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# MARITZA

## MASTER SPECIFICATION THERMAL INSULATION

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## 1. SCOPE

This document defines the conditions of design, materials procurement, and guarantees concerning the thermal insulation of pipes, equipment and large tanks.

- The following types of thermal insulation are considered herein :
- Heat-loss thermal insulation (conservation of calories),
- Insulation for personnel protection,
- Insulation for traced piping and equipment,
- Insulation for frost protection,
- Anti-condensation insulation,
- Acoustical, sound insulation
- Insulation of turbine casings and inlet valves,

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Thermal insulation of boiler and its associated equipment will be detailed later

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## 2. APPLICABLE CODES AND STANDARDS

- BS 3177 Permeability to water vapour of flexible sheet materials
- NFP 52306-1 Insulation of circuits - Equipment and accessories
- 1 • DIN 18165 Fibrous insulating building materials – HOLD: Validity to be checked
- DIN 4140 Insulation work on industrial installations and building equipment - Execution of thermal and cold insulation
- DIN 4102 Fire behavior of building materials and building components
- 1 • DIN 1725 Domestic furniture - Beds and mattresses - Safety requirements and test methods – HOLD: Validity to be checked
- AGI specification Q 135 Thermal insulation - Water soluble chlorides in mineral wool insulants - Determination, limit values, marking
- ISO 1182 Reaction to fire tests for building products - Non-combustibility test
- VDI 2055 Thermal Insulation for Heated and Refrigerated Industrial and Domestic Installations
- GGG/00/M/MCE---/EG018 Erection rules for thermal insulation (schematics).

## 3. BASIC DATA

### 3.1. Design of personnel protection insulations

1 All accessible parts of equipment or piping whose height is less than 2 m above the accessible floor or grating or is located within 0.8 m horizontally from any level within the reach of the operating personnel, with a surface temperature above 55 °C in steady state or transient operation, shall be provided with personnel protection by thermal insulation or perforated sheets. The personal protection insulation thickness is determined so that the external surface temperature of the insulation sheathing does not exceed the room temperature by more than 25 °C. For turbine the external surface temperature of the insulation sheathing does not exceed the room temperature by more than 20 °C.

### 3.2. Design of heat loss and tracing thermal insulation

The heat-loss thermal insulation is destined to the conservation of piping and equipment calories whose losses are included in the Unit heat rate. All pipe work or items of equipment whose surface temperature exceeds 55 °C in steady state operation shall be thermally insulated.

#### 3.2.1. Thermal insulation surface temperature

The thermal insulation thickness is determined in calm air so that in steady state the external surface temperature of the thermal insulation does not exceed the room temperature by more than 25 °C.

The ambient temperature for thickness calculation is 35 °C.

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The average thickness is calculated with an external surface heat transfer coefficient for the external sheathing of

- 11.5 w/m<sup>2</sup> °C for outdoor surface
- 10 w/m<sup>2</sup> °C for indoor surface

### 3.2.2. Limit heat losses for heat-loss and tracing thermal insulation

The thermal insulating layer thickness is determined in such a way that the unit heat losses of surfaces of piping or equipment, which are not singular points (e.g. elbows, valves, flanges, supports, etc.), remain generally below 250 W/m<sup>2</sup>.

### 3.2.3. Maximum values of the average thermal conductivity coefficient of the thermal insulating materials

The average thermal conductivity coefficient of the thermal insulating material shall not exceed the following values.

Fluid temperature (°C)	Mean temperature of insulating material (°C)	Average thermal conductivity coefficient – Maximum value (W/m/°C)
100	75	0.045
150	100	0.048
200	125	0.053
250	150	0.059
300	175	0.065
350	200	0.071
400	225	0.075
450	250	0.081
500	275	0.088
550	300	0.095

For intermediate values of fluid temperature, the maximum value of the average thermal conductivity coefficient is deduced by interpolation.

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### 3.2.4. Thicknesses of thermal insulations

The following table defines the average thicknesses of indoor or outdoor insulation to be adopted according to the fluid temperatures and piping or equipment diameters for the purpose of meeting the requirements of chapters 3.1 and 3.2. For diameters between 2 values of the table, the thickness to be chosen is the one corresponding to the higher value. For installation reasons, the thicknesses may be reduced locally.

