TECHNICAL SPECIFICATION

FOR

THERMAL INSULATION

(GENERAL REQUIREMENT)
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1.0 GENERAL

1.1 SCOPE
This standard covers the requirement for supply and application of materials for thermal insulation of equipment, piping and other items.

1.2 REFERENCE STANDARDS

- IS 14164: Code of Practice for Industrial Application and finishing of thermal insulation material at temperature -80°C and up to 750°C.
- IS 737: Wrought aluminium and aluminium alloys, sheet, strip
- IS 1254: Specification for corrugated aluminum sheet
- TS 6701: Thermal Insulation – Hot service
- TS 6702: Thermal Insulation – Cold service
- ASTM C-680: Standard Practice for Heat Loss or Gain and Surface Temp.

1.3 Deviations: Should unforeseen difficulties arise to comply with requirements of this standard.

Alternative material and application techniques superior to the requirements of this standard be submitted with complete details for approval of owner.

In case of contradiction between requirements of this standard and the NIT/Work order, the later will be followed.

1.4 LIMITATIONS

Temperature Limits.

This standard deals with insulation applied externally on piping equipments etc. as per the table below:

<table>
<thead>
<tr>
<th>Maximum Operating Temperature</th>
<th>Type of Insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>60°C to 750°C for C.S., A.S. &amp; S.S.</td>
<td>HOT</td>
</tr>
<tr>
<td>-180°C to 20°C</td>
<td>COLD</td>
</tr>
</tbody>
</table>

1.5 THICKNESS DESIGN BASIS

Thickness calculation method as per procedure given in ASTM C-680

1. Hot Insulation
   - Design Ambient Temperature: 35°C
   - Design Surface Temperature: 60°C
   - Permissible Heat Loss: 150 kcal./m2 hr.
Permissible Wind Velocity Outside : 1 m/sec
Permissible Wind Velocity Inside : 0.25 m/sec

2. Cold Insulation
   Design Ambient Temperature : 35°C
   Design Surface Temperature : 2°C below ambient/ 0.5 Deg C above the Dew Point
   Permissible Heat Gain : 10-12 kcal/m² hr
   Relative Humidity : 85%
   Permissible Wind Velocity Outside : 1 m/sec.
   Permissible Wind Velocity Inside : 0.25 m/sec.

1.6 GENERAL REQUIREMENTS.

1.6.1 Information to be supplied to contractor

- Material of construction / dimension of equipments / pipes required to be insulated.
- Temperature
- Location of equipment (Indoor/Outdoor/Elevn.)
- Requirement of removable box type insulation if any
- Special requirements if any regarding type of insulation material and other properties.
- These information shall be supplied in form of insulation schedule.

1.6.2 STORAGE OF MATERIAL

Insulation material shall at no time be stacked directly on the ground; instead it will be stored at a level higher than ground level. It should not only be covered by tarpaulin but other effective protections against weather are also to be provided. The contractor shall provide a properly covered storage to the satisfaction of engineer-in-charge (Refer IS: 10556).

1.6.3 HYDROSTATIC TEST FOR PIPES

Before taking up insulation job on piping or vessels it shall be ensured that hydrostatic test of the concerned equipment / piping is completed. Where it is felt necessary to take up the insulation job before such testing are performed all welded and mechanical joints shall be left un-insulated for a length of at least 150mm on either side of the joint.

1.6.4 PROTECTION OF INCOMPLETE JOBS

Any part of insulation job which is not provided with final weather proofing will be adequately protected by means of tarpaulins and other aids. After the day’s work similar protection should be provided for the partially completed jobs to be continued the next day to avoid any absorption of rain / moisture during the night.

2.0 INSULATION SUPPORTS (CLEATS) TO BE PROVIDED BY EQUIPMENT SUPPLIER

Suitable supports (cleats) in the form of rings, lugs, studs or pins shall be provided on equipment by equipment supplier as per Annexure-I. However should any additional supports or anchorage be felt necessary by the insulation contractor the same will be recommended by
them to the Engineer-in-charge for his approval before installation. These will be installed by
the contractor free of any extra cost.

3.0 MATERIAL REQUIREMENTS

3.1 INSULATION MATERIALS

3.1.1 General

- Whenever reference to any Standard is made it is presumed that the latest revision as
on date should be considered unless otherwise specified.

3.1.2 Specification and other requirements

Specification and other requirements will be as per TS-6701 for Hot Service and TS-6702 for Cold Service.

3.2 AUXILIARY MATERIALS FOR CLADDING

a) Aluminium Cladding
   - Horizontal Vessels
     Aluminium sheet as per IS-737 (designation 31000, condition H3 for flat sheet & 31500/51300, H4 for corrugated sheets)) shall be used for cladding. Insulation on overall piping, vessel and equipment, cladding will be coated on the side in contact with insulation with 3 mil thick polysurlyn film.

     Specifications for aluminium Cladding material shall be as follows:

     | Material                                           | Reference Code / Standard | Thickness       | Application                                      |
     |----------------------------------------------------|---------------------------|-----------------|-------------------------------------------------|
     | Aluminium sheet with applied moisture barrier      | IS : 737 / ASTM C-653     | 22 SWG (0.71mm) | For all piping, tanks, vessels, heat exchanger, flanges, valves, equipments etc. upto 24" outside dia |
     | of 3 mil thick Polysurlyn coating                   |                           | 20 SWG (0.91mm) | For piping, tanks, vessels, heat exchanger, flanges, valves etc. above 24" outside dia |

     Removable cover for flanges, valves etc. shall be made out of 1.0mm thickness Aluminium Sheets.

   - Vertical Vessels
     Cladding material for vessels with insulation O.D. 900 mm and less shall be same as for pipes. For vessels above 900 mm insulation O.D. 22 SWG corrugated aluminium sheet as per IS-1254 or ribbed aluminium sheet 32 mm x 5 mm deep corrugations may be used.

b) Screws
   Screws used with aluminium sheeting shall be of self tapping type, A No.8x12mm long cadmium plated / SS of high quality at intervals of 150mm.
e) **S-Clips.**
   Aluminium, 20x1.5mm or 25mm wide stainless steel banding bent to form a shape of “S” provide a minimum lap of 50mm.

d) **Bands for securing cladding.**
   Aluminium of dimensions 12mm width x 0.56 mm thick (24 SWG) for pipes. Stainless Steel bands Type 304, 0.4mm thick x 13mm wide for large dia pipes (above 24”) and cylindrical equipment up to outside dia 900mm, 0.5mm thick x 19mm wide for cylindrical equipment above 900mm outside dia meter.

e) **Quick release clips for removable covers.**
   Suitable quick release clips will be made as shown in fig. 7 from 20Cm width x 20 SWG aluminium sheet and some fig.7 from 20mm width x 20 SWG aluminium sheet and some suitable rectangular ring.

f) Sealant for cladding joints with MAS 94/ Foster 91-44 Mastics or equivalent.

g) **Rivets**
   Aluminium ‘POP’ blind eye type / Stainless Steel 9.5mm long x 5mm dia meter.

4.0 **INSPECTION.**

4.1 **General**
   All insulation material shall be subject to inspection by owner before application. In case of doubt Owner’s representative will have the liberty to get the material tested by the contractor at any approved test laboratory. Any material not meeting specified requirement will be rejected and the rejected material shall have to be replaced by the contractor with material of specified type and quality. Insulation found to be improperly installed shall be removed and reinstalled properly.

4.2 **Inspection**
   Inspection of materials and / or installation by owner shall not relieve the contractor of his responsibility to ensure that finished insulation conform to specified requirements and is free from defects, contractor shall correct any defects due to poor workmanship.

4.3 **Test for thickness**
   Test for thickness shall be carried out after application. Thickness at any point shall not be less than 2mm than the indicated thickness and excess thickness up to 115% of the specified thickness is Permissible.

4.4 **Testing for bulk density**
   Testing of bulk density of the insulating materials shall be carried out before the application of insulation. This should be within ± 15% of the specified value. Test location shall be selected by owner and its repair shall be done by contractor.
5.0 APPLICATION

5.1 General
Insulation thickness shall be as specified in the insulation schedule/specification/isometric drawings prepared for equipments/piping. Wherever the thickness is not indicated the same may be selected from TS-6701 & 6702.

