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**TECHNICAL JOB
SPECIFICATION**

800/2

REVISION 0

DATE 05/04/2011

HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

THERMAL AND ACOUSTIC INSULATION FOR M/R STATIONS

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QUALITY ASSURANCE PAGE

CHANGES LOG

REVISIONS LOG

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REFERENCE DOCUMENTS

Job Spec. No. 830/1
[External Painting]
Job Spec. No. 831/1
[Insulating Coating Materials for M/R Stations]
Job Spec. No. 831/2
[Application of Insulating Coating for M/R Stations]

ELOT EN 485
[Aluminium and aluminium alloys - Sheet, strip and plate]

1.0 SCOPE

This specification defines requirements for thermal and acoustic insulation applied to the exterior of piping and equipment.

Equipment is deemed to be: vessels, boilers, heat exchangers, pumps, filters and other components which are specified to receive insulation.

Requirements regarding the extent of insulation based on the intended service will be detailed on the following job documents:

- Engineering Flow Sheets.
- Line Classification Lists.
- Piping Isometric Drawings.
- Instrument Piping Details.
- Vessel and Equipment Insulation Schedule.
- Other specific drawings.

In case of conflict between this specification and the above mentioned documents, Manufacturer/Vendor has to bring this to OWNER attention for clarification before to proceed.

Insulation requirements which are not part of this specification include the following:

- Internal insulation, refractories, or linings.
- Cold piping and equipment applications including insulation for the control of external condensation.

In principle, the acoustic insulation of piping and vessels shall be applied in the same way as the thermal insulation.

Insulation material on vessels shall be wired mats (100 kg/m³).

Aluminium jackets shall have a sheet thickness as shown in the relevant **para 3.2.1** of this Specification and shall be provided with an internal coating with compound absorbing vibrations.

Supports of jackets shall be constructed in such a way that they will prevent vibrations in piping and vessels from being transferred to the jackets.

Valves and equipment with an irregular form shall be acoustically insulated with enclosing noise dampening boxes of a design approved by OWNER or their Representative.

For the items which are to be acoustically insulated, requirements to noise reduction are apparent from the data sheets.

2.0 DESIGN

The service or purpose for which insulation is required shall be classified and identified with the applicable symbols in accordance with **TABLE 1**. This table shall also be used to determine the general conditions applicable to each classification.

TABLE 1

HC - Heat Conservation	Insulate when normal operating temperature exceeds 50°C.
PS - Process Stabilization	Insulate at any operating temperature when controlled heat loss is required.
PP - Personnel Protection	Insulate or provide expanded metal shields where normal operating temperature exceeds 50°C. The extent of insulation for PP shall be within 1.000 mm. horizontally of normal working area or access ways for an height of 2.000 mm. above the grade or a platform.
FPI - Fire Protection	Where insulation must serve also as fireproofing, insulating material shall be calcium silicate or high temperature rock-wool, and the jacketing shall be flat stainless or galvanized steel, 0.6 mm. minimum thickness tightup with stainless or galvanized steel screws, respectively.
ST - Steam Tracing	Insulate at any operating temperature when steam tracing is required.
SJ - Steam Jacketing	Insulate at any operating temperature when steam jacketing is required.

Normal operating temperature of the fluid in the piping or equipment shall be used as the hot face temperature for considerations regarding insulation requirements as follows:

- When a vessel has more than one portion operating at different temperatures, each portion may be insulated as required to suit its operating temperature.
- For traced piping or equipment, the temperature of the traced fluid or that temperature to which the traced fluid is to be maintained shall be used.
- For jacketed piping or equipment the insulation requirements is to maintain a jacket (secondary) fluid temperature that will provide the necessary heat input of the process (primary) fluid.
This shall be accomplished with HC insulation unless otherwise indicated for a specific case.
- Unless indicated for specific cases, conditions which as may occur during start-up, shutdown, steam-out, process upsets, regeneration, e.t.c, need not be

considered in determining insulation requirements. However, when the surface temperature may exceed 50 °C, Personnel Protection shall be considered.

