100deg.C, the insulation may be rigid urethane foam.
- For equipment operated intermittently or continuously above 100⁰C or for acoustic insulation applications, the insulation may be calcium silicate. Calcium silicate insulation which contain asbestos filler shall not be acceptable.
- For equipment and piping which is to be operated intermittently or continuously at temperatures up to 260⁰C, primary insulation may be foam glass complying with ASTM C552 and with density of at least 88kg/m³ and a temperature rating of 315⁰C.
- For equipment and piping which is to be operated intermittently or continuously at temperatures up to 500⁰C, the insulation may be mineral wool with temperature rating of 500⁰C. All mineral wool shall be water repellent and tested for water absorption and retention.


Mineral wool blankets for piping and vessels greater than DN900 shall conform to ASTM C592. They shall have density of at least 128 kg/m³ and shall be faced with wire mesh inside and either wire mesh, expanded metal, or glass mat outside.

Mineral wool preformed sections shall be used for piping larger than DN40 and up to and including DN900. They shall conform to ASTM C547, have density of at least 160 kg/m³ and shall be faced with wire mesh inside and wire mesh or glass mat on the outside.

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<p>Mineral wool blocks and boards shall conform to ASTM C612. Their minimum nominal density shall be 160 kg/m3.</p>				
<p>5.5 MATERIALS FOR PERSONNEL PROTECTION (CLASS PP)</p> <p>Piping, vessels and equipment operating at a temperature of 54⁰C and above, or below 10⁰C for a cold service and not falling within any other insulation category, shall be protected by Stainless Steel metal mesh guard or similar protective material. The minimum distance between hot or cold surfaces and guarding shall be 32mm.</p> <p>Where this is not practical, thermal insulation, Class H or C as appropriate, shall be applied.</p>				
<p>5.6 SEALERS & ACCESSORIES</p> <p>Flashing compounds, joint sealers and bedding compounds shall be permanently flexible through a temperature range of -18⁰C to 500⁰C, be capable of withstanding repeated expansion and contraction without cracking and experience minimum shrinkage.</p> <p>All metal accessories shall be stainless steel.</p> <p>Wire to secure insulation shall be a minimum of 1.2mm annealed stainless steel. Heavier stainless wire or cable shall be used for insulation on vessel heads where floating rings are employed.</p> <p>Expander bands shall be capable of remaining in tension during the heating and cooling cycles experienced during normal operation.</p> <p>Breather springs for bands (if used) shall be capable of remaining in tension during the heating and cooling cycles experienced during normal operation.</p>				
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<p>Screw fasteners shall be stainless steel, self-tapping with pan heads.</p> <p>Wire mesh for cement reinforcement shall be 25mm hexagonal mesh with 0.8mm diameter Monel or stainless steel wire.</p> <p>Mineral wool insulating cement shall meet the requirements of ASTM C449, and be suitable for temperatures up to 315⁰C.</p> <p>Finishing cement shall be asbestos free, meet the requirements of ASTM C449 and shall be suitable for temperature upto 315⁰ C. It shall be fast drying cement that provides smooth, hard surfaces when dry. The cement shall contain a corrosion inhibitor to prevent corrosion when wet.</p> <p>5.7 MATERIALS FOR WEATHER PROOFING & ANCILLARIES</p> <p>5.7.1 GENERAL</p> <p>Jacketing materials for vessels, equipment and piping shall be stainless steel grade 316L, corrugated in accordance the thickness and corrugation requirements as follows:</p> <ul style="list-style-type: none">Aluminium sheets as per ASTM B209 for piping, for vertical vessels with 0.40mm thick with 32mm corrugations and for all horizontal vessels, shall be 0.40mm thick with 5mm corrugations.Aluminium shall be epoxy coated on exterior surface for all services and also for interior surface when used over calcium silicates. <p>Jacketing shall be installed and supported to withstand direct fire hose stream impingement, site and climatic conditions.</p>				
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5.7.2 PIPE WORK & EQUIPMENT LESS THAN DN900

Stainless steel jacketing used for pipework shall be so arranged that it shed water at all times. Overlaps shall be swaged and rendered watertight. Bands for piping shall be at least 12mm wide x 0.4mm thick and secured with wing type seals.

Jacketing for flange, valve and in-line instrument boxes shall be fabricated from stainless steel flat sheet as used for cladding of the adjacent pipework and shall be built in at least two parts. Joints in the jacketing at pipe tees, branches, welds, etc. shall be sealed with stainless steel segmented flashing or preformed sections and metal seam sealant.


5.7.3 PIPING & EQUIPMENT GREATER THAN DN 900

Panels on vessels and large diameter equipment shall be held tight over the insulation by means of 316SS circumferential metal bands and attachment to insulation support rings. Panels shall have minimum overlaps of 100mm for vessels and 50mm or pipes. All overlaps, which are not subject to thermal expansion, shall be rendered watertight by use of a metal seam sealant.

Bands shall be positioned on all horizontal overlaps and at 300mm centers maximum. The bands shall be held in their relative positions with clips fitted to jacketing at suitable centers. Bands for equipment and vessels shall be at least 19mm wide x 0.5mm secured with wing type seals. Breather springs with flat bands shall be used where required for expansion or contraction.

Vessel head jacketing shall consist of preformed flat stainless steel sheets in a 'segmented' construction with all radial seams overlapping. The exact method of construction shall be made available to the Company for review.

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The Supplier shall propose details of methods of attachment and support of jacketing.

The vessels, nozzles and piping shall have removable plugs in insulation lining for facilitating of thickness check (ultrasonic) of wall during lifetime of vessel. Typical drawings for the same are enclosed. Plug shall be made with the compatible materials. For nozzle pocket (plug) shall be in four directions at the center of the nozzle.

6.0 INSULATION THICKNESS


The following insulation thickness are to applied to piping and equipment for the various applications:


MINIMUM THICKNESS OF INSULATION (MM)


Nominal Equipment Size or Diameter of Pipe	Cold to 10 ⁰ C	Acoustic	Burn* r Freeze Stabilization	20 to 70	71 to 100	101 to 200	201 to 300	301 to 400	401 to 500
DN40 & smaller	40	75	25	25	25	40	50	75	90
DN50 to DN100	50	75	25	25	40	50	75	100	120
DN150	50	75	25	25	40	65	75	115	140
DN200 & larger	65	75	40	40	40	80	100	145	170


* For line temperature greater than 301 deg. C, the burn protection insulation thickness shall be as specified for conservation of heat.

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<p>Where the insulation thickness requirement exceeds 80mm, the insulation shall be applied in not less than two staggered layers.</p> <p>7.0 INSTALLATION</p> <p>7.1 APPLICATION OF LOW TEMPERATURE INSULATION (CLASS C)</p> <p>7.1.1 ITEMS REQUIRING INSULATION</p> <p>All pipe, valves, flanges and fittings shall be insulated. Valves shall be insulated to the packing gland.</p> <p>Vessel and exchanger flanges, manhole covers, and all appurtenances shall be insulated. All attachments to the vessel or exchanger such as skirts, supports, ladder and platform clips, etc. shall be covered with insulation for a distance of three (3) times the basic insulation thickness, with the vapour barrier continuing and sealing to the metal.</p> <p>7.1.2 GENERAL APPLICATION</p> <p>Insulation shall not be applied until welds have been inspected, the piping system has been pressure tested, and all related piping and equipment has been painted,</p> <p>in accordance with the relevant Project Specifications.</p> <p>The insulation manufacturer’s installation recommendations shall be followed. In the event of conflict between manufacturer’s recommendations and this Specification, the former shall govern.</p>				
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<p>Piping, vessel and equipment insulation thickness shall be as shown in Section 6. The thickness listed is those required to prevent condensation forming on the insulation surface at 20⁰ C and a relative humidity of 85%.</p>				
<p>7.1.3 PIPING APPLICATION</p> <p>Contraction joints shall be provided on straight runs of piping at 10m intervals.</p> <p>Insulation supports shall be provided on vertical piping immediately above each pair of flanges and at contraction joints.</p> <p>Pipes, valves and fittings shall be fitted with preformed insulation and secured in place with bands placed on 230mm centers. Joints are to be snugly butted together and sealed with joint sealer. Voids between fittings and fitting covers shall be filled with glass fibre insulation.</p> <p>Insulation shall be installed around valves and flanges so as to allow removal and re-use without damage to the insulation or jacketing.</p> <p>Pipe, fittings and valves of insulated lines shall be weatherproofed with a metal jacket. The jacket shall be secured with bands on 230mm centers. A band shall be applied over each circumferential lap joint.</p>				
<p>7.1.4 EQUIPMENT APPLICATION</p> <p>Insulation shall be installed around access hatches, inspection hatches, manholes and exchanger tube sheet flanges, vents, drains and sample points so as to allow removal and re-use without damage to the insulation or jacketing.</p> <p>For vessels and tubular equipment DN900 and smaller, pre-formed pipe insulation shall be used. Insulation may be blocks, beveled lags, or curved segments for vessels and exchangers DN900 and larger. All such pieces of</p>				
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<p>insulation shall be beveled or shaped to fit closely to the contour of the equipment.</p> <p>Insulation on vertical vessels and tubular equipment shells shall be secured in place with bands on approximately 300mm centers. Where irregular surfaces make banding impractical, tie wire shall be used. The butt edge surfaces of all segments and block sections of the insulation shall be buttered with approximately 1.6mm coating of joint sealer prior to application. All voids shall be filled with glass fibre. Vertical contraction shall be provided by installing glass fibre in the space below the support ring and covering with additional insulation.</p> <p>Insulation on all horizontal vessels, tubular equipment and other cold equipment surfaces shall be secured in place with bands on approximately 300mm centers. Where irregular surfaces make banding impractical, tie wire shall be used. The butt edge surfaces of all segments and block sections of the insulation shall be buttered with 1.6mm coating of joint sealer prior to application. All voids shall be filled with mineral wool insulation.</p> <p>Heads on vessels and tubular equipment shall be insulated with blocks. The butt edges of all segments shall be buttered with approximately 1.6mm coating of joint sealer and segments secured with bands attached to a floating ring in the center and to a stainless steel band installed at the tangent point of the vessel head. Band spacing shall be 300mm maximum at the circumference of the vessel.</p> <p>All insulated surfaces shall be weatherproof with a metal jacket. Metal jacketing over the top of any piece of equipment or vessel shall overlap the wall jacket so as to shed water.</p>				
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7.1.5 VAPOUR BARRIERS