Insulation for pipes should be in preformed shape in two halves upto 14”nb dia meter for first Layer and beyond that mattress to be used.

5.2 No. of Layers
When insulation thickness exceeds 75 mm, the insulation shall be applied in multi-layers with all joints staggered. Each layer will be separately secured with metallic bands/wires.

No. of layers shall be as follows:

<table>
<thead>
<tr>
<th>Insulation Thickness</th>
<th>No. of Layers (Min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 75mm</td>
<td>1 Layer</td>
</tr>
<tr>
<td>76 to 150 mm</td>
<td>2 Layers</td>
</tr>
<tr>
<td>151 and above</td>
<td>3 Layers or more.</td>
</tr>
</tbody>
</table>

5.3 GENERAL REQUIREMENTS

5.3.1 Surface preparation

- Surface to be insulated shall be cleaned of all dirt. Oil loose scale etc. by wire brushing. All insulation shall be applied at ambient temperature and both the metal surface and insulation material shall be dry prior to application of insulation.

- The surface for cold insulation shall be then coated with a bitumen emulsion or a mastic coating.

- If the vessel is made of stainless steel, it shall be wire-brushed with stainless steel wire brush.

5.3.2 Expansion / contraction joint

Depending on the type of insulation used the operating temperatures and nature of the material it may be necessary to provide expansion/contraction joints on vessels or pipes to prevent the insulation from rupturing/buckling when the surface expands/contracts. It is recommended that expansion joints will be provided in the intervals as follows:

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Intervals</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>201°C to 300°C</td>
<td>4M Interval</td>
<td>This is not reqd. where flexible wool is used as insulation</td>
</tr>
<tr>
<td>301°C to 400°C</td>
<td>3M Interval</td>
<td></td>
</tr>
<tr>
<td>401°C &amp; above</td>
<td>2M Interval</td>
<td></td>
</tr>
<tr>
<td>Cold service</td>
<td>5M Interval</td>
<td></td>
</tr>
</tbody>
</table>

- Expansion joints in horizontal vessel insulation shall be close to fixed support saddle (s)
- At the expansion joint there shall be a complete out through the insulation.
- On piping, expansion joints shall be provided on both sides and within 900 mm of each bend (within the above guide line for interval).
- The cut out in insulation shall be at-least 25 mm wide and dry filled with loose insulation.

5.3.3 Filling of Voids

All voids, irregularities and joints shall be packed with loose insulation material/insulation cement trowelled smooth whichever is applicable.

5.4 INSULATION PROCEDURE

5.4.1 Insulation procedure shall be as per TS-6701 & TS-6702 for hot & cold service respectively.

5.5 Metal Jacketing

a) General

- All joints shall have minimum 75 mm overlap arranged such as to shed water. For horizontal vessels and pipes, horizontal overlap shall be installed within 5-6-7 O - clock position.

- Jacket shall be secured to the spacer rings and to itself by self tapping screws, described earlier, at a pitch of 150 mm for longitudinal joints and 100 mm for circumferential joints or by metal bands.

- All outlets and cut outs shall be cut as close as possible to nozzles, manholes, supports, branch connections etc. and sealed weather proof. (Ref Fig.3).

- At all joints, edges of the jacket will be grooved.

- All openings through insulation finish shall be flashed weather tight by vapour seal mastic, particularly where connections are not insulated.

- Insulation of flange assemblies, valves, manholes hand-holes removable heads of heat exchangers etc. shall be of removable type.

b) Horizontal Vessels

Jacketing for dished heads shall be fabricated in form with the radial overlapped joint (with adequate overlap) secured by self tapping screws @100 mm pitch where it is not possible, suitable metal bands shall be provided as approved by Engineer-in-charge. The ends shall be secured to the vessels sheeting (Cylindrical shell) by circumferentially tensioned bands and reinforced by self tapping screws set at 150 mm pitch.

c) Vertical Vessel

Corrugated / Ribbed aluminium sheeting shall be adequately rolled and installed parallel to the axis of the vessels as shown if fig. 4 and shall be secured to the insulation supports available on the vessels. Otherwise they shall be secured to themselves and rings provided by the contractor by self tapping screws. All individual sheets shall be overlapped by at least 75 mm on longitudinal joints and 2 corrugations on circumferential joints, to shed water wherever possible. All joints shall be staggered.
Circumferential end laps shall be supported with S-clips so that top section can rest on the lower one and top section.

-**Heads**
  
  Guide lines for horizontal vessels will be followed.

d) Corrugated / Ribbed aluminium sheet shall be fixed with the help of suitable pop rivets on the sides of the tank. Flat sheet will be used for top of tank. Sheet to sheet longitudinal joints shall be sealed only with pop rivets and no screws shall be used. Circumferential joints need not be riveted.

e) **Heat Exchangers**
  
  Guide line for vessels shall be followed.

f) **Machineries like pumps. Turbines, Compressors etc.**
  
  Wherever sheeting will be required it will be specifically asked for and contractor shall submit his proposed details for each equipment for approval of the Engineer-in-charge.

g) **Spherical Vessels**
  
  Guide lines for horizontal vessels shall be followed.

h) **Piping Items:**

- **Elbows / Bends**

  On piping cladding shall be supplied with longitudinal and circumferential laps of 50 mm and secured by aluminium bands spaced 300 mm centres or by aluminium self tapping screws at 150 mm canters. Longitudinal laps on horizontal pipes shall be arranged minimum 300 below the horizontal centre line to shed water. Circumferential lap joints should be sealed with suitable adhesive sealer.

  Cladding of insulation over large bends shall be as per Fig.5. Cladding of insulation over elbows shall be spun aluminium jacket and the joint with cladding of adjacent straight pipe shall be flashed and banded as shown in fig. 5 (a).

  - **Valves & Flanges.**

  Where flanges and valves are not insulated, the end of insulation on both sides shall be suitably covered as shown in Fig.6 when these are required to be insulated they will have removable box or pad insulation as indicated on Fig. 7,8,9 & 10.

  Cladding of insulation over valves and flanges shall be prefabricated in half-sections and screwed together. The ends joining adjacent pipe jacket shall lap 50 mm and be sealed weather tight with reinforced mastic. In case of pad insulation, the pads will be tied tightly over the valves and flanges with suitable arrangements.

### 6.0 MEASUREMENT OF INSULATION WORK.

6.1 Measurement of insulation works shall be as per IS: 14164.
7.0 GUARANTEE

- The guarantee test shall be carried out when plant is fully operative.

- The surface temperature, reading shall be taken at six points per pipe line and at each point it shall be taken on all four sides in top, bottom, left side and right side.

- The above reading shall be taken at 2 hours intervals and shall be taken for 18 hours starting from 11 a.m. in the morning.

- Simultaneously ambient temperature shall be taken as per IS: 14164.

- A graph shall be plotted between ambient and surface temperature reading.

- From this graph the surface temperature against ambient temperature shall be found out.

- The contractor is required to guarantee the surface temperature of 60 °C (max.) for equipments and piping in case of Hot Insulation. For cold insulation of equipments and piping, the difference between skin temperature and ambient temperature shall not exceed 2 °C.

Ambient temperature and surface temperature shall be measured by duly calibrated instruments provided by CONTRACTOR.

The CONTRACTOR shall undertake immediate replacement of insulation material damaged in transit, storage or application.

Insulation contractor shall produce required number of copies of test certificates as per relevant IS/ASTM Standard. Insulation contractor shall certify that:

- All materials are new and unused and are as per specifications called for in this standard.

- The operating thermal conductivity shall be as specified.

- The workmanship shall be in accordance with good practice.

- Other terms & conditions of the guarantee clause shall be as per NIT / purchase order.
GENERAL REQUIREMENT

NO CONNECTION BETWEEN SHEETS TO ALLOW FOR EXPANSION. PROVIDE SIMILAR EXPANSION JOINT IN EACH SUPPORT.