- Piping returning steam condensate shall be insulated for heat conservation. Condensate piping discharging to a sewer shall be insulated through the last horizontal run as a precaution against freeze-up or as required for personnel protection.

Instrument components subject to flow and/or temperature conditions approximating those in the piping or equipment to which they are connected shall be insulated to the same requirements.

Insulation shall be omitted on the items listed below.

However, when PP is required, expanded metal shields shall be used as follows:

- All equipment and piping where heat loss is desired.
- Internally insulated piping or equipment. Such piping and equipment shall have a warning note painted on it stating that external insulation is prohibited.
- All valves, including control valves, and flanged connections where operating temperature is ambient to 150 °C. Bolting for insulated flanged connections shall be suitable for process temperature.
- Piping and equipment which becomes hot intermittently, such as relief valves, relief systems, vents, drains, pump-out and blow-down systems, steam-out and purge steam systems.
- Pipe union fittings.
- Strainers.
- Steam traps.
- Bellow portion of expansion joints, hinged joints and hose assemblies.
 - Sight flow indicators.
 - Nameplates on vessels, exchangers and machinery.
 - Supports for piping or equipment, except as stated in **para/3**.
 - Buried steel pipes and components in natural gas piping systems those will be insulating coated as per relevant DESFA Specifications (**Job Spec. No. 831/1 and Job Spec. No. 831/2**).

If the support skirts for vertical vessels are not fireproofed, the insulation on vessels shall be carried below the tangent line for a distance of 600 mm., but it shall end not less than 300 mm. above support concrete or steel. If the skirt is fireproofed, the insulation shall extend to the top of the fireproofing and stainless steel jacketing shall be used to protect the skirt insulation below the tangent line.

All valves, including control valves and flanged connections in insulated lines which operate at temperatures over 150 °C, shall be insulated using same insulation thickness as the pipe. The bonnets on the valves shall not be insulated. Flanged valves shall have removable insulation similar to insulated flanges. Screwed or welded valves shall be insulated with insulating cement and weatherproofed with mastic.

Insulation thicknesses given in **TABLE 2 and 3** are for heat conservation and personnel protection.

For process stabilization insulation, the thickness shall be based on calculations for the specific case and shall be indicated on the flow diagrams.

Expansion loops and cross-overs in the heat tracer that are external to the insulation shall be wrapped with a waterproof fiberglass cloth tape to a thickness of 6 mm.

Insulated piping shall be supported on steel shoes.

The height of the shoe shall be such that the bottom of insulation is above the support upon which the shoe rests.

Pumps and other mechanical equipment shall be insulated on an individual basis with consideration given to the requirements for process access and equipment maintenance.

Insulation shall be protected from the weather, spillage, mechanical wear, or other damage by a metal jacket. Weatherproofing mastic may be used on irregular surfaces or on surfaces for which metal jacketing is not practical.

Insulation support rings shall be provided on vertical piping and vessels. The spacing of the rings shall coincide with the insulation expansion joints.

Vertical vessels shall have minimum of two (2) insulation support rings, one at or below the bottom, tangent line and one at the top tangent line.

Expansion joints in the insulation shall be used to provide for the differences in the coefficient of thermal expansion between the insulation material and the piping or equipment material. Expansion joints shall be packed with a loose fiber insulation material. A 25 mm wide space packed with loose insulating fiber, shall be provided on vessels around all nozzle and manway necks, or any other attachment to the vessel wall.

Maximum spacing for circumferential expansion joints on vessels and piping shall be as follows:

MAX TEMPERATURE °C	MAX JOINT SPACING (m)
40 to 120	9
121 to 200	4.5
201 to 315	3.5
316 to 480	3
481 to 650	2

On vertical piping and vessels, the expansion joints shall be located under the insulation support rings.

