APPENDIX - VII

SPECIFICATION FOR INSULATION

1.1 Scope

a. Insulating materials for all types as specified/required.

b. Finishing materials of all types including cement, protective coating, and sheeting as specified / required.

c. Angles, irons, clamps, lugs, etc. for supporting insulation on pipes, ducts, furnace, valves & fittings and equipment.

d. Wire mesh, lacing/binding wires, bands, straps, screws, etc. as required.

e. Weather hoods.

f. Refractory, insulating and red brick works with suitable bonding material.

g. Any other material as may be required for making the refractory and insulation work complete.

1.2 Codes and Standards

The supply and application of thermal insulation to piping systems and equipment covered under this Specification shall comply with all currently applicable regulations and safety codes in the locality where the thermal insulation will be applied. The insulating materials shall also conform to the latest editions of the codes and standards listed below.

Nothing in this specification shall be construed to relieve the **SUPPLIER** of this responsibility.

IS:737 : "Specification for wrought aluminium and aluminium alloys sheet and strip (For General Engineering Purpose)

IS:3346 : Method of determination of thermal conductivity of thermal insulation material.

IS:10556 : Code of practice for storage and handling of insulating materials.

IS:14164 : Industrial application and finishing of thermal insulating materials at temperatures above 80°C and up to 700 Deg. C

American Society for Testing and Materials

IS:8183 : "Specification for Bonded Mineral Wool"

IS 3150 : "Hexagonal wire netting for general purpose".

IS 3144 : "Methods of test for Mineral Wool Thermal Insulation Material"

1.3 General Design Requirements

All exposed portions of the plant which operate at temperatures of 60°C and above during normal operation shall be thermally insulated so that the temperature on the outer surface of the cladding shall not exceed by more than 20°C above ambient, based on an ambient temperature indicated in site data.

The specified insulation thicknesses shall not include the thicknesses of wire netting, finishing cement or any other finishing or weatherproofing application.

Removable insulation arrangement shall be provided for manholes and hand holes.

Insulation shall not fill the contours of the expansion bellows.

Personnel Protection

Piping and equipment that are not insulated but having a surface temperature exceeding 50 Deg.C shall be insulated for personnel protection.

1.4 Insulation of Equipment and Piping

1.4.1 Material Specifications

1.4.1.1 Insulating Materials

Compressed Resin bonded mineral wool mattress insulating material is specified in Table 1, it shall be of the required grade. The application

density of insulation for temperature up to and including 400 Deg. C shall be 100 Kg/Cu. m. The application density for temperatures above 400 Deg.C shall be 120 Kg/Cu.m.

1.4.1.2 Sheeting Material

The sheeting material for all insulated piping and equipment shall be aluminium conforming to codes specified in Table 1. The thickness of aluminium sheeting to be used shall be as follows:

a. Pipes of 450 mm (18 in.) and above, over outside diameter of insulation - 1.219 mm (18 SWG)

b. Pipes of 150 mm (6 in.) and above, over outside diameter of insulation but less than 450 mm (18 in) - 0.914 mm (20 SWG)

c. Pipes less than 150 mm (6 in) over outside diameter of insulation - 0.711 mm (22 SWG)

d. Flues and ducts, not less than 22 SWG

1.4.2 Piping

1.4.2.1 All vertical pipes shall be provided with suitable insulation supports to prevent the insulation from collapsing due to its own weight. Any welding required shall be done by the **SUPPLIER** with the prior permission of the **PURCHASER**/Engineer and only under his direct supervision. Where welding is not permitted, suitable clamped supports shall be used by the **SUPPLIER**. The insulation shall be applied starting from bottom to top.

1.4.2.2 The insulation shall be formed to fit the pipe and applied with edges pulled together tightly at the longitudinal joint and secured by lacing wire. The insulation shall be turned to bring this joint to the lower side. Adjacent length shall be butted closely and aced together with lacing wire. For insulation thickness of more than 75 mm, where application will be in two or more layers, each layer of mattress shall be backed up with wire netting chosen from 20 SWG galvanised steel wire and having hexagonal opening of 25 mm size. If the interface temperature is 400 Deg.C or more, the wire netting shall be from 20 SWG stainless steel wire and having hexagonal opening of 25 mm size.

1.4.2.3 The ends of all wire loops shall be firmly twisted together with pliers, bent over and carefully pressed into the surface of the insulation.

1.4.2.4 All insulation shall be protected by an outer covering of aluminium steel sheeting. All insulation sheeting joints shall be sealed and made effectively weather and water-proof. Extreme care shall be taken during the designing and installation of the insulation and the outer sheeting keeping in mind that the boiler will be installed outdoors. All flat surfaces shall be adequately sloped to prevent pools of water collecting. The sheeting shall be protected internally with 2 coats of bitumastic paint. The jackets shall be installed with the longitudinal lap joints at 45 Deg.C below the horizontal for horizontal pipes and the joints sealed with bitumastic paint.