EXPANSION JOINT - BLANKET INSULATION WITH METAL CLADDING

FIG. - 1

GROOVED AND LAPPED

SELF TAPPING SCREW

LOOSE INSULATION

OUTER ALUMINIUM WEATHER PROOFING

INSULATION MATTRESS

MAIN PIPE

Ceramic Fibre Paper 3 mm THK

Ceramic Fibre Paper 3 mm THK

INSULATION EXPANSION JOINT FOR RIGID MATERIAL FOR PIPES

FIG. - 2
TECHNICAL SPECIFICATION
THERMAL INSULATION
GENERAL REQUIREMENT

**FIG. 3a**

- **ITEM F-2** (TWO PIECES REQD.) (F-2 FLASHING MATERIALS)
- BAND OR FLASH
- INSULATION
- VESSEL WALL

**FIG. 3b**

- TYPE-A FLAT HEAD ALUMINIUM SCREWS WITH NEOPRENE WASHER
- SEAL WITH ALUMINIUM PIGMENTED FIRE RETARDANT MASTIC.
- ALUMINIUM HEAD JACKET
- CONICAL FLASHING
- BAND
- INSULATION
- VESSEL HEAD

JACKETING DETAILS TOP OUTLET FLASHING

TOP OUTLET FLASHING DETAIL MAY BE USED FOR SIDE OUTLET AFTER TRANSFORMATION OF SHAPE FROM CORRUGATED TO FLAT HAS BEEN TAKEN CARE OF.

**FIG. 3c**

- ITEM F-1 AND F-2 MAY BE MADE BY TAKING TEMPER OUT OF CORRUGATED/RIBBED SHEET WITH BLOW TORCH AND FLATTENING ONE SIDE WITH MALLET.
- APPLY MASTIC TO BEVELED PIPE INSULATION INSTALL JACKET SNAPPING END TO BEND OVER BEVEL AND ALONG PIPE.
- VESSEL WALL
- INSULATION
- CORRUGATED/RIBBED JACKET
- PIECE TO TRANSFORM CORRUGATED CONFIGURATION TO FLAT ITEM F-1.

JACKETING DETAILS SIDE OUTLET FLASHING

FIG. 3c...
TECHNICAL SPECIFICATION
THERMAL INSULATION
GENERAL REQUIREMENT

LIGHT WEIGHT ANGLE
B.C. LAP
BANDS BETWEEN ALL JOINTS TO BE EQUALLY SPACED ON THE CENTRES NOT TO EXCEED 450 mm
B.C. LAP

CORRUGATED ALUMINIUM 19 x 75 mm
PTCH / RIBBED ALUMINIUM 5 x 32 mm
PTCH
BAND MUST BE LOCATED 25 - 75 mm ABOVE POINT B AT EACH OF B.C. LAP
B.C. LAP 75 mm MINIMUM POINT B
S CLIP POINT C

FIG. 4

BAND OVER EXPOSED HALF OF ALUMINIUM FLASHING
WEATHER LAPPED DOWN ALUM. TIE BANDS
PIPE
INSULATION
WEATHER LAP MITER-CUT ALUM. JACKET
FLASHING 50 mm DEAD SOFT ALUMINIUM 0.5 mm THICK
PIPE INSULATION
PIPE WALL

SPUN ALUMINIUM ELBOW JACKET
TUBULAR SNAP JACKET OVER PIPE INSULATION

SPUN ELBOW FLASHING (a)

TYPICAL FOR BENDS WITH 5 DIAMETER RADIUS OR GREATER

FIG.5 (b)
DETAIL - A

FIG. - 6 FLANGE ASSEMBLIES - UN INSULATED
TECHNICAL SPECIFICATION
THERMAL INSULATION
GENERAL REQUIREMENT

FIG-7
REMOVABLE FLANGE BOX IN HORIZONTAL LINES (HOT SERVICE)

FIG-8
TYPICAL DETAILS FOR REMOVABLE BOXES FOR VALVE & FLANGE CONNECTIONS IN VERTICAL LINES (HOT SERVICE)
TECHNICAL SPECIFICATION
THERMAL INSULATION
GENERAL REQUIREMENT

FILL AS SPECIFIED
OUTER FINISH AS SPECIFIED

PIPE INSULATION TO BE INTERRUPTED TO ALLOW FOR REMOVAL OF BOLTS.
PLASTIC SEALER

MIN.150 MIN. T

ALLOW FOR BOLT REMOVAL

REMOVABLE BOX FOR FLANGE ASSEMBLY
USING BLOCK INSULATION

FIG. - 9
Fig - 10

Typical detail for valve insulation box
(Using block insulation)

Vapour seal
Aluminium cladding
Felt

Allow for bolt removal
Equal to thickness of pipe insulation
ANNEXURE - I

INSULATION SUPPORTS ON VESSELS

1. Suitable supports in the form of rings, lugs, studs or pins shall be used to support insulation on vessel and pipes. Block insulation of vertical vessels and piping shall be supported by support rings. Welding studs are not to be used on any vessel having shell thickness less than 3 mm or shells of aluminium or other alloy materials where spot weldings is not permitted on the vessel surface. Approval must be obtained from the Engineer before welding will be permitted on any vessel or equipment. Normally insulation supports are provided after final erection of the plant. If site welding is not permitted then same should be considered at the design stage itself.

2. Support ring shall be 6 mm. thick and shall be as per fig. A I-A6. In case of stress relieved vessels insulation supports shall preferably be shop welded.

3. If support rings are used on a vessel, the insulation of the head shall be held in place with bands radiating from a floating ring made of 6 mm. round M.S. rod. The bands shall be spaced not more than 300 mm. apart at the tangent line. In case of cold insulation, lugs or supports shall in no case be more than 75% of the total insulation thickness in order to not to puncture the vapour barrier.

4. Stiffener angles, weld protrusions, ladder supports, insulation support rings, pipe hangers or any metal connections not otherwise scheduled to receive insulation shall be insulated if in direct contact with the cold surface in case of cold insulation. The insulation over such protrusions shall have an insulation thickness over them of at least 80% of the thickness of the adjoining insulation. In all such cases the insulation shall be extended to ensure that the nearest exposed surface has a temperature above 0°C or above dew point as specified by purchaser.

5. On large vertical vessels of a height of 6 m or more and on continuous run of 6 m or more of vertical pipe, support rings shall be provided at not more than 3 m interval, such rings shall encompass the vessel and pipe, and the material lugs thereon shall have a length equal to 75% of the total insulation thickness. Extra insulation shall be provided over the support rings. This shall extend for 25 cm. on each side of the ring and shall be mitred to 45 cm. for water-shed on the upper.

6. Where studs, clips or pins are used to support insulation, their spacing shall be approximately 600 mm centre for blanket insulation and one per block for block insulation. Split pins, if used, shall be spread, bent over and imbedded into the insulation.
**TECHNICAL SPECIFICATION**
**THERMAL INSULATION**
**GENERAL REQUIREMENT**

**Fig. A1**

**Fig. A2**

**Fig. A3**

**Fig. A4**

- **GALVANIZED STEEL WIRE OR BAND**
- **INSULATION SUPPORTS - VERTICAL VESSELS**
- **ABOVE -30°C UPTO 300°C**
- **300°C AND ABOVE**
- **OR -30°C AND UNDER**

**SECTION XX**

**DETAIL - A**

- **CLEATS AS PER DETAIL 'B'**
- **@ 300 mm C/C (Approx.)**
- **Both for hot & cold service.**

