

**RASHTRIYA ISPAT NIGAM LIMITED
VISAKHAPATNAM STEEL PLANT
VISAKHAPATNAM**

VSP-6.3 MTPA EXPANSION PROJECT

VSP-6.3/GS-M-06/R1

GENERAL SPECIFICATION

FOR

THERMAL INSULATION

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**M. N. DASTUR & COMPANY (P) LTD
CONSULTING ENGINEERS**



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GENERAL SPECIFICATION FOR THERMAL INSULATION

1.0 SCOPE

1.1 This General specification covers the thermal insulation required for hot as well as cold services, for pipes, ducts and various other requirements. The term Thermal insulation used here generally covers all items of the assembly used to minimise heat gain by cold services or heat loss by hot services and to avoid injury to people due to contact with hot or very cold surfaces. Such assembly shall include, but not be restricted to the material of insulation; the items, securing the insulation material to the part to which it is applied; the coating or wrapping applied to secure the insulation and to act as a vapour seal and/or protect the insulation material from damage due to environmental conditions and mechanical damage and cladding to hold the insulation in position, protect it from damage, give the insulation a neat and aesthetically pleasing appearance, and to act as a heat reflector, etc.

1.2 The design and installation of all thermal insulation shall be complete in every way for the service intended and suitable for achieving the desired reduction in heat transmission as well as maintaining the surface temperature within allowable limits. The installation shall be complete in all respects including all items essential for proper installation, irrespective of whether the requirements are specifically mentioned in the Technical and General Specifications.

1.3 This general specification does not cover thermal insulation for buildings and structures. However, for specific purposes such as air conditioning of work premises, for which thermal insulation of the conditioned space has been considered, relevant clauses of this specification shall be considered as applicable.

1.4 This specification does not cover insulation for furnaces, metallurgical and production equipment operating above 600 deg C, for cryogenic applications, for Cold Blast lines and for Steam lines in Power Plants.



1.5 If any special insulation system, not covered by this specification is required, the same shall be submitted with the proposal with detailed functional description and specification for the insulation system for Engineers' approval.

2.0 STANDARDS

2.1 The thermal insulation shall be designed, manufactured, tested and installed as per the standards mentioned in this specification. Detailed instructions on such aspects as are not indicated herein shall be as per the standards, codes and recommendations of Bureau of Indian Standards (BIS) or as per the national standards of the country of origin or the codes of practices followed by the manufacturer.

2.2 Wherever applicable, the following Interplant Standards for Steel Industry (IPSS) developed by the Steel Authority of India Ltd shall be followed.

- 1) IPSS:1-06-031-93 Code of Practice for Thermal Insulation of Cold Service
- 2) IPSS:1-06-015-93 Code of Practice for Thermal Insulation of hot pipelines and accessories

2.3 The thermal insulation used for electrical equipment shall conform to the latest codes of the International Electrotechnical Commission.

3.0 DESIGN BASIS

3.1 Thermal insulation shall be provided for all surfaces substantially hotter or cooler than ambient conditions. The following data shall be used for selection of thermal insulation.

Information of Plant Site and Design Ambient Condition:

Information of plant site and design ambient condition as given below shall be considered for design of air conditioning and ventilation systems.

Elevation above mean sea level (Formation level)	..	+ 10.5 m
Barometric pressure	..	760 mm Hg
Ambient temperature:		
Absolute maximum	..	45.3°C
Absolute minimum	..	10.5°C



Relative Humidity :		
Absolute maximum	..	100%
Absolute minimum	..	4%
Wind velocity:		
Highest monthly mean wind speed		
For 24 hours	..	21.4 Kmph
Extreme wind velocity	..	131.0 Kmph

3.0 DESIGN AMBIENT CONDITION

		<u>Summer</u>	<u>Monsoon</u>	<u>Winter</u>
Dry Bulb Temperature, (°C)	..	38	31	16
Relative Humidity, %	..	70	85	70
Cooling water temperature, (°C)	..	35		

3.2 Thermal insulation shall also be provided for spaces being served by air conditioning systems, if such insulation is specified in the relevant technical specifications or if such is warranted by reasons of economy or aesthetics.