FIRE PROTECTION

- Insulation material and jacketing are specified in **TABLE 1**.
- Jackets shall be banded on 150 mm. centers.
- Polyvinyl acetate mastic shall be used for weatherproofing on surfaces where it is impractical to use the jacket.
- Insulation thickness shall normally be the same as required for heat conservation.

3.0 **MATERIALS**

3.1 **BASIC INSULATION MATERIALS**

The materials to be used for the hot insulation shall be as follows:

- Glasswool blanket for fluid operating temperature up to 400 °C, when fire proofing is not specified. (For FP Insulation see **TABLE 1**). The blanket will be supported with wire mesh on one side.
- Rockwool blankets for fluid operating temperature from 400 °C up to 650 °C.

The blankets will be supported with wire mesh on one side.

- Rockwool reformed sections, blocks, slabs, up to the temperature limit specified by the Manufacturer.

Glasswool material shall have the following properties:

- Non combustibility.
- Chloride content: 30 ppm max.
- Density: 66 kg/m³.

Thermal conductivity at mean temperature shall not exceed by more than 10% the design thermal conductivity here specified versus temperature:

GLASSWOOL

TEMPERATURE (°C)	THERMAL CONDUCTIVITY (kcal/mt hr °C)
50	0.033
100	0.039
200	0.057
300	0.082
400	0.120

Rockwool material shall have the following properties:

- Non combustibility.
- Chloride content: 30 ppm max.
- Density: 100 kg/m³.

Thermal conductivity at mean temperature shall not exceed by more than 10% the design thermal conductivity here specified versus temperatures:

ROCKWOOL

TEMPERATURE (°C)	THERMAL CONDUCTIVITY (kcal/mt hr °C)
0	0.030
50	0.036
100	0.045
200	0.062
300	0.086
400	0.120

3.1.1 INSULATION THICKNESS

Insulation thickness to be used for heat conservation and for personnel protection are shown in **TABLES 2 and 3** herein attached.

3.2 **ACCESSORY MATERIALS**

3.2.1 METAL JACKET FOR WEATHERPROOFING

The metal jacket shall be aluminum material alloy in accordance with **ELOT EN 485** with H14 or H16 temper.

Aluminum sheets type and thickness shall be as per following Table:

		Piping with outside diameter, including insulation, 1500 mm and smaller	Piping with outside diameter, including insulation, larger than 1500 mm and equipment
(2)	Type	Flat	Corrugation
(2)	Thickness (mm)	0.8	0.6
(2)	Pitch of Corrugated (mm)		76
	Height of corrugation (mm)		19

Metal jacketing for vessel heads, machinery, pipe fittings and other irregular surfaces shall be flat, 1 mm thick.

3.2.2 Miscellaneous materials shall comply with the following:

- a. Bands (straps) and band seals to hold jacketing in place shall be 18% Cr-8% Ni Steel Straps for securing insulation and jacketing shall be 0,5 mm thick.

The widths of the bands for the various applications are given in **para 4.2**.

- b. Self tapping screws for closing longitudinal seams in aluminum jackets shall be 18% Cr-8% Ni Steel.
- c. Wire mesh shall be 25 mm. hexagonal pattern galvanized poultry netting. Wire for securing wire mesh can be galvanized iron material, 2mm. min. size.
- d. Support rings, welding studs and pins shall be carbon steel for carbon and low chromium steel vessels and 18% austenitic stainless steel for austenitic steel vessels.

They shall be installed prior to any postweld heat treatment of the item being insulated.

- e. 18% Cr - 8% Ni steel breather springs, corrugated bands and "S" clips shall be used to hold jacketing in place on such parts which operate at high temperature.

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Self tapping screws may only be used where high thermal stresses are not likely to be encountered.

- f. Floating ring to hold in place insulation on vessel heads shall be a 6 mm round steel rod.
- g. Mastic for weather-proofing type FOSTER 60- 25, 30-45 or equal.

4.0 INSTALLATION

4.1 GENERAL

All hydrostatic tests on vessels and pipework will be carried-out before insulation is applied.

Surfaces to be insulated shall be clean, dry and free from loose scale.