Insulation class	Operating temperature (°C)	Pipe size (mm)	Inner layer (mm)	Outer layer (mm)	Total (mm)
A	540 – 426	≤ 40	70	60	130
		50 – 100	80	70	150
		125 – 200	100	70	170
		≥ 250	100	100	200
B	425 – 261	≤ 40	90	--	90
		50 – 100	100	--	100
		125 – 250	120	--	120
		≥ 300	70	70	140
C	260 – 151	≤ 50	60	--	60
		≥ 65	70	--	70
D	150 – 65	≤ 250	40	--	40
		≥ 300	40	--	40
E	538 – 261	Equipment	120	90	210
F	260 – 96	Equipment	70	--	70
G	95 – 65	Equipment	40	--	40
H	Anti-sweat	≤ 40	13	--	13
		≥ 50	25	--	25
I	Anti-freeze 65 and below	All	50	--	50

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### 3.3. Sound Pressure Level attenuation of the thermal insulation

#### 3.3.1. Normal insulation

Insulation materials, metallic sheeting and accessories (supporting elements, connecting means like screws, etc.) shall achieve the following minimal attenuation for the Sound Pressure Level emitted by the equipment or pipe. (Insertion loss).

Insulation thickness	Attenuation in dB						
	Frequency Hz						
	63	125	250	500	1000	2000	4000
$30 \leq th < 100$	0	0	2	5	8	10	12
$th \geq 100$	0	2	4	7	10	12	14

#### 3.3.2. Acoustic type insulation

- Some equipment like bypass valves and their connecting steam pipes may be insulated with acoustic type insulation.
- The mattress isolation material is rockwool or glasswool with a minimal density of 80 kg/m<sup>3</sup>.
- One layer of antivibratil heavy material will be applied between two coats of rockwool or on the inside part of the external sheet. Furthermore, special attention shall be taken to avoid acoustic bridges through supports and connections.
- Acoustic type insulation shall achieve the following minimal attenuation for the Sound Pressure Level emitted by the equipment or pipe.

Frequency Hz	63	125	250	500	1000	2000	4000	8000
Attenuation dB	1	3	5	10	20	25	30	30

The minimal thickness of acoustic type insulation shall be 100 mm.

### 3.4. Dimensioning of anti-condensation thermal insulation

Anti-condensation insulation shall be installed on cold surfaces incurring high risks of condensation. These surfaces are determined from an hygrometric diagram. The cold surface is insulated when the surface temperature is below the dew point.

The principal surfaces concerned are the chilled water piping surfaces in air-conditioning plants, which insulation thickness is generally 50 mm.

The thermal insulating layer thickness shall be determined so as to achieve an insulation surface temperature higher than the dew point.

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### 3.5. Design of anti-frost thermal insulations

The thickness is determined according to the characteristics of the thermal insulating material, the geometry of the pipework or item of equipment, the water flow rate and initial temperature and, as and when applicable, the plant shutdown duration or the heating power installed.

## 4. DESIGN REQUIREMENTS

### 4.1. Insulating materials

#### 4.1.1. Main characteristics

Materials shall be free from asbestos and sulphur, chemically neutral, stable at the service temperature and under humidity, non-flammable, imputrescible and resistant to vermin.

For use on stainless steel surface, insulating materials shall be of low halogen content and with chlorine content less than 6ppm so that insulation meets the requirement of AGI specification Q135.

In all cases the limit temperature of the insulating materials shall be at least 50 °C higher than the considered fluid temperature.

The choice of the material shall allow :

- Sufficient mechanical strength
- Perfect cut-out of joints
- Exact fit to the shapes of the surfaces to be insulated.

#### 4.1.2. Nature and presentation of the insulating materials

According to their conditions of use and temperature, the materials used shall fall under one of the following categories :

- Rockwool piping sections as 1st insulating layer on piping of diameter up to ND 150 inclusive.
- Rockwool mattresses sewn on galvanized wire netting as :
  - first insulating layer on piping of diameter greater than ND 150,
  - other layers of all pipes,
  - removable insulation,
  - insulation of equipment.
- Mineral wool blanket insulation shall be applied up to 120mm maximum in one layer.

In case of use of mattress on stainless steel components or pipes, the rockwool shall be sewn on stainless steel wire netting.

- Rockwool, polyurethane or polyisocyanurate slabs for insulation of large vessels.