All vapor barriers shall be applied as a minimum of two coats of contrasting colors. Glass cloth shall be imbedded into the first layer whilst still wet. Following the manufacturer's recommended drying time, the second coat shall be applied to the appropriate wet film thickness. No glass mesh shall be visible after the application of the second layer.

Vapor barriers shall be applied as soon as practicable following the application of the insulating material to ensure the insulating material is kept dry.

Self-tapping screws shall not be used on metal jacketing for IL and IC services to prevent puncture of the vapor barrier. Pop rivets with a metal backing strip shall be used on insulation classes requiring a vapor barrier.

7.2 INSTALLATION OF HIGH TEMPERATURE INSULATION (CLASS H)

7.2.1 GENERAL


Insulation shall be applied after all pipe welds have been inspected and pressure tested, and the piping or equipment has been painted in accordance with the relevant Project Specification.

Insulation on equipment and piping shall be stopped far enough from flanges or mechanical joints to permit the removal of bolts without damage to the insulation. Insulation near the flanges or mechanical joints shall be beveled at 45° & weatherproofed.

Insulation manufacturers' installation recommendations shall be followed. In the event of conflict between any manufacturer's recommendations and this Specification, the former shall govern.

Piping, vessels and equipment insulation thickness shall be as shown in Section 6.

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7.2.2 PIPING APPLICATION

Single thickness sectional pipe insulation shall be applied with longitudinal joints staggered and shall be secured with wire ties on no more than 230mm centers. The insulation shall be applied with the joints tight and with all cracks and voids filled with insulating cement.

Screwed and welded fittings DN40 and smaller shall be insulated with insulating cement applied in 12mm layers to a thickness equal to that of the insulation on adjacent piping. Fittings DN50 and larger shall be insulated with preformed or mitered sectional pipe insulation, securely wired in place. Weatherproofing shall extend a minimum of 80mm under the adjacent pipe weatherproof jacketing joints between cement and jacketing shall be sealed with mastic to prevent water ingress.


Vertical piping shall include insulation supports at a maximum of 3m intervals. The material for the support ring shall be identical, or compatible to the material of the equipment to which they are attached in order to prevent galvanic corrosion.

Straight portions of insulated lines shall have metal jackets. All joints shall be lapped at least 80mm and arranged to shed water. The jacket shall be secured with bands on no more than 230mm centers. A band shall be applied over each circumferential lap joint.

Fittings DN50 and larger shall be covered with pre-formed metal jackets.

Where insulation is required around flanged joints in piping or vessel nozzles, the flanges shall be encased in an insulation-lined box as shown attached. Drainage shall be provided from the base of the box to provide indication of

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leakage. The Supplier shall ensure leakage of heat transfer fluid will not drain onto walkways, platforms or ladders.

7.2.3 VESSEL & EQUIPMENT APPLICATION

For vessels and tubular equipment DN900 and smaller, single-layer or preformed pipe insulation and cement shall be used as above. For larger diameter vessels and tubular equipment, blanket insulation shall be used.


Where the insulation thickness requirement (as shown in Section 6) exceeds 80mm, the insulation shall be applied in not less than two layers.

Blanket insulation on vertical vessels shall be applied with stagger joint arrangement. Top and bottom edges shall be securely tied over support rings with wire at no more than 300mm centers. Vertical and intermediate horizontal seams shall be laced together with gauge wire or hog rings at no more than 300mm centers. The insulation shall then be secured in place with bands spaced on no more than 300mm centers. Nozzle projections through insulation shall be adequately insulated.



Blanket insulation on horizontal vessels heaters and exchangers shall be applied in a staggered joint arrangement with all edges securely laced together with wire or hog rings at no more than 300mm centers. Nozzle projections through insulation shall be adequately insulated. Further securing shall be with bands spaced at no more than 300mm centers.


Heads of all vessels and tubular equipment shall be covered with preformed or segmented metal jackets. If a surface is so irregularly shaped that it cannot be jacketed, it shall have a topcoat of weather proofing mastic. Total finish coat shall be a minimum of 3mm thick when dry. Weatherproofing shall extend a minimum of 80mm under the adjacent jacketing.


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<p>Heavy fillets of mastic shall be applied to all corners and crevices where water is likely to collect. Mastic shall also be used as flashing at all possible sources of moisture penetration, such as intersections of insulation, nozzles and other protrusions through the surface coating.</p> <p>Straight shells of vertical vessels with diameters over DN900 shall be weatherproofed with metal jacketing as follows:</p> <ul style="list-style-type: none">• Securing of the jacket shall be with banding located over every circumferential lap of the jacket and on 300mm maximum centers. When expansion springs are required, the same number of expansion springs per band shall be used on all banding securing the jacket.• Corrugated sheets shall be applied with the corrugations positioned vertically with the vertical seams lapped a minimum of two corrugations and the horizontal seams lapped a minimum of 80mm, arranged to shed water.• Corrugated sheets shall be supported at the horizontal laps with stainless steel S-clips.• Straight shells of vertical vessels DN900 and smaller and all horizontal vessels and exchangers shall be weatherproofed with metal jacketing as follows:• Securing of jacketing shall be with banding located over girth seams and on no more than 300mm centers. <p>8.0 INSPECTION, TESTING & CERTIFICATION</p> <p>8.1 QUALITY ASSURANCE</p> <p>The contractor shall develop QA/QC procedures for the work, which shall include the inspection of all materials, preparatory works and application, before commencement, during progress and after completion of the insulation work.</p>			