Piping and equipment in continuous service with operating temperatures up to 93 °C shall be cleaned and primed in accordance with General Specification for Painting **Job Spec No. 830/1**.

Painted surfaces shall be insulated only after paint has dried.

Insulation shall not be installed over joints (welds, flanges, pipe thread, e.t.c.) or tracer until required field testing has been completed and such joints or tracers are proven tight.

The materials shall not be stored in contact with the ground.

Insulation on pipes shall be discontinued at the flanged connections to permit removal of the studs. The distance from the end of insulation to back of flange on both sides of the connection shall be equal to one stud length plus 25 mm.

The ends of insulation shall be beveled at non insulated flanges.

At insulated flanges, the ends of insulation shall be straight.

In both cases the ends of insulation shall be weatherproofed.

Weatherproofing for process temperatures up to 150 °C may be a sealant such as Foster 30- 45 or equal. For higher temperatures, aluminum or stainless steel flashing shall be used.

Voids due to fitting of rigid insulation may be filled with insulating-finishing cement.

However, such cement shall not be used in contact with any stainless steel components or with electrical tracers. Instead, in such cases, the insulation shall be cut to eliminate the voids.

If insulating cement is necessary over a tracer, aluminum foil shall be used to prevent the insulating cement from entering between the tracer and the component. Cement shall not be used in expansion joints of insulation.

Single-layer insulation shall be applied with longitudinal joints staggered. In multiple-layer application, all joints or adjacent layers shall be staggered. All insulation shall be installed with the joints tight, except at packet expansion joints.

Stiffening rings on equipment shall be covered with same insulation thickness as the equipment itself.

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If blanket insulation used on large vessels requires to be impaled on pins, welded to the vessel, all welding required for installation of insulation must be approved by OWNER.

4.1.1 INSULATION ON HEAT EXCHANGERS (SEE FIGURE 1)

Insulation on shell and tube heat exchangers shall be removable as far as necessary to allow pulling bundles without damaging insulation.

The heat exchanger insulation shall be applied in accordance with the instruction given for vessels and pipes but with the following exceptions:

- flanges are not to be insulated, there shall be sufficient space between insulation and flanges to remove bolting in both directions (see **FIGURE 1**).
- shell cover shall be provided with removable insulation fixed by bends and toggled fasteners.

Insulation material shall be held in place with tie wires or bands as follows:

INSULATION TYPE	OUTSIDE DIAMETER OF INSULATION	WIRE OR BAND SIZE	SPACING (*)
Single or Outer of Double Layer	300 mm max.	Wire	230 mm to 300 mm
Inner of Double Layer	900 mm max.	Wire	230 mm to 450 mm
Single or Outer of Double Layer	Over 300 mm to 900 mm	Wire	230 mm to 300 mm
Single or Outer of Double Layer	Over 900 mm to 1.8 m	13 mm wide Band	300 mm to 450 mm
Inner of Double Layer	Over 900 mm to 1.8 m	Wire	450 mm
Single or Outer of Double Layer	Over 1.8 m to 3 m	13 mm Wide Band	300 mm
Inner of Double Layer	Over 1.8 m to 3 m	Wire	300 mm
Any Layer	Over 3 m	20 mm Wire Band	300 mm

(*) Not less than two wires (or bands for single or outer layers over 1 m) per standard length of insulation.

4.2 WEATHERPROOFING

Metal jackets shall be installed in a manner to shed water and shall have a minimum of 75 mm. overlap (with corrugated finishing) for horizontal and circumferential seams. Where jacket surfaces are cut to provide for protrusions, flashing shall be provided and installed in a manner to keep water from entering behind the jacket. Orange peel segments of head jackets shall be lapped 75 mm. minimum and shall be sealed with mastic type Foster 60-25 or equal.

This mastic seal shall also be used for the vertical seals of all metal jackets (i.e., all longitudinal seams on vertical piping and equipment and all circumferential seams on horizontal piping and equipment).