3.3 The thermal insulation provided shall ensure that the temperature of outside surface of insulation (Cladding) shall be as follows:

- a) For hot service: Outside surface temperature shall not exceed 10°C above maximum ambient temperature
- b) For cold service: Outside surface temperature shall not be more than 10°C below the ambient temperature

4.0 MATERIALS AND APPLICATION

4.1 Insulation for Hot Services

4.1.1 These cover pipelines carrying hot fluids such as steam, condensate, hot water, hot oils, hot air, hot flue gases, etc., as well as equipment operating at elevated temperatures.

4.1.2 Insulation Materials

4.1.2.1 Mineral wool (made from rock, slag & glass) insulation materials shall be used for hot services. The insulation material shall be one of the following types.



4.1.2.2 For pipe work upto DN 350, pipe-sections of light resin-bonded mineral wool (rock/slag wool) as per IS:9842 shall be used. In addition to the compulsory requirements indicated in clauses 4.1 to 4.11 of the IS code, optional requirements laid down in clauses 4.12.1 to 4.12.4 of the IS code shall be fulfilled in all cases.

4.1.2.3 For pipe sizes above DN 350 and for flat surfaces and equipment, resin bonded mineral wool (rock wool) mattress as per IS:8183, with factory stitched G.I. Wire netting on outer surface. In addition to the compulsory requirements indicated in clauses 4.1 to 4.9 of the IS code, optional requirements laid down in clauses 4.10.1 to 4.10.7 of the IS code shall be fulfilled in all cases.

4.1.2.4 The minimum bulk density of insulating materials shall be as per clause no. 2.3 of IPSS:1-06-015-93.

4.1.3 **Anti-corrosive property:** The insulating material shall not cause corrosion of the surface on which it is applied. Chloride content of the insulation material shall not exceed 35 ppm, for application on stainless steel surface to avoid chloride corrosion. The thermal insulation shall be chemically inert and non-corrosive to GI. If chloride content of insulation exceeds 35 ppm at the time of application, GI foil wrapping (0.1 mm thick) shall be provided over the stainless steel surface before application of insulation.

4.1.4 **Heat resistance:** The insulating material of the selected bulk density shall be suitable for continuous use at the maximum service temperature specified in the technical specification. When tested as per IS:3144 by heating to the maximum service temperature, the material shall maintain its general form and shall not suffer visible deterioration of the fibrous structure.

4.1.5 **Insulation thickness**

4.1.5.1 For hot service equipments the required thickness shall be provided to ensure that the outside surface temperature of insulation is limited to values specified in clause 3.3 above. However, the minimum thickness of insulation adopted shall be 40 mm.

4.1.5.2 For hot service piping, the thickness of insulation shall not be lower than the thicknesses indicated in the table in Annexure-1. Where the actual maximum pipe surface temperatures are different from Table-1, the required insulation thickness shall be provided to ensure that the outside surface temperature of insulation is limited to value specified in clause 3.3 above.



4.1.6 **Insulation Application**

4.1.6.1 **Cleaning of surface**

The surfaces to be insulated shall be thoroughly cleaned, dried and made free from all loose scale, dirt, rust oil and grease.

4.1.6.2 All insulating materials shall be dry before application and shall be protected from moisture, weather and ingress of dirt.

4.1.6.3 For all types of insulation, expansion/contraction joints shall be provided at regular intervals not exceeding 8 metres. These joints shall be made by providing a gap of 25 mm between adjacent sections and filling up the same by compressing loose insulation of the same material. Suitable expansion joints shall also be provided on the metal cladding over insulation.

4.1.6.4 GI foil wrapping shall be provided over stainless surface to be insulated, as per clause 4.1.4 of this specification.

4.1.6.5 **Application of pipe section insulation**

4.1.6.5.1 The preformed pipe sections shall be snapped on to the pipe surface in a staggered configuration. End joints of adjacent pipe section blocks (both for straight runs and for blocks/segments for valves, bends etc) shall be staggered by one-and half of the length of the block. All insulation sections shall be trimmed and tightly butted to eliminate voids.