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<p>Inspection shall be carried out after completion of any one stage and before commencement of the following stage.</p> <p>In progress fabrication and installation checks shall be conducted at various fabrication and installation phases, starting from material checks to final performance checks.</p> <p>For foamed-in-place insulation, the Supplier shall utilize control sheets for each pipe spool in order to assess the step-by-step inspection status on a continuous basis.</p> <p>8.2 INSPECTION OF MATERIALS</p> <p>Inspection of materials shall be made either at the supplier’s work or in the field.</p> <p>Laboratory test results for various insulating materials carried out by independent authorities must be available prior to commencement of the work together with the “Site Instruction Manual” complied by Supplier.</p> <p>A “Compliance Certificate” shall be prepared in case of various production batches to certify that the materials are in accordance with the technical specifications of the first production batch.</p> <p>8.3 PRE-INSULATION INSPECTION</p> <p>Equipment and piping surfaces shall be clean and dry and coated prior to insulation installation.</p> <p>Equipment and piping shall be hydrostatically tested prior to insulation installation.</p>				
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<p>Hangers and supports must be properly located and free from obstruction to allow sufficient space for support insulation application and normal expansion/contraction of the system.</p> <p>Positions for installation of the expansion/contraction joints in the insulation shall be clearly defined and marked.</p> <p>Heat tracing, electrical and all wiring tubing for instrumentation shall be installed, tested and accepted before insulation installation.</p> <p>8.4 FINAL INSPECTION & RELEASE</p> <p>Final inspection shall be conducted by all the parties involved at the point when installation is considered complete or as soon as possible thereafter. An agreed warranty or official release shall be determined at that time.</p> <p>The Supplier shall inspect the installation to determine that the insulation is of the proper thickness, that its materials, workmanship and finishes meet the specifications and that all the Sub-Supplier obligations have been met. Inspection checklists shall be completed and signed to record the inspection results.</p> <p>Infrared inspection techniques may be used after start-up to verify the proper performance of the insulation system.</p> <p>8.5 TESTING</p> <p>For each batch of insulation supplied to the job site, the following tests have to be carried out a minimum of three times during the usage of this batch:</p> <ul style="list-style-type: none">Density as per ASTM D1622.Closed cells content as per ASTM D2856				
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<ul style="list-style-type: none">Thermal conductivity as per ASTM C516 at 24 deg.C mean temperatureCompressive strength as per ASTM D1621Flammability in accordance with ASTM D3014 <p>Results of the tests shall be recorded for two samples of foam from each batch of chemicals. Batches shall be identified by serial number and date.</p> <p>9.0 APPLICATION DETAILS</p> <p>Typical sketch are attached for following details</p> <p>9.1 Pipe Insulation – Class H</p> <p>9.2 Pipe Insulation – Class C</p> <p>9.3 Termination of insulation on pipe work detail</p> <p>9.4 Typical detail for un-insulated flanged valve class H insulation</p> <p>9.5 Valve insulation class C</p> <p>9.6 Vertical support for class cc insulation</p> <p>9.7 Expansion/contraction joints</p> <p>9.8 Insulated support for vertical insulated pipe</p> <p>9.9 Typical detail of flanged joint class H</p> <p>9.10 Vessel support, flashing & weatherproofing details – class H Insulation</p> <p>9.11 Insulation support ring detail class H Insulations</p>				
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<div>9.12 Vessel support, flashing & weatherproofing details – class C Insulation</div> <div>9.13 Typical Vessel nozzle flanged detail for class C insulation</div> <div>9.14 Valve box cover construction</div>				
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9.1 PIPE INSULATION – CLASS H

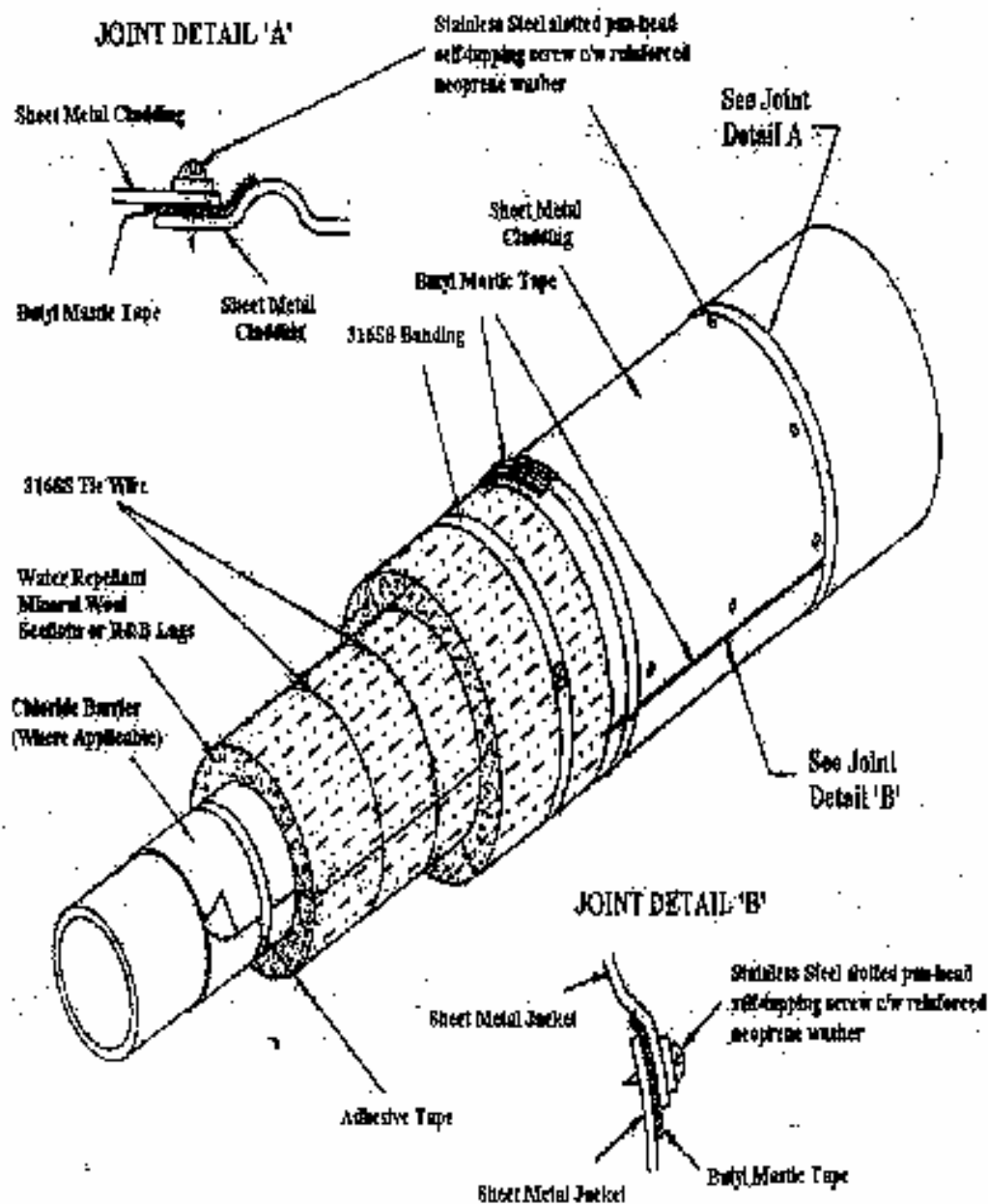



FIGURE 1 – Typical method of installing insulation for Class H

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9.2

PIPE INSULATION – CLASS C:

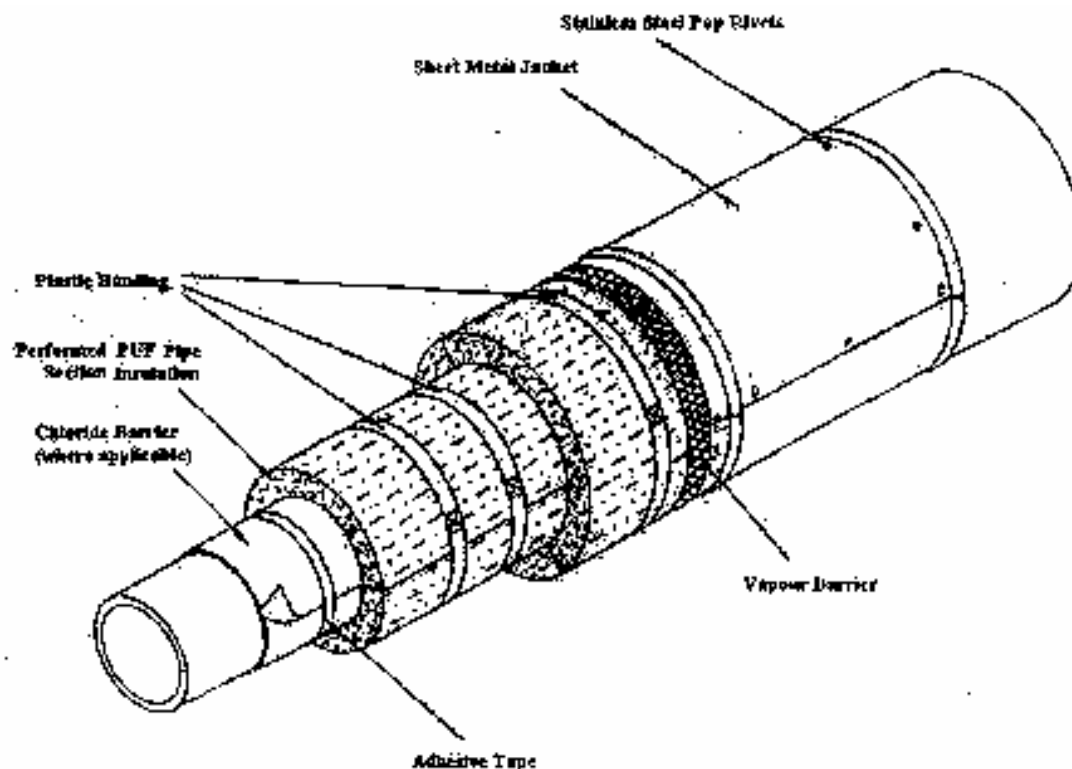



FIGURE 2 – Typical method of installing insulation for Class C

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9.3 TERMINATION OF INSULATION ON PIPEWORK