Mastic weatherproofing shall be applied in two coats. For pipe sizes larger than DN50, the mastic shall be reinforced between coats with 250 x 250 mm. mesh glass fabric.

Transitions between metal jacketing and mastic cover protection, or terminations of either type of cover, shall be in a manner to provide for water runoff. This may be accomplished either by flashing or overlapping as follows:

- a. For horizontal conditions, the mastic shall extend under the metal jacket for at least 75 mm.
- b. For joints at top of vertical cylinders, the mastic or head jacket shall overlap the outside surface of the metal jacket, or flashing shall be used. The overlap, in any case, shall be at least 75 mm.
- c. For joints at the bottom of vertical cylinders, the mastic or jacket of the head shall be installed under the jacket of the cylinder.
- d. In locations where mastic extends over the outside of metal jackets or steel rings, e.t.c, masking tape shall be used and removed to effect an even termination of the mastic.

Metal jackets shall be held in place with bands and self tapping screws as follows:

- O.D. of jacket 760 mm and less: One 13 mm. wide band at each circumferential joint, plus at least one intermediate band. Maximum band spacing shall be 300 mm.
- O.D. of jacket over 760 mm: One 20 mm. wide band at each circumferential joint, plus at least one intermediate band. Maximum band spacing shall be 600 mm.
- On vertical piping, vessels and equipment, "S" clips shall be used to keep jacket sheets from sliding. "S" clips shall be spaced at 300 mm. intervals, but not less than two clips per sheet.
- "J" clips shall be used to support the bands on vessels over 3 m. in diameter. The "J" clips shall be attached to the jacket with self-tapping screws and shall be spaced about 1,8 m. apart.

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- Galvanized screws shall be used on longitudinal joints and for securing flashing sheets to provide weather-tight installations. Spacing of screws shall not exceed 150 mm.
- Breather springs, corrugated bands and "S" clips shall be used to hold jacketing in place on parts which operate at high temperature. Self tapping screws may only be used where high thermal stresses are not likely to be encountered.
- Jackets attachment shall be designed to hold the jacket in place for the condition of design (fastest mile) wind velocity (... km/h).

When piping to be insulated is to pass through sleeves, then the jacketing of the insulation shall be sealed off properly against the protecting sleeve.

Vessel and machinery nameplates and code inspection plates shall not be covered with insulation.

Insulation shall be beveled away from such markings and sealed against water entry. Cavities created by the absence of insulation over the nameplates, which are positioned in a way that water, dust, or other matter may accumulate in them, shall be fitted with removable plugs made from the insulation material. Such plugs shall be clearly and permanently marked with the word "NAMEPLATE".

Insulation Contractor shall temporarily protect insulation material against wetting when it must remain exposed to the weather, for any length of time and for any reason, before final jacketing protection is installed.

5.0 GUARANTEES

Refer to Purchase Order.

TABLE 2
INSULATION THICKNESS FOR HEAT CONSERVATION (mm)

NOMINAL PIPE SIZE	OPERATING FLUID TEMPERATURE (°C)										
	100	150	200	250	300	350	400	450	500	550	600
20	40	40	40	40	60	60	60	60	80	80	80
25	40	40	40	40	60	60	60	80	80	80	80
40	40	40	50	50	60	60	80	80	80	80	100
50	40	40	60	60	60	80	80	80	80	100	100
65	40	40	60	60	60	80	80	100	100	100	130
80	40	50	60	80	80	80	100	100	100	130	130
100	40	50	60	80	80	100	100	100	100	130	150
150	40	50	80	80	100	100	100	130	130	130	150
200	40	60	80	100	100	100	100	150	150	150	180
250	40	80	80	100	100	100	100	150	150	150	180
300	50	80	80	100	100	100	150	150	150	150	180
350	50	80	80	100	100	130	150	150	150	180	180
400	50	80	80	100	100	130	150	150	150	180	180
450	50	80	80	100	100	130	150	150	150	180	180
500	50	80	80	100	100	130	150	150	150	180	210
550	50	80	80	100	100	130	150	150	180	180	210
600	60	80	80	100	100	130	150	150	180	180	210
750	60	80	80	130	130	150	150	180	180	210	210
FLAT	60	80	80	130	130	150	150	180	180	210	250