- **FOR HOT SERVICE ONLY**

- **5 mm THK. FLAT PLATE FOR COLD INSULATED VESSEL ONLY.**

**W = T₁ / 2 FOR SINGLE LAYER INSULATION.**

**W = T₁ + T₂ / 2 FOR DOUBLE LAYER INSULATION.**

**T₁ = THICKNESS OF FIRST LAYER OF INSULATION.**

**T₂ = THICKNESS OF SECOND LAYER OF INSULATION.**

**DETAIL - 'B'**

**FORM NO: 02-0000-0021F3 REV2**

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TECHNICAL SPECIFICATION
THERMAL INSULATION
GENERAL REQUIREMENT

TYPICAL DETAIL OF SUPPORT TANK
FIG.-A5

SUPPORT ANGLE DETAIL FOR HORTON SPHERE
FIG.-A6
TECHNICAL SPECIFICATION

FOR

THERMAL INSULATION

HOT SERVICE

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2.2.2 Insulation Cement

2.2.3 Hard setting plaster

2.2.4 Wire (netting & stitching wire)

2.2.5 Banding wire

2.2.6 Lacing wire

2.2.7 Bands for sewing insulation material

2.2.8 Foil for wrapping S.S. surface

2.2.9 Spacer rings

2.2.10 Aluminium jacket

2.2.11 Heat transfer putty for tracers (viz. Thermo-bond).

3.0 APPLICATION OF INSULATION

3.1 Thickness of Insulation

3.2 General Requirements

3.2.1 Extent of Insulation

3.2.2 Insulation of S.S. Surface

3.3 Insulation Procedure
3.3.1 Vessels & Columns

3.3.1.1 General

3.3.1.2 Vessel head

3.3.2 Tanks

3.3.3 Heat Exchangers

3.3.4 Machineries (Pumps, Turbines, Compressors etc.)

3.3.5 Pipings
   a) General
   b) Hot services
   c) Steam traced lines
1.0 GENERAL

1.1 SCOPE

This standard covers the requirement for supply and application of materials for thermal insulation of equipment, piping and other items for Hot Service. TS-6700 is supplementary to this standard and all the applicable requirements of TS-6700 shall be complied with in conjunction with the requirements specified here in.

1.2 REFERENCE STANDARDS

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS-6700</td>
<td>Thermal Insulation – General Requirements</td>
</tr>
<tr>
<td>IS:14164</td>
<td>Code of Practice for Industrial Application and finishing of thermal insulation material at temperature -80°C and up to 750°C.</td>
</tr>
<tr>
<td>IS:8183</td>
<td>Specification for bonded mineral wool</td>
</tr>
<tr>
<td>IS:9842</td>
<td>Specification for performed fibrous pipe insulation</td>
</tr>
<tr>
<td>IS:8154 / IS:9428</td>
<td>Calcium silicate pipe sections &amp; blocks</td>
</tr>
<tr>
<td>IS:9743</td>
<td>Insulating cement</td>
</tr>
<tr>
<td>IS:9742</td>
<td>Specification for spray able mineral wool.</td>
</tr>
<tr>
<td>IS:15402</td>
<td>Specification for Ceramic Fibre Insulation</td>
</tr>
<tr>
<td>ASTM C-680</td>
<td>Standard Practice for Heat Loss or Gain and Surface Temp.</td>
</tr>
</tbody>
</table>

1.3 DEVIATIONS

Should unforeseen difficulties arise to comply with requirements of this standard.

- Alternative materials and application techniques equivalent or superior to the requirements of this standard may be submitted with complete details for approval of PDIL.
- In case of contradiction between requirements of this standard and the NIT/work order, the latter will be followed.

1.4 LIMITATIONS

Temperature Limits

This standard deals with insulations applied externally on piping / equipments etc. for temperature ranging from 60°C to 750°C.
1.5 GENERAL REQUIREMENTS

1.5.1 Personnel Protection (PP)

Insulation for personnel protection is usually called for when the surface temperature is above 60°C and process requirement does not necessitate any insulation. Wherever, requirement of such insulation for P.P. is indicated, extent of insulation will be as follows:

a) Insulation all such portions of the surface which could be touched in the course of normal operation / maintenance duties.

b) Insulate up to a height of 2.5 M above grade level/working platform level.

c) Insulate all portions of the surface within a distance of 600 mm from the edge of any walk way / operating platform/ladder.

2.0 MATERIAL REQUIREMENTS

2.1 INSULATION MATERIALS

2.1.1 General

➢ Wherever reference to any standard is made it is presumed that the latest revision as on date should be considered.

2.1.2 Specification and other requirements as per table below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Specification</th>
<th>Applied density Kg/m³ (minim.)</th>
<th>Temp. limit °C</th>
<th>Maxim. Thermal conductivity mW/cm °C at 100°C mean temp. # .</th>
</tr>
</thead>
<tbody>
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<tr>
<td>A)</td>
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<tr>
<td>i)</td>
<td>Bonded rock wool mattress/slabs as per IS:8183 Gr.3</td>
<td>100</td>
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<td>0.51</td>
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<tr>
<td>ii)</td>
<td>Bonded glass wool mattress/slabs as per IS:8183 Gr.3</td>
<td>85</td>
<td>400</td>
<td>0.51</td>
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<tr>
<td>iii)</td>
<td>Bonded rock wool mattress / slabs as per IS:8183 Gr.3</td>
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<td>401-550</td>
<td>0.51</td>
</tr>
<tr>
<td>B)</td>
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<td></td>
<td></td>
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<tr>
<td>i)</td>
<td>Preformed bonded Rock wool/glass wool pipe sections as per IS:9842 Gr. 2</td>
<td>85</td>
<td>400</td>
<td>0.51</td>
</tr>
</tbody>
</table>
### TECHNICAL SPECIFICATION

#### THERMAL INSULATION – HOT SERVICE

**DOCUMENT NO. REV**

**SHEET 6 OF 29**

<p>| | | |</p>
<table>
<thead>
<tr>
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<tr>
<td>ii)</td>
<td>Preformed bonded rock wool pipe sections as per IS:9842 Gr. 2</td>
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<td>iii)</td>
<td>Preformed calcium silicate pipe sections as per IS:8154/9458 &amp; ASTM C 533.</td>
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<tr>
<td>C)</td>
<td>Ceramic Fibre Blanket Insulation as per IS : 15402</td>
<td>128</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>D)</td>
<td>Ceramic Fibre Pad Insulation</td>
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<td></td>
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<tr>
<td>E)</td>
<td>Inner layer Ceramic Fibre and subsequent outer layers Rockwool Insulation</td>
<td>128 &amp; 150</td>
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<td></td>
</tr>
<tr>
<td>F)</td>
<td>Ceramic Fibre Rope 18-24mm for Insulation of Impulse / Small dia pipelines (1 ½ inch &amp; below) as per IS : 15402</td>
<td>250</td>
</tr>
</tbody>
</table>

# Please also refer Thermal Conductivity Values at different mean Temperatures.

### NOTES:

1. Insulation material manufactured from slag is not acceptable.
2. Bonding agent will not be more than 4.5% by weight in the insulation material.
3. Insulation material on application directly over austenitic stainless steel (upto 450ºC) shall not contain leachable chloride more than 10 ppm. For application on C.S. & A.S. surfaces and on S.S. surfaces covered with aluminium foil (upto 450ºC), leachable chloride in the insulation material up to 100 ppm could be permitted. In case of calcium silicate, suitable corrosion inhibitor (sodium silicate) shall be added and sodium silicate content shall not be less than 20 ppm for each ppm of leachable chloride. Factory inhibited insulation shall be preferable, whereby sodium silicate solution will be sprayed on to the Insulation at factory.
4. Where foot traffic is expected on the insulated surface, the minimum density of applied insulation will be 150 Kg/m³ irrespective of temperature.
5. Sprayable Mineralwool as per IS: 9742 or Ceramic Pads as per IS:15402 may be considered for irregular shaped equipments like turbines, pumps, valves, flanges etc.
6. All optional requirements as per cl.3.10.3, 3.10.5, 3.10.6, 3.10.7 of IS: 8183 and cl.3.12.1, 3.12.4 of IS: 9842 shall be complied with.
7. Large pipe means pipe having nominal size 26” NB and higher.
8. Pipe sections shall be applied up to 14” NB Dia pipelines.
9. For multi layer insulation, only first layer to be pipe sections and subsequent layers with mattress insulation.
10. For water prone areas Water Repellent Grade insulation to be used as per BS: 2972.