On vertical pipes the jacketing shall be applied working from bottom up. Each section of jacketing shall have a minimum lap of 50 mm longitudinally and circumferentially. Each circumferential joint shall be made weather-proof by securing with an aluminium/galvanised steel strap and sealing with bitumastic paint. Longitudinal lap joints shall be fixed with zinc plated screws on approximately 150 mm centres.

1.4.3 Valves and Fittings

1.4.3.1 All valves, fittings and specialities shall be covered with the same type and thickness of insulation as specified for the adjoining pipe, with the special provisions and/or exceptions as listed below.

1.4.3.2 All valves and flanges shall be completely insulated with removable type of boxes fabricated from aluminium sheets of same thicknesses as used on adjoining pipes. Pipe insulation adjoining flanges shall be beveled back to permit removal of the bolts and nuts. The insulation shall be applied after the finish has been applied over insulation on the adjacent piping.

1.4.3.3 Flanges on lines covered with the minimum thickness of insulation (lower temperature range) shall not be insulated. Flanges on all other lines shall be covered with provisions for making the insulation removable and replaceable.

1.4.3.4 Unions shall not be insulated.

1.4.3.5 Non Metallic Expansion Joints shall not be insulated.

1.4.3.6 Safety valves, traps and safety valve discharge lines shall not be insulated. However, trap discharge lines shall be insulated for personnel protection.

1.4.3.7 Nozzles and other connections on tanks, heaters and other equipment shall be insulated in the same manner as the pipes.

1.4.3.8 Valves shall be insulated up to and including their bonnet flange.

1.4.3.9 Pipe hanger clamps shall be covered with insulation along with the pipe. When pipe hangers pass through insulation on piping outdoor, a metal hook placed with waterproof sealing material shall be supplied and installed. Care shall be taken to ensure that the upper bolts of hangers clamps are not insulated.

1.4.4 Equipment

1.4.4.1 Mineral wool blanket insulation to the specified thickness shall be provided. The supplier shall tack weld suitable 9 SWG wire lugs atleast 25 mm longer than the required length to support the insulation in place. These lugs shall be bent and secured with the metal fabric of the blanket, after the insulation has been applied. Where welding is not permitted, clamps of mild steel flats with bolts, nuts and lugs welded over the flat shall be used. The lugs shall be spaced at approximately 300 mm centres. Spacer rings, at 1000 mm shall be provided for fixing aluminium sheets. All blanket joints shall be butted tightly and the blankets shall be secured with 10 mm wide 25 SWG galvanised bands. After banding, all blanket edges shall be laced tightly.

1.4.4.2 All equipment shall have a smooth sheet aluminium jacket, applied in a manner similar to that specified for piping. All vertical and horizontal sheets shall be overlapped at a minimum of 50 mm. The longitudinal lapped joints of adjoining sections of sheets shall be secured with zinc plated screws. On all vessels over 2.5 metre diameter, the jacketing shall be further secured by circumferential bands at approximately one more centres. Each sheet joint shall be sealed with bitumastic paint. The roof sections shall overlap the side walls to prevent water seepage between insulation and the vessel wall. Side wall sheets shall be securely banded at inter-sections of the side wall and roof sections.

1.4.4.3 All equipment and vessel manholes, hatches, bolted or screwed cover plates, flanged ends, etc. shall have removable box type insulation, with same thickness of insulation as for adjacent surfaces. Insulation adjoining such equipment or vessel openings shall be tapered towards these openings to permit removal of bolts, screws, heads, covers or plates with no damage to adjacent surface insulation or cover.

The insulation applied to equipment shall be reinforced with 25 mm (1 inch) 20 SWG galvanised wire netting with hexagonal mesh. One course of wire netting shall be applied to the surface of the equipment, with an additional course per 40 mm of thickness. All

irregularities of the surface shall be filled and leveled over with insulating cement. Mineral wool blankets as specified shall be applied over the dry cement surface and secured with annealed wire lacings.

TABLE 1 - RECOMMENDED MINIMUM THICKNESS FOR THERMAL INSULATION (MINERAL WOOL)

NOMINAL DIA IN MM	OPERATING TEMPERATURE (°C)								
	100	150	200	250	300	350	400	450	520
15	25	25	40	40	50	60	75	90	100
20	25	25	40	50	60	60	90	90	115
25	25	25	40	50	60	60	90	100	115
40	25	40	40	50	60	65	90	115	150
50	25	40	40	60	75	75	100	115	150
65	25	40	40	60	75	75	100	115	150
80	40	40	50	60	75	90	100	125	150
100	40	40	50	60	75	90	115	125	150
150	40	50	50	75	75	100	115	150	175
200	40	50	60	75	75	100	125	150	175
250	40	50	60	75	75	115	125	150	175
300	40	60	60	75	80	115	150	175	200
350	50	60	65	75	80	115	150	175	200
400	50	60	75	75	85	115	150	175	200
450	50	60	75	90	90	115	150	175	200
	100	150	200	250	300	350	400	450	520
500	50	60	75	90	90	115	150	175	200
550	60	60	75	90	90	115	150	175	200
600	60	65	80	95	95	115	150	175	200
ABOVE 600 and for flat surfaces	60	65	80	95	95	115	150	175	200