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- Antisweat insulation shall be flexible elastomeric cellular thermal insulation. Outdoor antisweat insulation shall be protected with paint or lagging according manufacturer recommendation
- Loose mineral wool for padding/spraying around the HP/IP bodies of the steam turbine and around the bodies of their stop valves.
- For reasons of standardization, rockwool may be used for all applications

#### 4.1.3. Minimal density of insulating materials

- Rockwool : 80 kg/m<sup>3</sup>
- Polyurethane and polyisocyanurate : 35 kg/m<sup>3</sup>
- Loose mineral wool after padding : 140 kg/m<sup>3</sup>

#### 4.1.4. Settling

The settling of the insulating material at the maximum service temperature under a pressure of 103 Pa, measured according to VDI 2055 standard, shall be less than 5 %.

#### 4.1.5. Fire resistance

The insulation material should be non combustibile according to DIN 4102 A1

#### 4.2. Protective external sheathing of the thermal insulating material

All insulated surfaces of equipment, ductwork, piping, and valves shall be lagged with aluminium alloy seawater resistant, Alloy AlMg2Mn098, acc. to DIN 1725 or acceptable equal. All aluminium lagging shall be stucco pattern embossed.

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The hard case of the insulation of the steam turbine HP and IP bodies and their stop valve bodies is generally constituted of insulating cement with a thickness of approximately 5 mm. An oil-resistant, water proof coat will be applied as additional protection.

A coating reinforced with glass or nylon cloth may be applied on trench piping. This coating shall satisfy the protection and tightness requirements of the insulation and serve as a vapour barrier. Its other characteristics are given in paragraph "Vapour barrier".

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**Minimal thickness of the metal sheathing, in mm :**

**a) Piping and equipment**

Outside diameter of insulation		Aluminium or aluminium alloy
Piping:	≤ 330 mm	0.8 mm
	> 330 mm	1.0 mm
Equipment	Ribbed	0.8 mm
	Flat	1.2 mm
Removable boxes	Valve or flange ND ≤150	0.8 mm
	Valve or flange ND > 150	1.0 mm

To make sheet procurement easier, one of the thicknesses may be suppressed, in which case it shall be replaced by the next higher thickness.

#### 4.3. Accessories for installation of thermal insulations

As a rule, the accessories (wire, screws, rivets, strap, putty, etc.) must hold in place the insulating materials and the sheathing and prevent any corrosion-attack.

#### 4.4. Drain and vent pipes

Drain and vent pipes, except for personnel protection cases, shall be thermally insulated up to the drain or vent valve upstream flange.

#### 4.5. Instrumentation on steam piping

Instrumentation lines on hot piping will be insulated for personnel protection up to the last sectional valve.

#### 4.6. Level columns and associated measuring instruments

- The level columns and the associated measuring instrument pots shall be thermally insulated according to the same technique as the other items, but with insulation, corresponding to the saturation temperature.
- Level columns and associated measuring instruments of the boiler are not concerned with this requirement and will be the subject of special engineering.

#### 4.7. Thermal insulation for personnel protection

The drain and vent pipes, the discharges to the sewer and the valve exhausts as well as all the lines whose surface temperature exceeds 55°C in steady state or transient operation and whose heat losses are not included in the Unit heat rate calculation shall be thermally insulated up to a height of 2 meters only, if located within 0.8 m horizontally from any level within the reach of the operating personnel.

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#### 4.8. Coating near oil piping

When thermally insulated pipes conveying fluid at more than 200°C run near flammable oil pipes, the coating of the thermal insulation shall be made tight. To this end, before laying on the protective sheet, the thermal insulating material shall be wrapped in a glass cloth covered by a tight and non-flammable coating withstanding a temperature of 85°C so as to prevent any accidental oil penetration of the insulating material. Furthermore the sheathing shall be sealed with a tight joint resisting a temperature of 85 °C in order to avoid all penetration of oil inside the insulating material.

#### 4.9. Vapour barrier for anti-condensation and anti-frost insulation

The anti-condensation or anti-frost insulation of piping and equipment shall be protected from humidity by a vapour-barrier, which consists of :

- 2 layers of putty (FOSTER 30 - 36 or equivalent) reinforced by glass or nylon cloth. The weight of this coating shall be 3 kg/m<sup>2</sup>
- or one thin aluminium sheet (Mylar type) with a sealing of the joint between the sheets by self adhesive tapes.

The compatibility of the vapour barrier with the insulating material has to be checked.

The permeability of the putty shall be less than 0.050 g/(s.MN) as per BS 3177

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## 5. CONSTRUCTION REQUIREMENTS

The following requirements set out principles of installation of the thermal insulation that affect procurement of insulating materials. The specifications for installation of thermal insulation are included in the erection rules for thermal insulation.