2.2 AUXILIARY MATERIALS

2.2.1 Paints

a) Heat resisting (for application on S.S. surface Hot Service)

<table>
<thead>
<tr>
<th>Type</th>
<th>Single pack</th>
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</thead>
<tbody>
<tr>
<td>Composition</td>
<td>Silicon resin based with aluminium flakes as pigment.</td>
</tr>
<tr>
<td>Dry film thickness</td>
<td>20 microns / coat (minim.)</td>
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<tr>
<td>No. of coats</td>
<td>2 coats</td>
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<tr>
<td>Other requirement</td>
<td>It should be suitable to withstand temperature up to 550°C.</td>
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</table>

2.2.2 Insulation Cement

This is used for filling voids & surface irregularities. This shall be high grade mineral wool/calcium silicate plastic composition based cement having a volumetric shrinkage not exceeding 20% of wet coverage and with a max thermal conductivity of 0.01 mw/cm degree C at 205°C mean temperature.

2.2.3 Hard Setting Plaster

Hard setting plaster shall be a mixture of cement sand or cement mineral fibre or plaster of paris - mineral fibre. This will be applied over the specified wire netting/chain link mesh. The plaster shall conform to IS: 9743.

2.2.4 Wire (for netting, lacing or stitching)

Wire netting for machine stitched mattresses shall be galvanized steel wire of dia 0.56 mm (minimum) making 25 mm hexagon meshes. Lacing wire to bind the ends of wire netting shall be galvanized steel wire of minimum dia 0.56 mm.

2.2.5 Banding Wire

Wire for securing insulating blankets or sections shall be galvanized soft, annealed steel wire of 1.625 mm diameter for pipes and 2.640 mm dia for vessels.

2.2.6 Lacing Wire

Lacing Wire to stitch wire netting of adjacent mattresses shall be of G.I. wire of 22 SWG.

2.2.7 Bands for securing Insulation material

Shall be aluminium or S.S. 20x0.5 mm. For spherical surfaces only S.S. bands will be used.
2.2.8 Foil for wrapping S.S. surfaces

Aluminium foil of 0.1 thicknesses, free from pin holes.

2.2.9 Spacer Ring

1. Spacer rings shall be provided when mattress insulation is used to provide frame work on which aluminium sheeting (Refer Fig. 1) used for protecting the insulation, is cladded. These rings shall be fabricated from 25 x 3 mm MS flats.

Spacer rings are not required when pipe lines are insulated with performed pipe section.

The outside dia of these rings shall be equivalent to the diameter of the pipes/vessels measured over the insulation. Spacer rings shall not be required when insulation in the form of performed rigid pipe sections is used.

2. Spacer rings may not be used for pipes where insulation O.D. is less than 150 mm.

3. Spacer rings shall be provided with “Z” shaped stays fabricated from the same size MS flats. Stays shall be provided at intervals of not more than 300 mm along the circumference of the insulation, subject to a minimum of 3 stays spacer rings shall be provided on the pipes at a pitch of not more than 900 mm.

4. To minimize direct heat conduction through the stays, a packing of 2 sheets of 3 mm thick Ceramic Fibre Paper (density 320 kg/m3) shall be provided at the joints of the stays and pipes, while the joints of stays and MS rings shall be riveted by 6 mm dia. MS rivets with 2 sheets of 3 mm thick Ceramic Fibre paper interposed as shown in Fig. 1.

2.2.10 Aluminium cladding with inner side coated with Polysurlyn coating – As per TS: 6700

2.2.11 Heat transfer putty (viz. thermo bond) for tracers.

3.0 APPLICATION OF INSULATION

3.1 THICKNESS OF INSULATION

Insulation thickness shall be as specified in the insulation schedule/specification/isometric drawings prepared for equipments/piping. Wherever the thickness is not indicated the same may be selected from Table – I.

3.2 GENERAL REQUIREMENT

3.2.1 Extent of Insulation

- All steam traced lines, steam jacketed piping and vessels shall be insulated.
- Stem trap and piping downstream of it shall not be insulated.
- Turbines, pumps and compressors operating below 120°C shall not be insulated unless otherwise specified.
- Flanges & flanged valves on lines operating above 65°C but below 200°C shall normally not be insulated except for personnel protection. In such cases, insulation shall terminate at such a distance from the joints as to provide sufficient space for removal of bolts.
Drain and vent piping for hot service up to the first valve on insulated equipment shall be insulated with similar type of insulation and finish as the equipment to which attached.

Steam supply headers, and tracer lines used for steam tracing as shown on steam trap hook-ups shall be insulated.

All instruments which are steam traced shall be insulated for heat conservation.

All sample connections and drains on steam lines shall be insulated.

All name plates and vessel markings should remain visible.

### 3.2.2 Insulated of S.S. Surface

For operating temperatures up to 450°C the stainless steel surface shall be wrapped with Minimum 0.05 mm thick aluminium foil with 50 mm overlap at longitudinal and circumferential joints before application of insulation. All joints of the aluminium foil shall be lapped and sealed to be Proof against leakage. Aluminium foil shall be firmly secured on to the stainless surfaces by aluminium bands at a pitch of 450 mm. Care shall be taken while applying aluminium foil over the pipes to ensure that the foil is not punctured at any place during wrapping and clapping with aluminium bands.

For operating temperatures from 451 to 550°C, the stainless steel surfaces shall be painted with two coats of heat resistant paint before application of insulation. When the paint becomes dry, the painted surfaces shall show no discontinuity.

In case of factory made inhibited grade insulation within 10 ppm, same can be applied directly on to the SS surface upto 450°C

### 3.3 INSULATION PROCEDURE

The application procedure described in for rock/glass wool. For other insulations, the application procedure shall be submitted by the tenderers.

#### 3.3.1 Vessels and Columns

##### 3.3.1.1 General

Insulation blankets shall be applied with the retaining wire mesh exposed on the outside. The edges of blankets shall be well butted up to each other and laced together with galvanized wire and secured to the vessel with circumferential bands as shown in Fig. 2, 3, 4 & 5 when two layers are to be applied the first layer may be secured by means of galvanized wire in lieu of the bands.

On flat surfaces, blankets/blocks/slabs shall be applied by impaling them over 9 gauge galvanized wire pins welded perpendicular to the surface. The extending ends of the wires shall then be bent upward at right angles and pressed into the blanket. The edges of blankets shall be tightly butted and laced together with galvanized wire. Where more than one layer of insulation is applied, securing bands of the layers shall not coincide with each other. All joints in successive layer shall be staggered.
3.3.1.2 Vessel Heads

Insulation on heads shall be secured by radial bands from a floating ring centered at the crown of head and tied to a circumferential band placed approx 300 mm inside the tangent line on insulation O.D. Ref. Fig. 2. On to heads of vertical vessels, these radial bands protecting the blanket insulation shall be provided with distance pins placed every 300 mm and of a length equal to insulation thickness. The pins shall be welded or riveted to the strip steel.

For bottom heads, in all skirt supported vessels insulation supports are provided inside the skirt as indicated in the equipment drawings. Floating rings or wire loops around the nozzle and bands may be used to support downward facing of insulation. Such a floating ring may be supported from the lagging support ring fixed inside the skirt. Blanket shall be shaped and secured on to the head by means of bands stretched across the floating ring and insulation support rings. The insulation shall be covered with galvanized wire netting firmly laced together and secured in place. Insulation details shall be as per Fig. 6. All wire ends shall be cut short and turned into the insulation.

For vertical vessels having temperatures more than or equal to 450°C, the upper 600 mm of the supporting skirt shall be insulated both on inside and outside.

3.3.2 Tanks

The details of support cleats will be as indicated in Fig. 7.

- Mineral wool mattresses faced with galvanized iron wire netting shall be pressed onto the supporting pins of 8 SWG GI wire. All joints shall be closely butted as shown in Fig. 7 A, B.
- For the top of tank the following procedure shall be adopted where angle supports/wire lugs are not provided by fabricator. All these will be supplied by insulation contractor.
- Laying of central and peripheral angle rings and details are shown in fig. 3, 3a, 3b.
- Welding M6 studs of length T + 6 mm (where T = thickness of insulation) at 300 mm pitch to MS flats shall then be laid on the tank top connecting the central and peripherical rings riveted/welded at both ends. Fix the 15 x 6 mm flat cross stiffeners with stud welded.
- Fix resin bonded mineral wool slabs of required thickness by pressing on to the studs.
- Stretch 20 SWG chain link mesh, anchoring it to the M.S. studs by means of speed washers.
- Apply approx. 19 mm thick hard setting plaster trowelled to a smooth and even finish.
- When hard setting compound is completely dry apply a standard four course bitumen felt, water proof treatment as per IS: 1346 or 3mm thick APP modified Bitumen Felt.
- Fix a “shed-water” shroud constructed from 200 galvanized iron plain sheet at the periphery of the tank. This shall be fitted prior to the application of the hard setting compound.