4.1.6.5.2 The insulation shall be firmly secured in place with at least three (3) loops of binding wire/band - two (2) located at 75 mm from each end and one (1) located at the middle. Mitred sections at bends and elbows shall be secured by minimum two (2) wire loops. Insulation at valves and other fittings shall also be suitably secured. Binding wire shall be 16 SWG (1.63 mm) G.I. wire. Band shall be of GI, 0.63 mm thick, and at least 20 mm wide. For pipe sizes DN 150 mm and below, insulation segments at bends shall be secured by spirally winding 16 SWG (1.63 mm) G.I. wire.

4.1.6.6 **Application of Mattress Insulation**

4.1.6.6.1 **Regular surfaces:** The surfaces to be insulated shall be cleaned of loose materials. Flat surfaces and larger diameter vessels/equipment shall be provided with M.S. spikes or studs welded to hold the insulation. Vertical pipelines shall be provided with M.S. collars as per clause 4.3.2. The insulating mattresses shall be fitted closely to



the surfaces, butting all joints tightly and laced down with 0.915 mm dia (20 SWG) G.I. wire joints in vertical as well as in horizontal planes which shall be staggered at least by 150 mm.

4.1.6.6.2 Irregular surfaces: In case of irregular surfaces after securing the insulation in place, all voids, depressions, cracks etc shall be filled with loose insulation material. Valves shall be insulated upto bonnet flanges: the insulation shall be applied only after initial operation has stabilised tightness and operation of valves and specials. Insulation for a flanged joint shall be forged in the shape of a continuous ring block, reinforced with metal lathe or equal with sleeves to cover adjacent pipe ends by at least 50 mm and be butted with the pipe insulations; the flange insulation shall be applied only after pressure testing of the pipeline. In case of flanged joints at pipe terminations and connections to uninsulated equipment, the pipe insulation shall be nearly levelled down to the flange so as to end inside the bolt circle.

4.1.7 Insulation Finishing

4.1.7.1 Cladding support: All insulation shall be provided with weather proof cladding of 0.63 mm thk GI sheets. The cladding shall be supported on spacers made of 25 x 3 mm thick steel flats, the spacers shall be fitted with 4 mm dia rivets to angle cleats, welded on to the surface being insulated. The angle cleats shall be of size, so that the gap between the surface being insulated and outer surface of the spacer is same as the desired insulation thickness. Pure asbestos mill board packing of 3 mm thickness shall be used between the cleats and spacers to minimize heat conduction. Spacer rings are not required for 80 mm dia and smaller pipes.

4.1.7.2 Cladding application: The cladding shall be bent true to shape, grooves made on all sides for making water tight joints and holes drilled for fixing. Each sheet shall be fixed to the spacers by means of studs: self tapping, flat headed, nickel plated steel screws shall be used for jointing the sheet. Suitable bitumen washers shall be used below all screws and studs and bituminous felt strips used between sheet metal joints to ensure water proofing. Irregular items like flanges, valves etc shall be clad with sheet metal boxes fitting the contour of insulation and continuous with the main cladding. Openings in the cladding shall be avoided as far as possible. Where openings are essential e.g. around pipe saddles, hangers, clamps, anchors etc., they shall be well filled with insulating material and finished smooth with the pipe insulation.



4.1.7.2.1 The cladding shall be applied with minimum 50 mm overlap on both longitudinal and circumferential joints. All overlaps shall be arranged to shed water. GI bands of 0.63 mm thick, 20 mm wide shall be fixed to secure the GI cladding, on a maximum 300 mm centres. One band shall be located on each circumferential joint and the distance between the joints divided into equal band spacing.

4.1.7.2.2 Metal cladding on vertical or near vertical piping with insulation outside diameters of 300 mm or more shall be supported from the adjacent lower section with minimum two (2) Nos. "S" clips fabricated from 0.63 mm thick GI sheet. The "S" clip shall be of sufficient length to allow minimum overlap of 50 mm.

4.2 Insulation for cold services

4.2.1 These cover pipelines carrying cold fluids, such as chilled water, cold drinking water, chilled brine, refrigerants, cold air ducts, air conditioned spaces etc as well as cold sections of refrigeration equipment, cold air handling units etc.