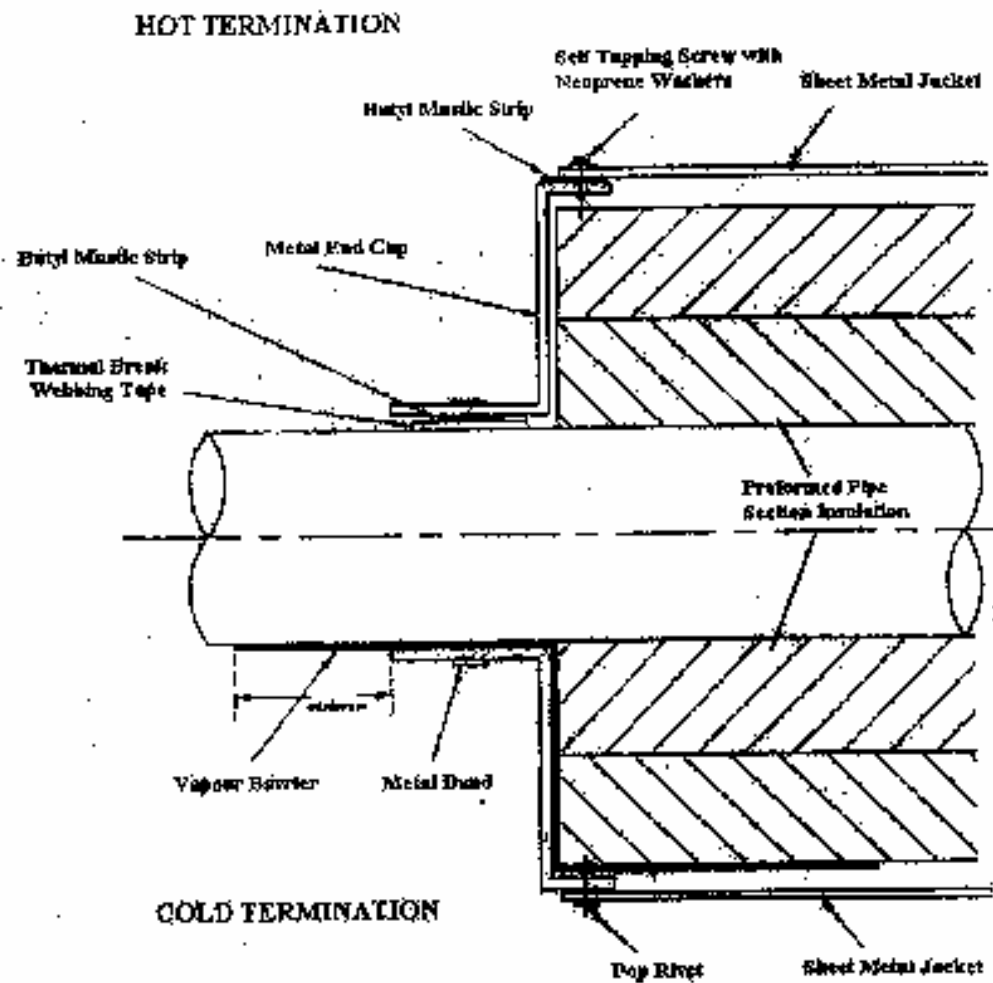



FIGURE 3 – Termination of insulation on pipework detail

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9.4 VALVE INSULATION CLASS H:

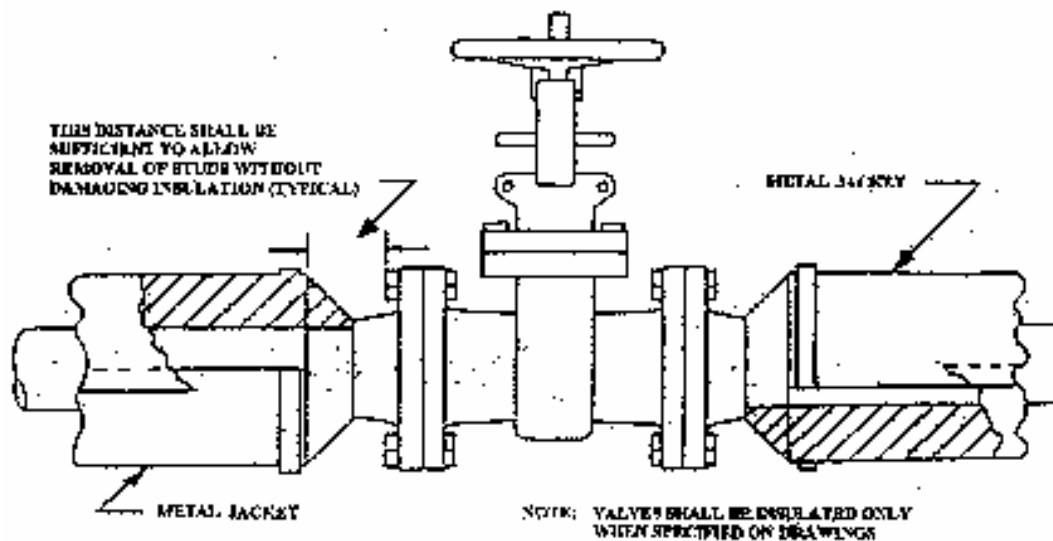



FIGURE 4 – Typical detail for uninsulated flanged valve Class H insulation

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9.5 VALVE INSULATION CLASS C:

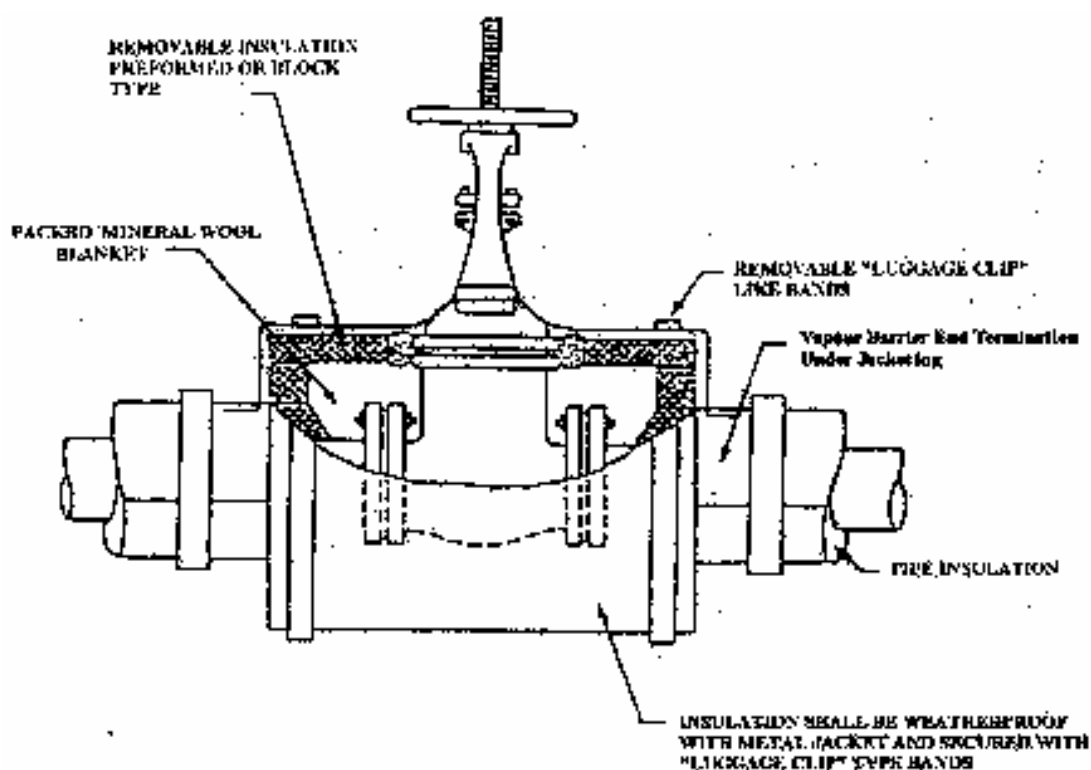



FIGURE 5 - Typical detail of insulated flanged valve for Class C insulation

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9.6 VERTICAL SUPPORT FOR CLASS C INSULATION:

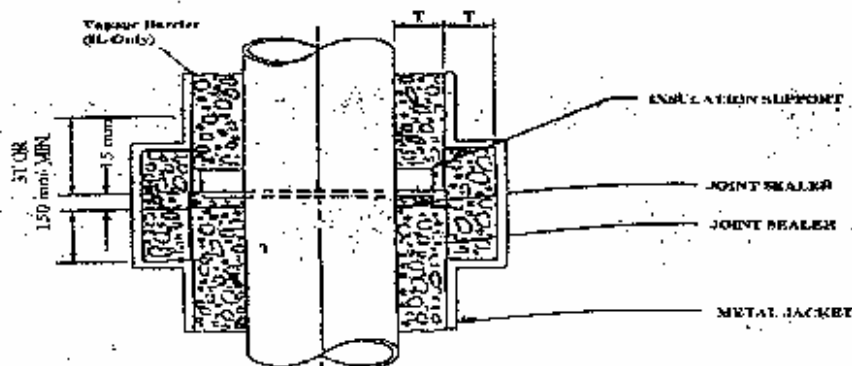



FIGURE 6 – Vertical support for Class C insulation

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9.7 EXPANSION/CONTRACTION JOINTS

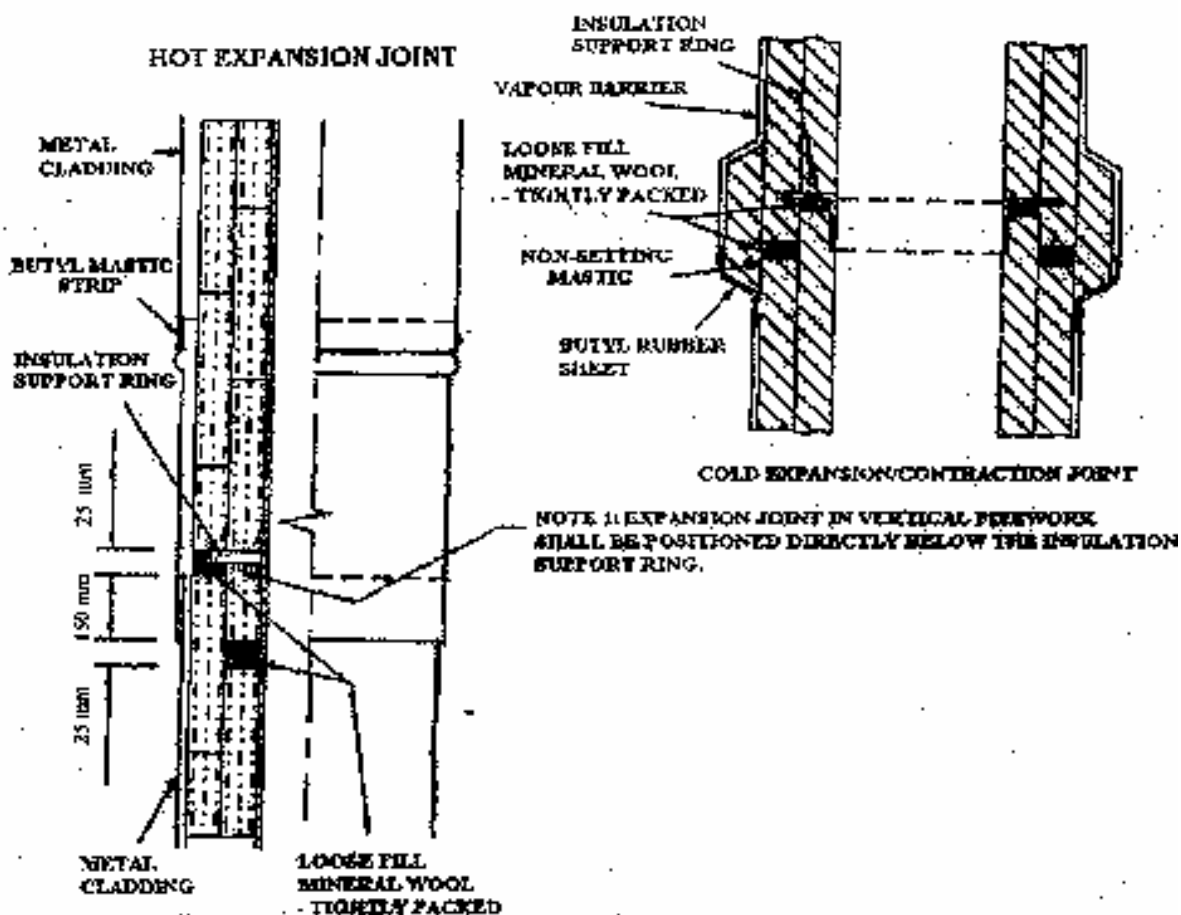



FIGURE 7 – Expansion/Contraction joints

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9.8 INSULATED SUPPORTS FOR VERTICAL INSULATED PIPE:

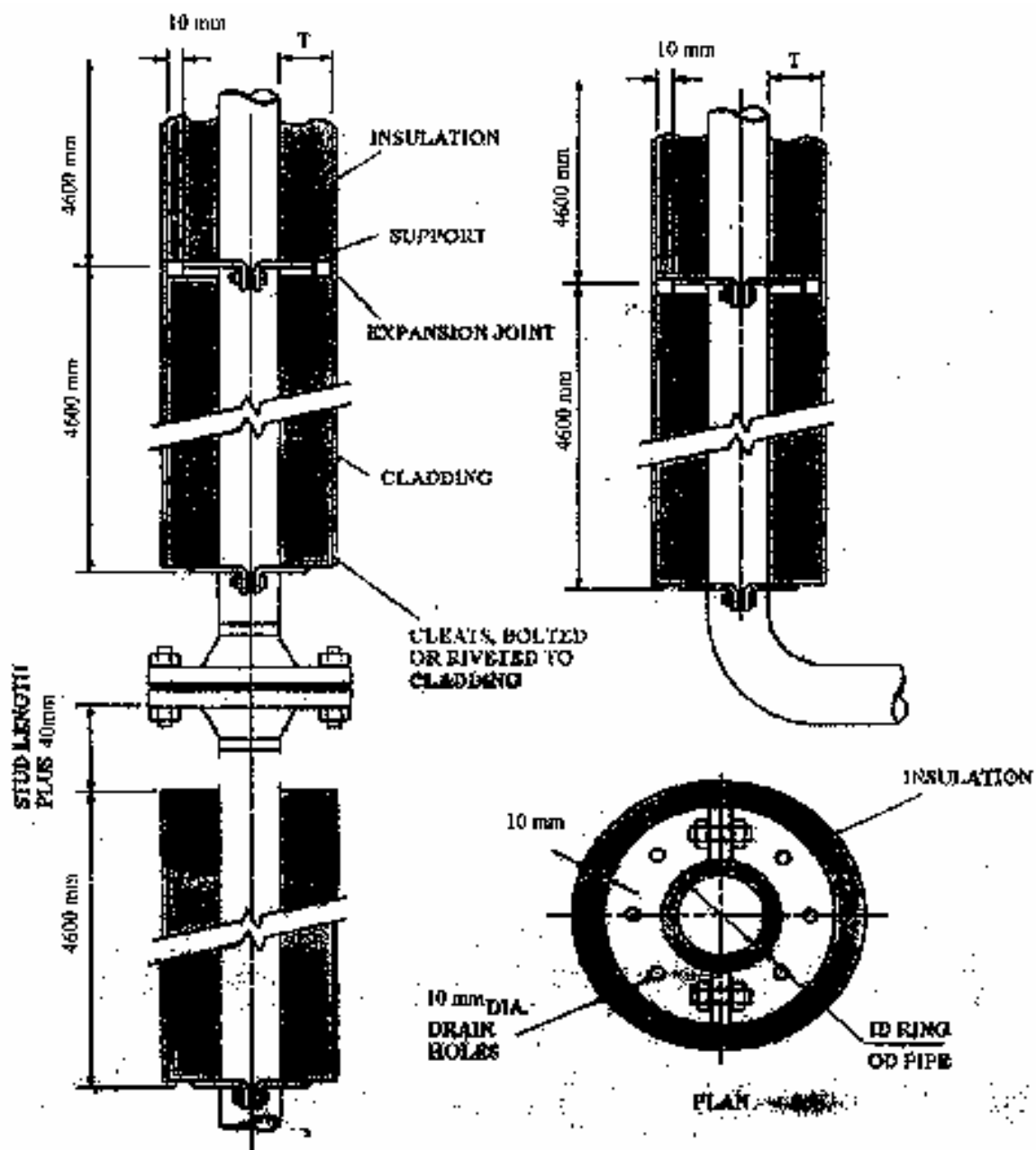



FIGURE 8 – Insulated supports for vertical insulated pipe

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9.9 TYPICAL DETAIL FOR FLANGED JOINT CLASS H:

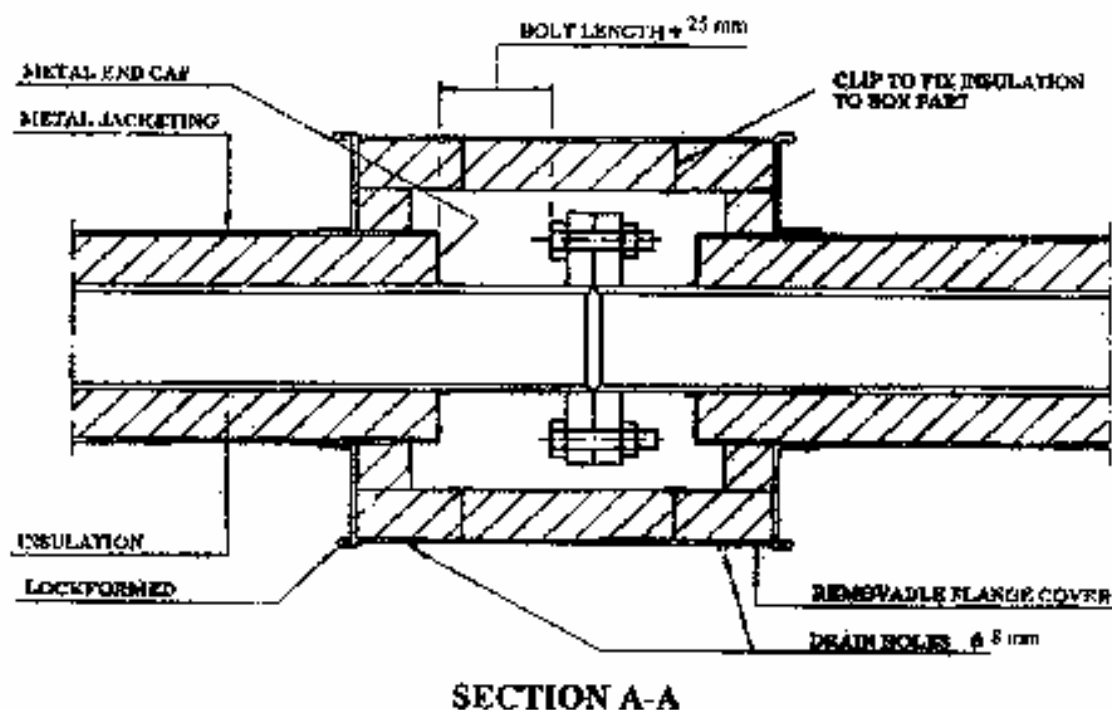



FIGURE 9 – Typical detail for flanged joint Class H

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9.10 VESSEL SUPPORT, FLASHING & WEATHERPROOFING DETAILS – CLASS H INSULATION

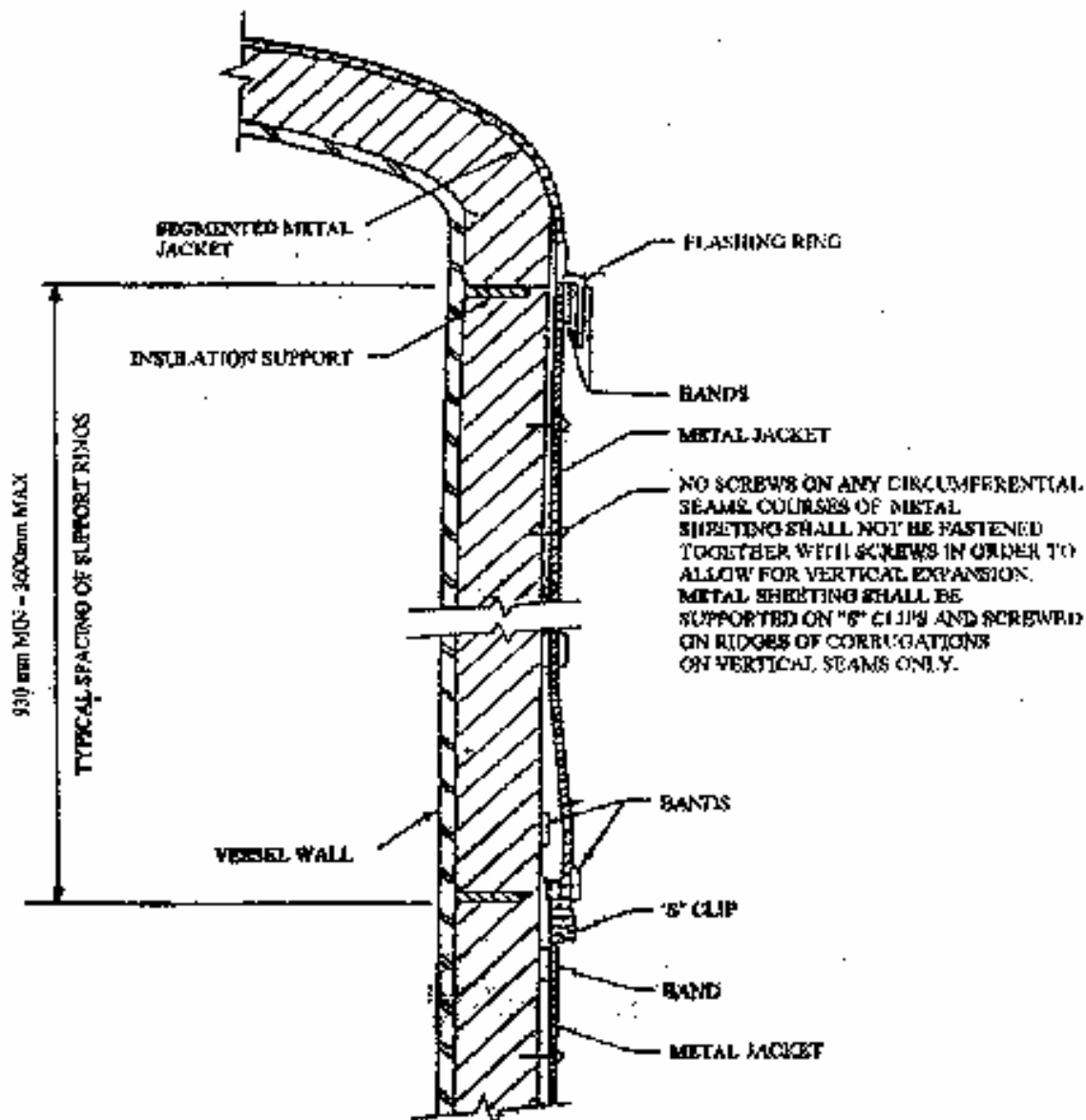



FIGURE 10 – Vessel support, flashing and weatherproofing details – Class H insulation