3.3.3 Heat Exchangers

Exchangers shall be insulated with insulation mattresses as specified for vessel. Channels and channel covers will be insulated with removable aluminium covers lined with insulation. Unless otherwise mentioned flange bolting shall be left un-insulated for hot service ref. Fig. 4.

3.3.4 Machineries like pumps, turbines, compressors etc.
In general these will be insulated in such a way that the same is of removable type to allow easy maintenance. The contractor shall supply insulation detail to engineer-in-charge for approval.

3.3.5 Piping

a) General

- Vertical lines shall be provided with welded support rings Ref. Fig. 8 spaced at approximately 4000 mm. Expansion/contraction joints shall be provided under each support ring for hot./cold service.

- Insulation around support shoes etc. shall be trimmed closely and thoroughly sealed with vapour seal mastic. For hanger support special care shall be given for weather proofing jacket and sealing mastic. Ref. Fig. 9 & 10.

b) Hot Service

The performed pipe section of required thickness shall be fixed on the pipe surface with the help of 20 mm x 24 SWG aluminium band.

The blankets shall be wrapped round the pipe closely, completely covering the outer surface. Edges shall be tightly butted and laced with galvanized wire Ref. Fig. 11 & 12. The blankets shall be secured in place with galvanized bands/wires spaced at 300 mm. Ends of the wire loops shall be twisted and pressed back into the insulation. All voids, irregularities and joints shall be painted up and trowelled smooth with insulations cement. Longitudinal joints in jackets on horizontal pipes shall be located 30° below center line of pipe. Spacer rings as shown in Fig. 1 shall be installed at 100 mm interval to support the jacket.

In consideration of possible pipe line movement with change in fluid temperature different pipes should be separately insulated.

For temperatures above 500°C, combination of first layer Ceramic Fibre (25mm) followed by Rockwool Mattress will be tied with SS bands.

Flanges, valves & expansion joints shall be insulated with removable type pad arrangement as per requirement of TS: 6700.

For Small dia pipes of 1 inch & below Ceramic Fibre rope (18-24mm dia) may also be used and covered with Aluminium tape wherever exposed to atmosphere.

c) Steam Traced Lines

The steam traced line shall first be wrapped with 24 SWG x ¾” hexagonal mesh GI wire netting so that it passes round the supporting hooks for the racer line or lines. Thus ensuring tracer pipe bearing tightly against the line which is steam traced. This prevents the insulating material from entering the air jacket formed between the insulation and the pipes. The details are give in Fig. 13 & 14. In case of steam traced lines with thermo-bond or with Al foil the material supply and application, as per ES: 6016 will be in the scope of insulation contractor.

For stainless steel main lines having steam tracer, the method of application of insulation shall be the same as described in above except that an aluminium foil, shall be wrapped round the main pipe and tracer pipe as per the procedure described in clause 3.3.2.
For Electric traced lines, the tracer wires to be wrapped over the pipes and held in position with aluminium tape. Subsequently insulation mattress to be applied and tied with bands.

3.3.6 Aluminium cladding with inner side (in contact with insulation) coated with Polysurlyn shall be applied over the finished insulation surface as per TS:6700.
**TABLE-1**

**INSULATION THICKNESS (MM) FOR HOT SERVICE**

**DESIGN CRITERIA**
- **AMBIENT TEMPERATURE**: 35 Deg. C
- **SURFACE TEMPERATURE**: 60 Deg. C
- **WIND VELOCITY**: 1 m/s
- **DESIGN HEAT LOSS**: 150 Kcal/hr.m²
- **MATERIAL**: ROCKWOOL (Density = 100 Kg/m³ up to 400 Deg. C & 150 Kg/m³ from 401-650 Deg. C as per IS 8183 Gr. 3)

**OPERATING TEMPERATURE (Deg. C)**

<table>
<thead>
<tr>
<th>PIPE DN (MM)</th>
<th>&lt;=150</th>
<th>151-200 ºC</th>
<th>201-250 ºC</th>
<th>251-300 ºC</th>
<th>301-350 ºC</th>
<th>351-400 ºC</th>
<th>401-450 ºC</th>
<th>451-500 ºC</th>
<th>501-550 ºC</th>
<th>551-600 ºC</th>
<th>601-650 ºC</th>
<th>UPTO 250 ºC</th>
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</table>

**NOTE 1**: For temperatures above 500deg.C, first layer of 50mm Ceramic Fibre Blanket of density 128 kg/m³ to be applied and subsequent layers with Rockwool Mattress.

**NOTE 2**: Flat surface includes Equipments and large dia pipes (DN>600).
TABLE -2

INSULATION THICKNESS (MM) FOR HOT SERVICES

<table>
<thead>
<tr>
<th>DESIGN CRITERIA</th>
<th>AMBIENT TEMPERATURE</th>
<th>35 Deg. C</th>
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<tr>
<td>SURFACE TEMPERATURE</td>
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<tr>
<td>WIND VELOCITY</td>
<td>1 m/s</td>
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<tr>
<td>DESIGN HEAT LOSS</td>
<td>150 Kcal/hr.m²</td>
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<tr>
<td>MATERIAL</td>
<td>CALCIUM SILICATE</td>
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<table>
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<tr>
<th>OPERATING TEMPERATURE (Deg. C)</th>
<th>HOT INSULATION</th>
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<tr>
<td>PIPE DN (MM)</td>
<td>&lt;=150 °C</td>
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**Note**: Flat surface includes Equipments and large dia pipes (DN>600).
### Thermal Conductivity Table for Insulation Materials

<table>
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<tr>
<th>Sl. No</th>
<th>Mean Temp. (deg. C)</th>
<th>Rockwool Density-100kg/m³ IS 8183</th>
<th>Rockwool Density-150/144 kg/m³ IS 8183/9842</th>
<th>Rockwool Density-250 kg/m³ IS 8154</th>
<th>Calcium Silicate Density-128 kg/m³ IS 15402</th>
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TECHNICAL SPECIFICATION
THERMAL INSULATION – HOT SERVICE

DETAILS OF SPACER RING

FIG. 1

NOTE: SPACER RINGS SHALL NOT BE REQUIRED WITH PREFORMED PIPE SECTION.
20 x 0.5 bands spaced approximately 300mm on centres

Galvanized wire girdles spaced 1.2 m on centres or width of blankets whichever less.

Blanket insulation wired to girdles

Bare surface

FIG. 2 Application of mineral wool blanket insulation for tanks 3 m dia and above

9SWG galvanized wire girdles pulled tight around curved surfaces, spaced 1.2 m on centres

Blankets affixed to 9SWG girdles with 16SWG galvanized hair-pin wires, 300 mm on centres.

Blanket edges laced with 16SWG galvanized wires

Bare surface

Blanket insulation with wire netting.