4.2.2 Insulation Materials

4.2.2.1 For pipe work upto DN 350, pipe-sections of light resin-bonded mineral wool (glass wool) as per IS:9842/expanded polystyrene shall be used. In addition to the compulsory requirements indicated in clauses 4.1 to 4.11 of the IS code, optional requirements laid down in clauses 4.12.1 to 4.12.4 of the IS code shall be fulfilled in all cases.

4.2.2.2 For pipe sizes above DN 350 and for flat surfaces and equipment, resin bonded mineral wool (glass wool) mattress as per IS:8183/expanded polystyrene, with factory stitched G.I. Wire netting on outer surface. In addition to the compulsory requirements indicated in clauses 4.1 to 4.9 of the IS code, optional requirements laid down in clauses 4.10.1 to 4.10.7 of the IS code shall be fulfilled in all cases.

4.2.2.3 Expanded polystyrene boards/resin bonded glass wool shall be used as underdeck insulation for the building roofs exposed to sun. Similar insulation shall also be used for insulating building walls, whenever necessary. In fire hazard area, self-extinguishing type resin bonded glasswool shall be provided. Expanded polystyrene blocks and pipe sections/segments shall be used for chilled water pipelines/valves. The material shall conform to IS:4671 and shall be of type 1 unless specified otherwise. The apparent density shall be compatible with the loading conditions. Self-extinguishing (type 2) material shall be used where fire hazard exists.



4.2.2.4 Entire supply air duct and part of return air duct passing through higher temperature zones shall be insulated. Resin bonded glasswool shall be provided for the purpose of insulation.

4.2.3 Insulation Thickness

4.2.3.1 For cold service equipment, the required thickness shall be provided to ensure that the outside surface temperature of insulation is limited to the values specified in Clause 3.3 above. However, the minimum thickness of insulation shall be 25 mm.

4.2.3.2 For cold service piping, the thickness of the insulation shall not be lower than the thicknesses limits indicated in the Table furnished in Annexure-1. Where the actual maximum pipe surface temperatures are different from Table-1, the required insulation thickness shall be provided to ensure that the outside surface temperature of insulation is limited to value specified in clause 3.3 above.

4.2.3.3 Initial 5m of supply air conditioning duct from the mouth of air handling/package air conditioner shall be provided with the acoustic insulation. The acoustic insulation shall be resin bonded glass/mineral wool with density not below 48 kg/m³ & thickness of the same shall be 12 mm, Cladding to be provided over insulation using Al sheet 30 G.

4.2.3.4 Supply and return air conditioning duct shall be insulated up to tail end. The insulation material shall be closed cell nitrile rubber/polyurethane Foam with density of 60±2 kg/m³ and having thickness of 13 mm in conditioned space, 25 mm thickness in unconditioned space. The thermal insulation material may also be provided Al foil faced resin bonded glass wool having density of 48 kg/m³ and thickness of 25 mm in conditioned space, 50 mm thickness in unconditioned space, the insulated duct shall be covered with 24 SWG Aluminium sheet.

4.2.4 Insulation Application

4.2.4.1 If mineral wool insulation is used, the method of application shall be as mentioned in clauses 4.1.7.1, 4.1.7.2, 4.1.7.3, 4.1.7.5 and 4.1.7.6. Before application of insulation a coat of solvent free anti-corrosive suitable primer shall be applied on the surface to be insulated. For galvanised steel surface, a special primer suitable for the purpose shall be used. The method of application for expanded polystyrene insulation shall be as per clauses 4.1.7.1, 4.1.7.2, 4.1.7.3 and as follows:



4.2.4.2 **Regular surfaces:** The surfaces to be insulated shall be thoroughly cleaned, dried and made free from all loose, scale, dirt, oil or grease and a coat of solvent free, anti-corrosive, suitable primer shall be applied. For galvanised steel surface, a special primer suitable for the purpose shall be used. Insulation blocks or shaped pieces shall be coated on the inside surfaces as well as edges, with hot industrial bitumen of grade 85/25 or other suitable solvent free bonding compound. The insulation shall then be stuck to the primed surfaces with adjacent sections tightly pressed; all joints shall be staggered and filled with bitumen. The insulation segments shall be secured by hexagonal G.I. wire netting of 0.915 mm dia (20 SWG) and the netting stitched with 0.915 mm dia (20 SWG), G.I. wire.