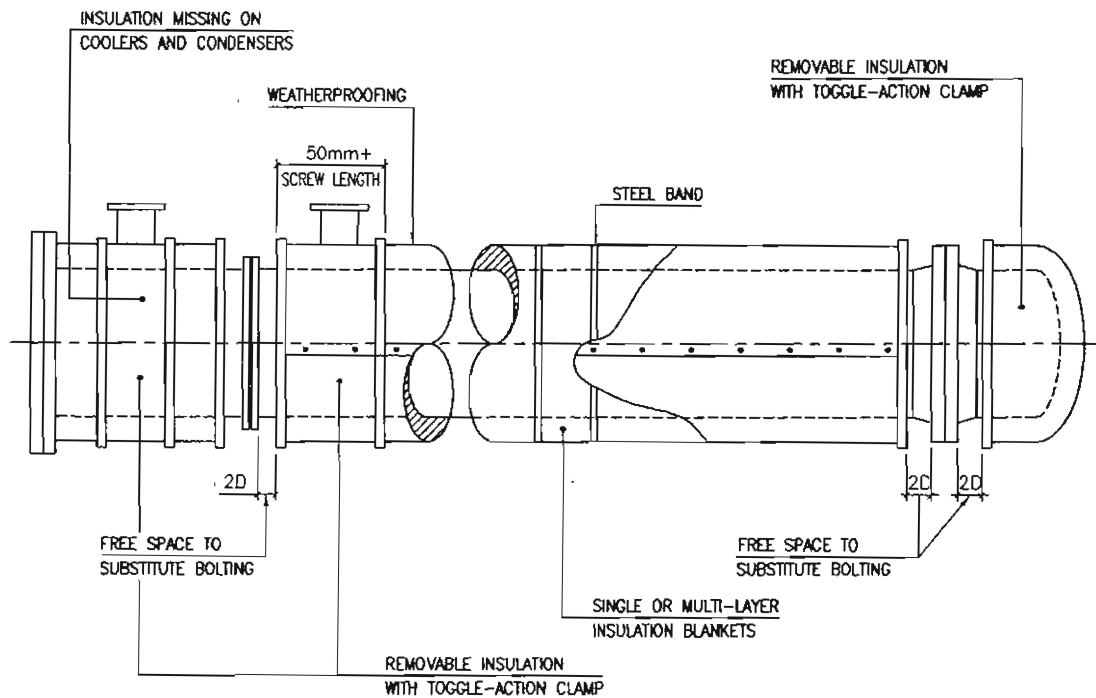
(1) Insulation for thickness greater 100 mm shall be applied in two or more layers.