Blanket secured with 20 x 0.5 bands spaced approximately 300mm on centres

Bare surface

FIG. 3 Methods of fixing mineral wool blankets
TECHNICAL SPECIFICATION
THERMAL INSULATION – HOT SERVICE

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SHEET 18 OF 29

T=5 mm LONG STUDS AT 500 mm PITCH
M.S. ANGLE RING (25 x T x 6)
M.S. FLAT (15 x 5)
25 x 6 FLAT M.S. RING
ARRANGEMENT IF WELDING ON TANK TOP
NOT PERMITTED
T= THICKNESS OF INSULATION IN MM

DETAILS OF TANK ROOF INSULATION
SUPPORTS

FIG. 3a

WATER SHROUD

SECTION A-A

FORM NO: 02-0000-0021F3 REV2
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TECHNICAL SPECIFICATION
THERMAL INSULATION – HOT SERVICE

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DETAILS OF TANK TOP SETTING PLASTER FINISH

FIG. 3b
FIG. 4 HORIZONTAL VESSELS AND EXCHANGERS—HOT INSULATED

1. Insulation material blankets or blocks
2. Hog clips spacing 100mm (When blanket insulation)
3. Band φ 20 x 0.5
4. Angle ring and brackets
5. Aluminium jacket
6. Self tapping screws
1. Insulation material, mattress or blocks.
2. Hoop rings, spacing 100mm (when blanket insulation).
3. Band 12 x 0.5 for insulation.
4. Distance pin Ø 5, spacing 300mm (when blanket insulation).
5. 10 # Floating ring.
6. Angle ring and brackets.
7. Aluminium.
8. Self-tapping screws.
9. Weatherproof coating, 3mm thick.
10. Band for aluminium jacket for towers above elevation 20m only.
TECHNICAL SPECIFICATION
THERMAL INSULATION – HOT SERVICE

FIG. 6 BOTTOM HEAD WEATHER PROOFING
FOR VERTICAL VESSELS

- Insulation Mattress
- Loose mineral fibre
- 9 Galvanised wire ties
- Spacers
- Stainless steel
- Tensioned M.S. bands 25mm x 3mm
- Fire proofing by others
- 2 or 3 Loops of 10 SWG wire around Nozzle

Skirt
Insulation support by Vessel's vendor
(A) DETAIL FOR FIXING OF WIRE NAILS FOR HOLDING INSULATION BLANKETS

- Holes for self tapping screws @ 200 centres
- Aluminium covering sheet 200 x 6
- 6mm thick angle ring (Not to be welded to bottom lug)
- 6mm plate @ 1000 centres

DETAIL-X

B) SUPPORT DETAIL FOR METAL COVERING OF INSULATION

FIG. 7 DETAIL FOR FIXING OF BLANKETS AND METAL COVERING FOR STORAGE TANK
TECHNICAL SPECIFICATION
THERMAL INSULATION – HOT SERVICE

Support ring
Aluminium sheet
Self tapping screw
Spacing of support ring (4000 mm)

Metal cladding
Self tapping screw
3mm Ceramic fibre paper for piping of temp
Rivet
Spacer ring

FIG. 8A INSULATION SUPPORT FOR VERTICAL PIPING

SEC. 'B-B'

FIG. 8B SUPPORT RING FOR VERTICAL INSULATED PIPING

VIEW 'C-C'
TYPICAL ARRANGEMENT OF MULTILAYER FIBROUS INSULATION FOR HORIZONTAL PIPE

SINGLE LAYER MATTRESS INSULATION WITH ALUMINIUM SHEET FINISH.

FIG. 8c

MULTIPLE LAYER FIBROUS INSULATION - SPACER RING FOR HORIZONTAL PIPE

FIG. 8d
The 2 layers must be applied in such a way that the joints are staggered. All seams have to be tightly sewed with galvanized binding wire.

**FIG.11 DOUBLE THICKNESS INSULATION**

**FIG.12 APPLICATION OF INSULATION MATS ON VERTICAL LINES**
FIG. 13  STEAM TRACING INSULATION

(A) SINGLE TRACER DETAIL

(B) DOUBLE TRACER DETAIL

(C) TRIPLE TRACER DETAIL

Insulation matress

Main pipe

Free space for heat conductive putty (Thermobond)

Wire netting
FIG. 14: DETAILS OF INSULATION ON STEAM TRACING
(WITH SPACER RING)
TECHNICAL SPECIFICATION

FOR

THERMAL INSULATION

COLD SERVICE
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1.1 Scope

1.2 Reference Standards

1.3 Deviation

1.4 Limitations

2.0 MATERIALS REQUIREMENTS

2.1 Insulation Materials

2.2 Auxiliary materials

3.0 APPLICATION OF INSULATION

3.1 Thickness of Insulation

3.2 Extent of Insulation

3.3 Insulation Procedure

3.3.1 Vessels & Columns

3.3.1.1 General

3.3.1.2 Vessel heads

3.3.1.3 Spherical Vessels

3.3.2 Machineries (Pumps, Turbines, Compressors etc.)

3.3.3 Piping

3.4 Weather Proofing

3.4.1 Vapour seal mastic

3.4.2 Protective layer for cold insulation
1.0 GENERAL

1.1 SCOPE
This standard covers the requirement for supply and application of materials for cold insulation of equipment, piping and other items except Horton sphere.

1.2 REFERENCE STANDARDS

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tbody>
<tr>
<td>TS-6700</td>
<td>Thermal Insulation – General Requirements</td>
</tr>
<tr>
<td>IS:14164</td>
<td>Code of Practice for Industrial Application and finishing of thermal insulation Materials at temperatures - 80°C to 750°C.</td>
</tr>
<tr>
<td>IS : 13205</td>
<td>Specification for Cast-in-Situ Polyurethane and Polyisocyanurate Foams for Thermal Insulation</td>
</tr>
<tr>
<td>ASTM C-680</td>
<td>Standard Practice for Heat Loss or Gain and Surface Temperature.</td>
</tr>
</tbody>
</table>

1.3 DEVIATION
Should unforeseen difficulties arise to comply with requirements of this standard.

- Alternative materials and application techniques superior to the requirements of this standard may be submitted with complete details for approval of Owner.
- In case of contradiction between requirements of this standard and the NIT/work order, the latter will be followed.

1.4 LIMITATIONS

Temperature Limits

This standard deals with insulations applied externally on piping's/equipments etc. for working temperatures between -180°C to 20°C.
2.0 MATERIAL REQUIREMENTS
2.1 INSULATION MATERIALS

2.1.1 General
Whenever reference to any standard is made it is presumed that the latest revision as on date should be considered.

2.1.2 Specification and other requirements as per table below:

Polyurethane foam prefabricated sections conforming to IS: 12436 with the following characteristics:

Density - 36+/-2 kg/m³ (min)
Thermal conductivity - 0.03 W/mK hr (0.026 kcal/m2hr) at 50°C mean temp
Or 0.021W/mK (0.018 kcal/m2hr) at 10°C.
Horizontal Burning - IS: 11239 part 12/ BS: 4735
- Extent of burn 125 mm (max.)
Self extinguishing as per ASTM D 1692
Or
Poly isocyanurate foam prefabricated sections conforming to IS: 12436 having the following characteristics:

Density - 32 +/-2 kg/m³ (min)
Thermal conductivity - 0.03 W/mK (0.026 kcal/m2hr) at 50°C mean temp.
Or 0.021W/mK (0.018 kcal/m2hr) at 10°C
Horizontal Burning - IS: 11239 part 12/ BS: 4735.
- Extent of burn 25 mm (max.)
Surface spread of flame - over cladded surface (optional) Class I as per BS: 476 Part 7
Or
Polyurethane / Polyisocyanurate Cast-in-Situ application of density 45-60 kg/m3, thermal conductivity 0.03 W/mK (0.026 kcal/m2hr) at 50°C mean temp Or 0.023W/mK (0.020 kcal/m2hr) at 10°C to be applied over pipes, tanks and equipments upto -50°C.

NOTE:
In case of dual temp application where the system is expected to be steam cleaned or where the temp may rise occasionally beyond 120 deg C, first layer of bonded mineral wool as per IS:8183 of suitable thk to ensure interface temp. <100 deg C.

2.2 AUXILIARY MATERIALS:

2.2.1 Paints
a) Asphaltic/Bitumen base primer density about 1200 kg/cu.mtr (IS:1322)

2.2.2 Joint Sealer
MAS-35 or Foster 30-45.

2.2.3 Coating and vapour seal mastic
MAS-130 or Foster 60-35 coating.

2.2.4 Banding wire
Wire for securing insulation shall be galvanized, soft, annealed steel wire of 1.625 mm diameter.

2.2.5 Bands or straps for securing insulation material aluminium or S.S. 20x0.5mm thk. For spherical surfaces only S.S. bands shall be used.