4.2.4.3 **Irregular surfaces:** In case of irregular surfaces such as flanged joint, valves etc, the main insulation shall be terminated at a distance necessary for removal of bolts. All irregularities on the surface shall be filled up with a mixture of expanded polystyrene granules and bitumen on which suitably cut insulation blocks or shapes shall be stuck to as in the case of regular surface, overlapping the main insulation. The insulation shall be secured with the main insulation by metal bands or tape and not stuck to one another by industrial bitumen. Valves shall be insulated upto their bonnet flanges.

4.2.5 **Insulation Finishing**

4.2.5.1 For mineral wool insulation the insulation finish shall be as mentioned in clause 4.1.8. Before applying the GI cladding, a vapour barrier shall be provided as described below:

4.2.5.1.1 **Vapour barrier**

A 3 mm (wet) thick coating of approved vapour seal mastic (suitable to retain its sealing properties at prevailing temperatures, non-corrosive to GI and stainless steel, compatible with the insulation material and fire resistant) shall be applied to the surface of the insulation as soon as possible, after erection, to reduce moisture ingress into the insulation system. Whilst this coat is still wet, open weave 10 mesh glass cloth (5 mil thick) shall be laid over the surface and embedded in the mastic. Care shall be taken to ensure that the glass cloth is laid smooth and free from wrinkles and that no pockets of air are trapped beneath the surface. At junctions in the glass cloth, the overlap shall not be less than 75 mm.



A second 3 mm coat of mastic shall be applied after approximately 12 hours. When dry, these two wet (3 mm + 3 mm = 6 mm) coats of mastic shall be converted to minimum 1.50 mm dry film thickness. The vapour seal shall be carried down over all exposed edges of insulation and bonded to the surface of pipe or vessel with a mastic fillet on long runs of pipe, the ends of insulation shall be sealed off at regular intervals, and the vapour seal shall be carried down to the pipe surface. The mastic shall not be applied over wet insulation. During the drying time, the insulation shall be protected from the weather by "Alkathene" film type tarpaulin or similar approved materials.

4.2.5.1.2 While fixing GI cladding, care should be taken to ensure that the vapour barrier is not punctured anywhere.

4.2.5.2 For expanded polystyrene insulation, Membrane type vapour barrier shall be used as per Clause 4.4 and 5.2.3 of IPSS:1-06-031-93. The finish of insulation shall be as indicated below.

4.2.5.2.1 For pipes, the insulation shall be covered with galvanised steel chicken wire of approved quality, finished with 1:4 cement sand plaster. Under deck insulation shall be applied at soffit of roof with two (2) coats of hot bitumen @ 2 kg/sqm over a primer coat of emulsion as per manufacture's specification. The insulation shall be covered with galvanised steel chicken wire of approved quality. For underdeck insulation, where there is no provision of false ceiling, the insulation shall be finished with 1:3 cement sand plaster.

4.2.5.3 The insulation shall be continuous as far as possible. Openings shall be made for supports, brackets, clamps etc., and where required timber saddles shall be provided on the lower half of pipe or duct in place of insulation.

4.3 **Special Insulation**

4.3.1 In case of special requirements not covered by clauses 4.1 & 4.2 of this specification, the insulation material, thickness, application and finish shall be subject to Purchaser's approval.

4.3.2 **Vertical Insulation Supports**

For all types of insulation on vertical or inclined piping (at an angle greater than 45 degree from horizontal), 6 thk M.S. collars (bolted) shall be provided at approximately 5 metres interval. O.D. of collar shall be 10 mm less than O.D. of insulation.



4.3.3 Insulation for Electric Heat Traced/Steam Traced Lines

Insulation on electrical heat traced/steam traced lines shall be applied so as to enclose both main pipe and tracer, and shall fit as snugly as possible. In case of steam traced lines, the steam tracer expansion loops shall be insulated and finished same as adjoining main pipe insulation.