TABLE 3

INSULATION THICKNESS FOR PERSONNEL PROTECTION

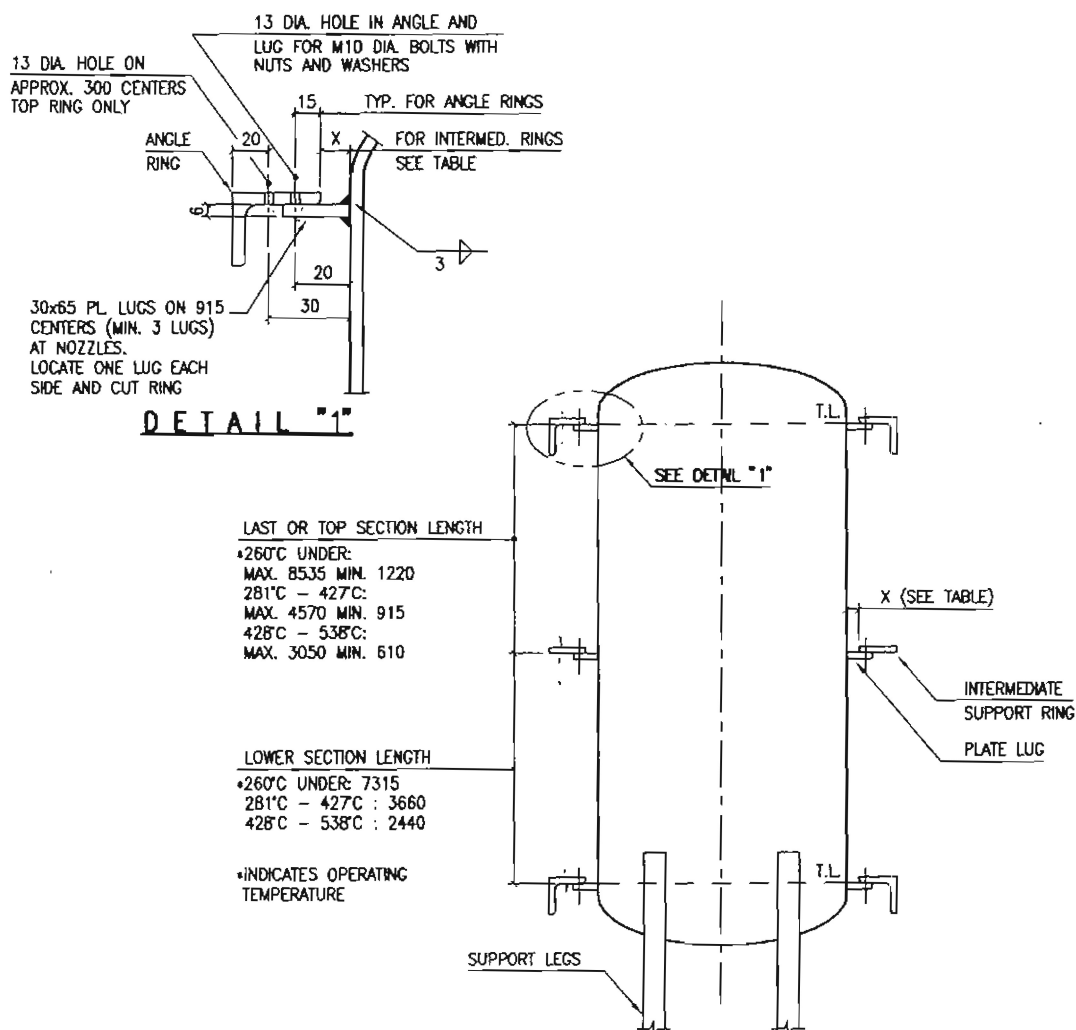
OPERATING TEMPERATURE (°C)	INSULATION THICKNESS (mm)
50-100	30
101 -200	30
201 -300	40
301 -400	60
401 - 500	100

HEAT EXCHANGER
FIG. 1



D = BOLT DIAMETER

INSULATION ATTACHMENTS FOR VERTICAL HOT VESSELS SUPPORTED ON LEGS
FIG. 2



INSULATION THICKNESS (SEE VESSEL DWG)	INSULATION ANGLE AND RING SIZE		
	ANGLE (3)	FLAT INTERMED. SUPPORT RING	DIMENSIONS "X"
40	50 x 50 x 5	40 x 5	0
50	60 x 60 x 5	40 x 5	3
60	75 x 50 x 6	45 x 5	6
80	90 x 90 x 8	60 x 6	10
100	120 x 80 x 8	80 x 6	10
130	150 x 100 x 12	110 x 6	10
150	160 x 80 x 8(2)	130 x 6	10
180	190 x 80 x 8(2)	160 x 6	10

NOTES

1. ALL DIMENSIONS ARE IN mm.
2. ANGULAR RING OBTAINED FROM FLAT BAR.
3. DIFFERENT SIZE OF ANGULAR RINGS MAY BE ACCEPTED BUT THE LONG LEG DIMENSION OF ANGLE TO BE MAINTAINED.