2.2.6 Reinforcing fabric (for cold insulation) 10x10x5 micron mesh glass fabric

2.3 Insulation material, joint sealer, vapour seal mastic and glass fabric shall be approved by PDIL.

3.0 APPLICATION

3.1 THICKNESS OF INSULATION
Insulation thickness shall be as specified in the insulation schedule/specification prepared for equipments/piping. Wherever the thickness is not indicated the same may be selected from Table – I.

3.2 EXTENT OF INSULATION
For cold service all portions of piping, connections for drains, instrument connections, sample points along with valve flanges etc. shall be insulated, only name plates of equipments will be kept visible.

3.3 INSULATION PROCEDURE

3.3.1 Surface Preparation
The surface of the tanks, vessels, piping and valves etc. on which cold insulation is to be applied shall be free of dust, loose paints or any other foreign matters.

3.3.2 Vessels and Columns

3.3.2.1 General
In general, vessels and columns for cold services shall be insulated by “in situ” application as per IS: 13205 specifications.
Suitable curved blocks or mitre-cut blocks of Specified thickness to fit the diameter of the vessels shall be employed. Insulation blocks shall be installed with all joints staggered and tightly butted. Joints shall be carefully fitted and filled with a joint sealer. The inner most layer is normally dry-set however with joints duly sealed with sealant.

All butt edges and ends of the blocks shall be sealed with recommended thickness of Joint sealer.
Final layer of insulation shall be secured in place with bands at 300 mm centers, Ref. Fig. 1. Band shall be provided with band-seals. When banding is impracticable banding wire shall be used. Inner layers, however require to be held in place using pressure sensitive adhesive tapes.

When multi layers of insulation is required the outer layer shall have side and end joints staggered over proceeding layer, so that two joints do not coincide and each layer shall be separately secured in place.

For Cast-in-Situ application, spacer blocks equal to the thickness of insulation to be applied over the vessel / tank surface at 300mm centre to centre and held in position with aluminium bands. Aluminium sheet cladding to be fixed over the spacer blocks and band applied over it. Holes will be drilled through the aluminium cladding and chemicals will be poured. The procedure to be from bottom to top. Finally the holed to be capped.

Insulation for hand holes, manholes etc. shall be carried out in semi-removable construction as shown in Fig. 2.

Nozzles in cold service shall be insulated as shown in Fig. 2 & 3.

3.3.2.2 Vessel Heads

Insulation on heads shall be secured by radial bands from a floating ring (made by 2-3 loops of wire) centered at the crown of head and tied to a circumferential band placed approx 300 mm inside the tangent line on insulation O.D.

Supporting legs and skirts shall be insulated simultaneously with the insulation of the vessel. The insulation shall be extended on the legs up to a length equal to four times the insulation thickness. The insulation thickness on the supports shall have the same thickness as that of the vessel and shall be laid starting from the supporting plate welded to the vessel. The insulation shall be sealed with mastic carefully.

In case the vessel is resting on a metal plate skirt, the skirt shall be insulated as shown in Fig. 1.

3.3.3 Machineries like pumps, turbines, Compressors etc.

In general these will be insulated in such a way that the same is of removable pad type to easy maintenance. (The contractor shall supply insulation detail to engineer-in-charge for approval). All such Insulation normally cannot be re-used

3.3.4 Piping

a) General

Insulation shall be applied to piping in the form of moulded pipe sections (upto 14" NB pipe dia) covering of specified thickness with all successive layers of insulation with cut slab pieces staggered and tightly butted and sealed with recommended thickness of joint sealer. In general application of various pipes shall be as per Fig. 5. For typical details of supported horizontal lines Ref. Fig. 6.
The final layer of insulation shall be secured with aluminium bands at 300 mm centers on all pipe covering.

In single layer application for temperatures below 0°C shiplap finished edge pipe sections are to be used.

For Cast-in-Situ applications suitable cavity to be formed over the pipe surface equivalent to the thickness of insulation by placing insulation blocks over the pipe surface fixed with adhesives placed at 300mm centre to centre & held in position by applying bands. Aluminium sheet cladding will be fixed over the spacers and held in position with self tapping screws & bands. Finally insulation chemicals will be poured through drilled holes on the cladding. The drilled holes to be finally sealed with caps. Application shall be in compliance with IS: 13205 specifications.

Flanges, valves and other fitting shall be insulated employing larger sections of pipe covering the same specified thickness as for adjacent pipes as illustrated in Fig. 6. Bends shall be insulated with mitre-cut insulation to suit the curvature of the bend. Valves shall be insulated up to the backing gland.

3.4 WEATHER PROOFING

3.4.1 Vapour Seal Mastic

a) After insulation is installed, before jacketing over it, heavy adhesive coat vapour seal mastic shall be applied by spraying, brushing or trowelling. While still tacky, glass fabric shall be laid smooth and embedded in the coating. Care must be exercised that weave does not rupture and fabric is overlapped 75mm at joints. A final coating of vapour seal mastic shall be applied over the glass fabric uniformly to give a total dry thickness of as per recommendation.

b) Junctions of insulation at supports shall be vapour sealed as follows:

While the second coat of vapour seal mastic is still tacky at the support, a 300 mm wide glass fabric shall be laid smooth and embedded in the coating. The fabric shall overlap at least 75mm at the joint. A second coat of vapour seal mastic is applied over the glass cloth as in para 3.4.1 (a).

c) Subsequently a 25 mm thick bonded mineral wool blankets shall be applied tightly over the vapour seal mastic and fixed with 20 x 0.5 thk. bands at a spacing of 300 mm.

d) The insulation shall be finished with aluminium Cladding with inner side (in contact with insulation) coated with 3 mil thick polysurlyn.
TECHNICAL SPECIFICATION  
THERMAL INSULATION – COLD SERVICE  

**INSULATION THICKNESS TABLE FOR COLD INSULATION**

**DESIGN CRITERIA**

- **AMBIENT TEMPERATURE**: 35 Deg. C  
- **RELATIVE HUMIDITY**: 85%  
- **SURFACE TEMPERATURE**: 33 Deg. C  
- **WIND VELOCITY**: 1 m/s  
- **DESIGN HEAT GAIN**: 10-12 Kcal/hr.m²  
- **MATERIAL**: POLYURETHANE (PUF) (Density 36±2Kg/m³) / POLYISOCYANURATE (PIR) FOAM (Density 32±2Kg/m³)

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**Note:**  
1. Flat surfaces include Equipments and large dia pipes(DN>600).  
2. Upto 60 mm thickness only single layer of Insulation shall be used.
1. Insulation
2. Vapour Barrier
3. Band for Polyurethane Sec.
4. Glove Cloth
5. 25 mm Bonded Mineral Wool with Wire Mesh
6. Hog Rings, Spacing 100 mm
7. Band for Mineral Wool
8. Aluminium Jacket
9. Self Tapping Screws
FIG. - 2
REMOVABLE CAP FOR MANHOLE AND HANDHOLE

1. FIXED INSULATION
2. REMOVABLE HOOD
3. INSULATION
4. GALV. WIRE MESH
5. SECTIONAL REINFORCEMENT OR ANGLES
6. WEATHER PROOFING MASTIC
7. SNAP FASTENER
8. CLIPS TO FIX INSULATION TO HOOD
FIG. - 3

PIPE TO VESSEL CONNECTION OF COLD INSULATED VESSELS

1. INSULATION BLOCK
2. 25 mm BONDED MINERAL WOOL BLANKET FOR PROTECTION OF VAPOUR SEAL
3. RAW STUFFING MATERIAL
4. ALUMINIUM JACKET
5. SELF TAPPING SCREWS
6. PLASTIC SEALER
7. WEATHER PROOFING MASTIC
8. VAPOUR SEAL
1. Primer
2. Adhesive
3. Insulation
4. Vapour Barrier
5. Gloves Cloth / Fabric

6. Insulation material (mineral wool blanket 15 m.m. thick) to be used only when screws are used to fix Aluminium jacket.
7. Al. sheet

Fig. 4 Different Layers of piping Insulation (Cold service.)
FIG. - 5  COLD INSULATION - SUPPORTED HORIZONTAL LINES

Notes:
(1) Material for support sheet - Carbon steel
(2) The length of the wood underlayer equals the length of the support sheet