If the traced line may at times be below dew point temperature, then the insulation shall be suitably sealed to make all joints vapour tight.

4.4 Special consideration for coastal location

Special consideration as laid down in Appendix-1 of IPSS:1-06-031-93 shall be taken into consideration for selection, application and installation of all types of insulation.

5.0 INSPECTION AND TESTING

5.1 Routine and type tests for various items shall be performed at manufacturer's works and test certificates including those for material/accessories furnished.

6.0 PAINTING

6.1 Hot surfaces provided with insulation and cladding need not be painted for corrosion protection. For cold surfaces provided with insulation and cladding, a primer coat as indicated in Clause 4.2.4 shall be applied.

6.2 Pipework having insulation and cladding shall however, be provided with colour identification for the fluids handled and for indicating direction of flow.

6.3 Equipment surfaces having insulation and cladding shall also have identification numbers and any other relevant data provided on the insulated surface.

6.4 All painting done as mentioned above for insulated surfaces shall conform to the relevant clauses of General Specification for Painting VSP-6.3/GS-P-01.



7.0 MEASUREMENTS

7.1 Measurements for insulation shall be taken over the finished insulation surfaces, in accordance with the measurement clauses in IS:14164 (latest). In case of any dispute, the decision of the Purchaser/Engineer shall be final and binding.

8.0 PERFORMANCE TESTING

Performance of the installed insulation system may be assessed against the specified requirement as per clause 7.1 of IPSS:1-06-015-93.

9.0 DRAWINGS AND OTHER DOCUMENTS

9.1 The following types of drawings and technical information shall be provided by the Insulation Contractor:

9.1.1 Properties of the insulating materials and test certificates.

9.1.2 Complete design data and drawings for all insulation works.

9.1.3 Sketches/Technical literature showing insulation materials, finish and method of application.

9.1.4 Manuals dealing with safety aspects and instructions for combating fire arising out of insulation work.

9.1.5 Instruction on maintenance of insulation work and storage of spare insulating materials.



ANNEXURE - 1

1.0 MINIMUM thickness of INSULATION FOR PIPES (In millimetres)

Pipe Size DN, mm	Hot Service			Cold Service
	Steam (315°C)	Steam (190°C)	Condensate (170°C)	Chilled water (Supply and Return) (7°C & 13°C)
15	60	40	40	25
20	60	45	40	25
25	60	45	40	25
40	65	50	40	40
50	70	50	40	40
65	75	55	40	40
80	75	55	50	40
100	80	55	50	50
125	90	60	50	50
150	90	60	50	50
200	90	60	60	75
250	100	65	75	75
300	100	65	75	75
350	100	65	75	75
400	100	65	75	75
450	105	65	75	75
500	105	70	75	75
550	105	70	75	75
600	110	70	75	75

NOTE:

- 1) The table above indicates the minimum insulation thicknesses for the above mentioned specific services. However, actual thickness shall be based on the above table or as per following, whichever is higher:
 - a) For hot service: Outside surface temperature of insulation cladding shall not exceed 10°C above maximum ambient temperature
 - b) For cold service: Outside surface temperature of insulation cladding shall not be more than 10°C below the ambient temperature.



- 2) In addition to the above the chilled water pipes (supply & return) will be insulated as follows:

The chilled water pipes will be insulated by PUF insulation or Closed cell Nitrile rubber/Polythene, CFC/HCFC free Insulation

PUF insulation (Thermal conductivity 0.04 W/m deg C at 10 deg C mean temperature & density shall not be less than 40 kg/m³) thickness shall be as follows:

For pipe size 100 NB and below - 50 mm

For pipe size 125 NB and above - 75 mm

Closed cell Nitrile rubber/Polythene, CFC/HCFC free Insulation (Thermal conductivity 0.035 W/m deg C at 0 deg C mean temperature & density shall not be less than 60 kg/m³) thickness shall be as follows:

For pipe size 40 NB and below - 25 mm

For pipe size 50 NB and above - 32 mm

Aluminium cladding will be provided over insulation of chilled water pipes.