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9.11 INSULATION SUPPORT RING DETAIL CLASS H INSULATION

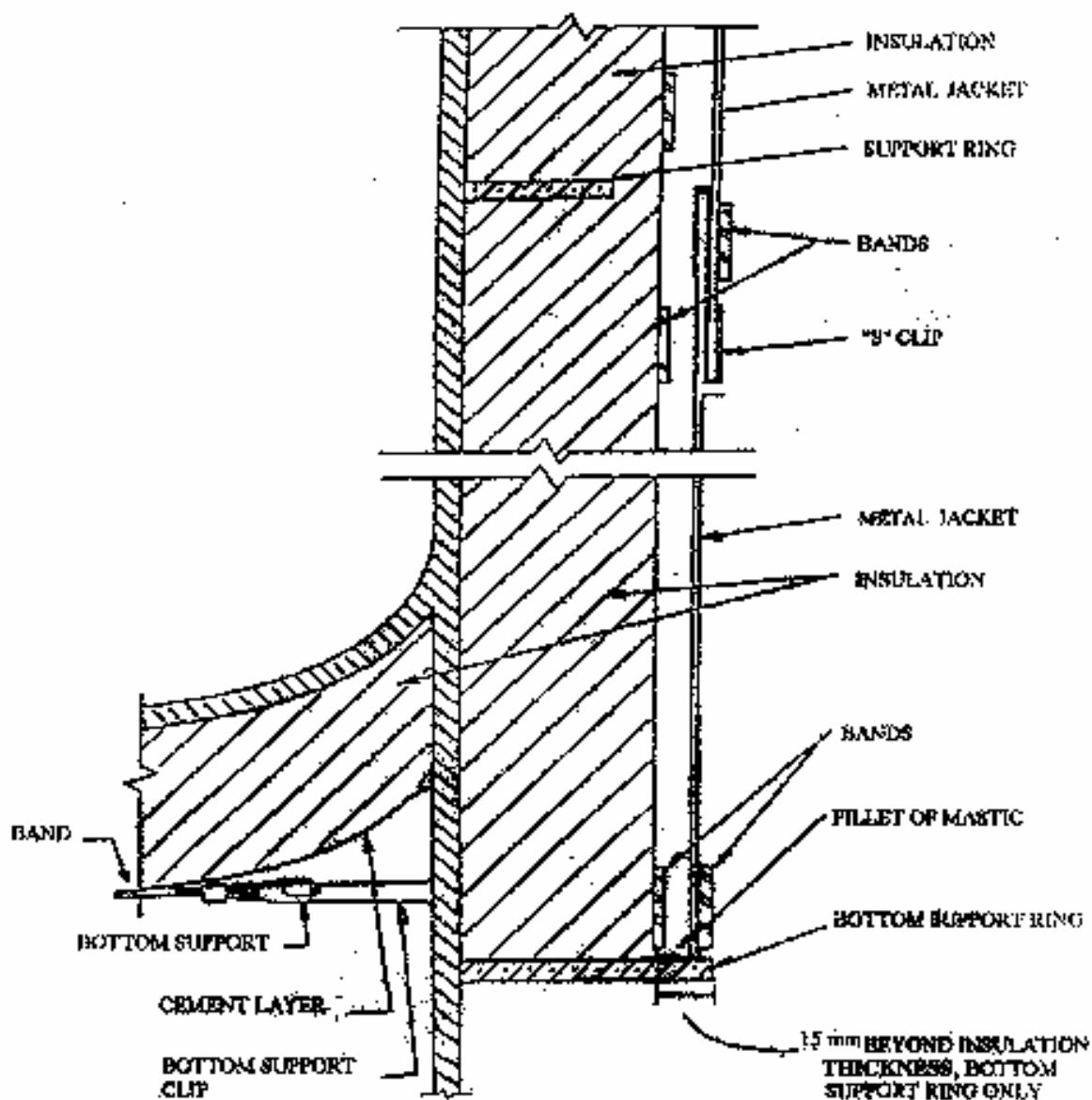

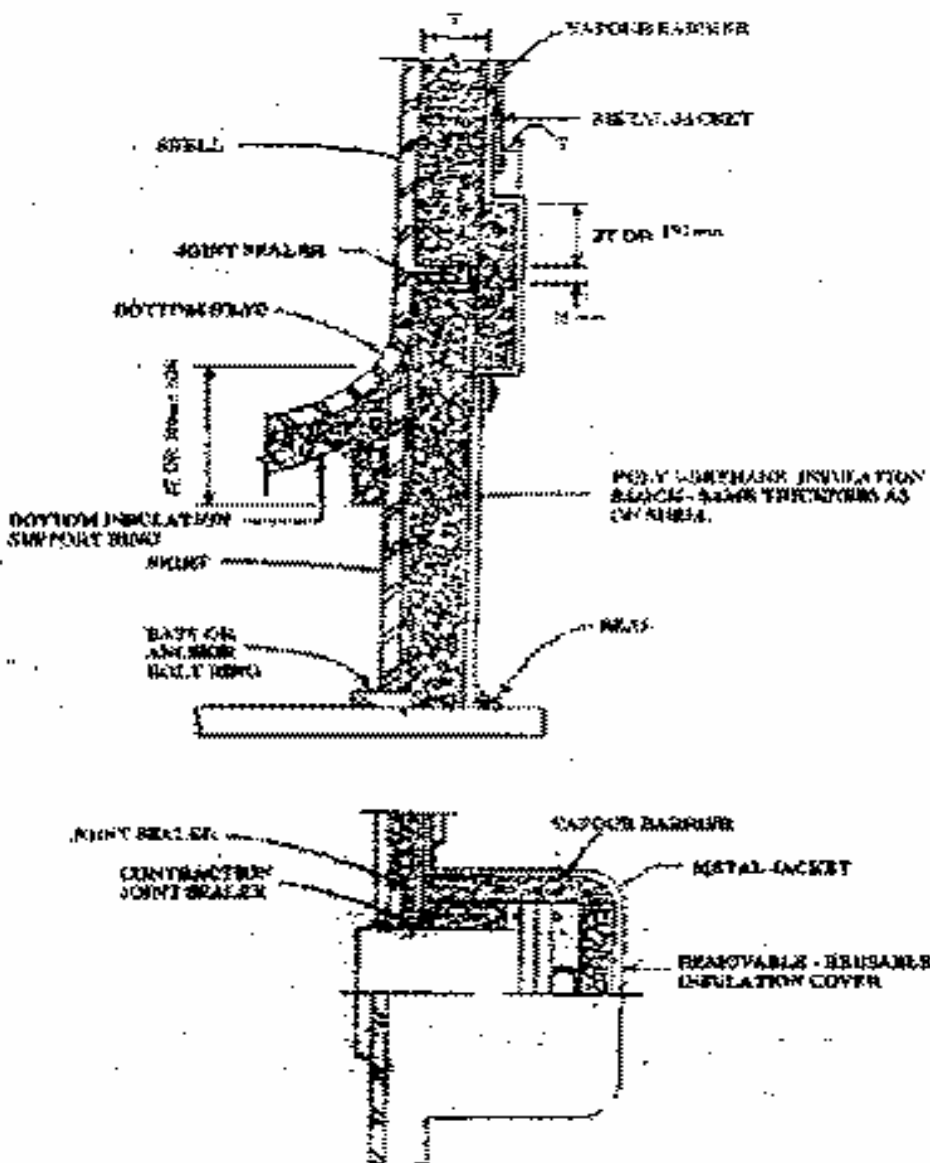



FIGURE 11- Insulation support ring detail Class H insulation

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<div style="text-align: center;">  </div> <p>9.12 Vessel support, flashing & weatherproofing details Class C insulation (FIGURE 12)</p>			

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9.13 TYPICAL VESSEL NOZZLE FLANGE DETAIL FOR CLASS C INSULATION

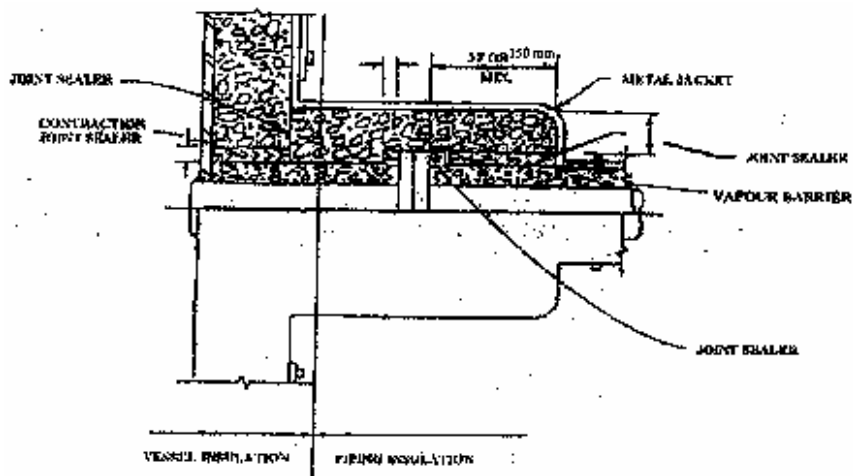



FIGURE 13 – Typical vessel nozzle flange detail for Class C insulation

Format No	Ref. Proc. No	Issue No	Rev No	Rev. Date
ODS/SOF/004B	ODS/SOP/008 to 015	02	01	01/08/2006

	DESIGN DIVISION Engineering Services ISO-9001:2000	FUNCTIONAL SPECIFICATION FOR INSULATION OF PIPING & EQUIPMENT	
			Spec No. 2006
			Rev. No. 02
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9.14 VALVE BOX COVER CONSTRUCTION:

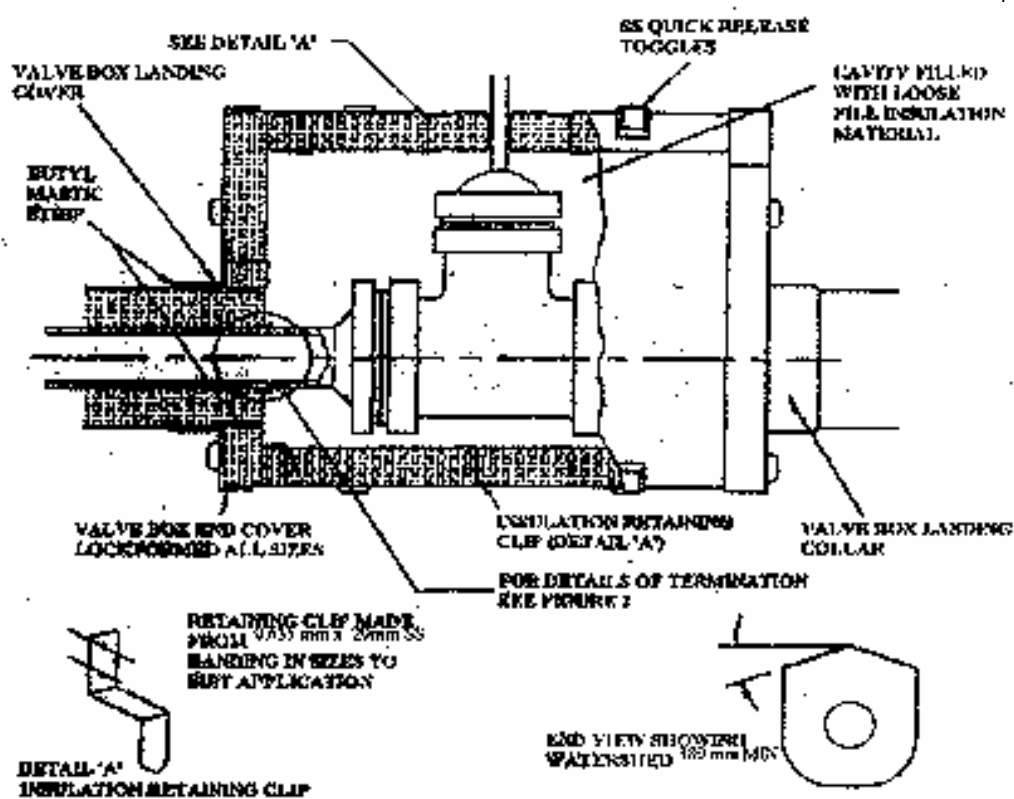


FIGURE 14 – Valve box cover construction

Format No	Ref. Proc. No	Issue No	Rev No	Rev. Date
ODS/SOF/004B	ODS/SOP/008 to 015	02	01	01/08/2006

FUNCTIONAL
SPECIFICATION
FOR
INSULATION OF
PIPING &
EQUIPMENT

Spec No. 2006

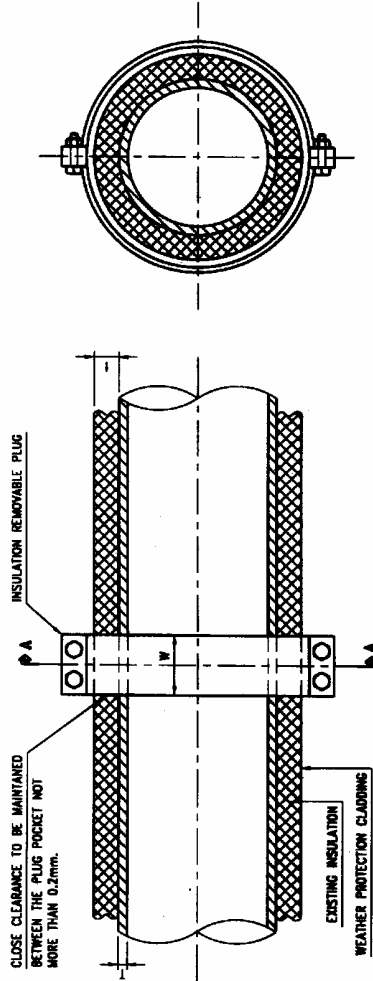
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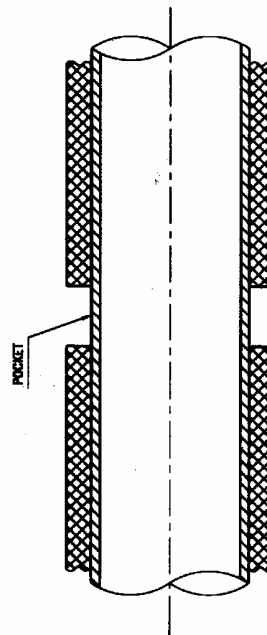
NOTES:-

- 1) DENSITY OF INSULATION FOR REMOVABLE PLUG AS FOLLOWING :-
MINERAL WOOL 150kg/m³
CALCIUM SILICATE 250kg/m³
POLY URETHANEFOAM 50-40kg/m³
- 2) THICKNESS OF CLADDING SHALL BE AS FOLLOWS
AL-22 SWG AND SS-24 SWG.
- 3) SCREWS FOR SECURING CLADDING SHALL BE OF SELF TAPPING TYPE WITH NEOPRENE WASHER UNDER THE HEAD.
- 4) BOLTS & NUTS OF THE REMOVABLE PLUG SHALL BE SAME MATERIAL AS THAT OF CLADDING.
- 5) T = PIPE WALL THICKNESS
- 6) t = THICKNESS OF INSULATION
- 7) W = WIDTH OF INSULATION PLUG
(50mm FOR 'Y' < 50mm)
(75mm FOR 'Y' < 50mm)
- 8) LOCATION AND NUMBER OF REMOVABLE PLUG FOR INSULATION JOINT SHALL BE FINED UP DURING DETAILED ENGINEERING.



SECTION: A-A

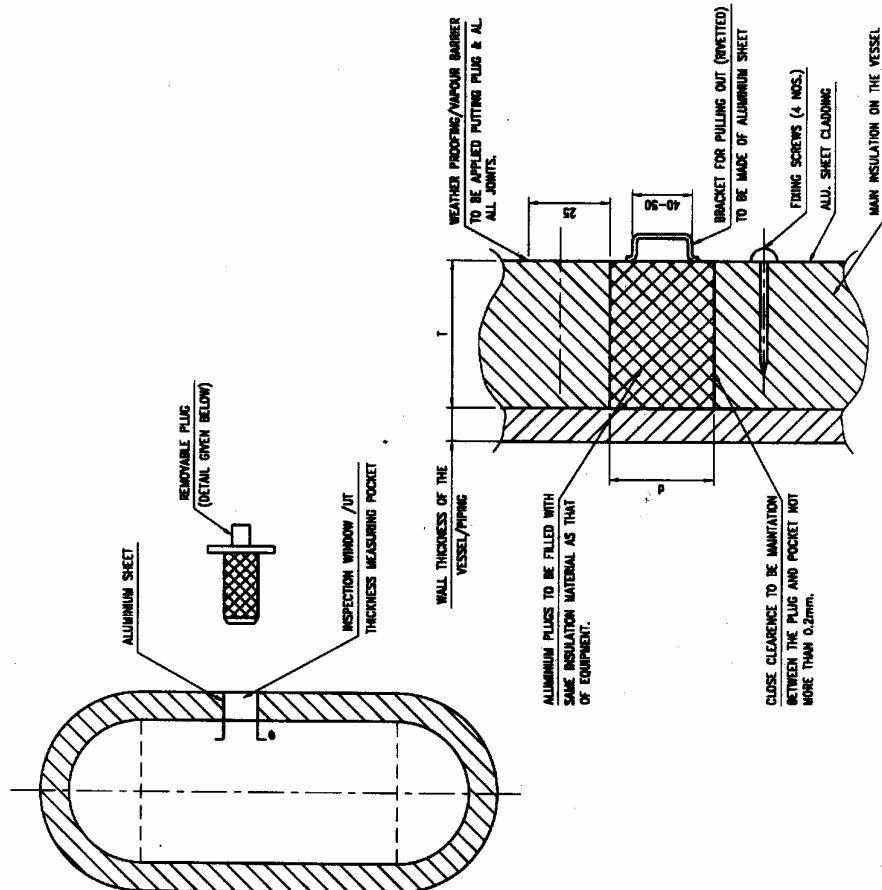
PIPE SECTION SHOWING INSULATION AND REMOVABLE PLUG



PIPE SECTION AFTER REMOVAL OF INSULATION PLUG

REMOVABLE PLUG FOR INSPECTION WINDOW HAVING ALUMINIUM SHEET (CLADDING)

- NOTES:-**
- 1) ALL DIMENSIONS ARE IN MM.
 - 2) T - THICKNESS OF INSULATION
d - DIA OF PLUG
d - 50 (FOR T < 50)
d - 75 (FOR T > 50)
 - 3) LOCATIONS AND NUMBERS OF REMOVABLE PLUG FOR INSPECTION POINT SHALL BE FIRMED UP DURING DETAIL ENGINEERING.



ate