As a rule, the accessories of fixation and the sheets shall not include any part to be welded by the thermal insulator on the piping or the pressure part.

### 5.1. Fixation of insulating materials and sheets

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- The wire netting of the mattresses shall be laced with galvanized or stainless steel wire
- For equipment straps or bands shall be 20 mm by 0.5 mm galvanized steel.
- The removable mattresses used for the insulation of the steam turbine are fitted with stainless steel fasteners for the lacing with stainless steel wire or with brass fasteners for the lacing with brass wire.
- Ducts with external stiffeners shall have insulation installed between the stiffeners, and a second layer of insulation installed thereon, so that stiffeners are insulated and a level surface achieved.
- The non-fibrous insulating materials used for anti-condensation and anti-frost protection (polyurethane and polyisocyanurate) shall be glued to the surface to be insulated and then jointed with putty.

The sheets shall be put in place with the following overlaps :

Outside diameter of insulation	Overlaps at longitudinal and circumferential ends (mm)
OD * 150 mm	30
OD * 150 mm	50
Equipment	50
Large tanks	100

All lagging shall be secured in place using panhead self-tapping screws, fitted with neoprene washers. Screws shall be 1.4301 / 1.4541 stainless steel. Spacing of screws for joints in ribbed aluminium lagging shall be not more than 300 mm. Spacing of screws for flat aluminium sheet shall be not more than 160 mm. All joints shall be placed to shed water.

Self-tapping screws shall also be used for assembling more than 2 sheets together. Screws and rivets shall be of the same material as the sheets or of a metal preventing the formation of an important electrolytic couple.

Tightness of sheets outdoors or on trench piping shall be ensured by a rubber joint arranged at the sheet overlap. In special cases, tightness can be ensured by putty which resists the temperature of the adjoining pieces, or by a sheet deflector. Open ends of all fluted sections shall be provided with tightfitting closure pieces.

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Piping elbow shall be covered using mitered segment aluminum elbow jackets, constructed with rolled interlocking edge joints. Mitered segments shall not exceed 15 degrees included angle.

All areas of contact between dissimilar metals shall be protected against galvanic corrosion by a suitable insulating coating or adhesive tapes.

For insulation of pipes near oil piping, anti-condensation and anti-frost insulation, where the insulating materials are covered with a sealing coating, the metallic sheet should be fixed by outside circumferential strip, in order not to pierce the coating.

## **5.2. Suppression of thermal bridges**

Insulating plates and bands shall be inserted wherever there is a risk of thermal bridge, in particular at the supporting points of sheathing, on pipework, equipment and vessels as well as at the insulating breaks.

These plates or bands shall be fixed firmly to the thermally insulated surface or to the supports originating such thermal bridges.

## **5.3. Supports of sheathing**

In order to prevent insulating material settling, the sheet supports shall be placed every 2 m approx. on the horizontal piping lines whose thermal insulating layer thickness is not less than 120 mm. These supports can be made up of steel flats or calcium silicate rings cut to the dimensions of the pipes and the sheets. These supports are also placed on both sides of the valves above ND 80 with thermal insulation at least 120 mm thick, and wherever settling is to be feared.

In order to support the insulating material and the sheathing on vertical pipes above 3 m in height and with thermal insulating layer more than 120 mm thick, circumferential flat straps and flat spacers are bolted to the pipes every 3 m.

In case of acoustic insulation, the supplier can suggest another system to hold up the sheets.

## **5.4. Installation of thermal insulating material on feedwater tank and the deaerator**

The mattresses shall be impaled on pins welded on circumferential strip bands which are tensioned over the equipment and then riveted. "Prestole" type plates are passed through the pins in order to maintain the insulation. Supports made of steel flat bars, belts and spacers are installed for supporting the sheathing.

## **5.5. Erection of the insulating material around the steam turbines HP/IP bodies and around their inlet stop valves bodies**

The mineral wool is confined and hand padded in a metallic structure (in galvanized wire netting mesh) fixed on steel rods round bars which are welded on bosses on the casted casing. For realizing this weld without preheating and without postwelding heat treatment, the steel rods are directly welded on local existing bosses provided for.

## **5.6. Installation of thermal insulation on large tanks**

The sheathing is held in place by steel flat bar rings fixed on supports welded to the shell of the tank.

Bent sheet supports are fixed to the roof of the tanks by welded lugs.

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### 5.7. Removable thermal insulation

Welded valves, flanged valves, flanges, manholes and all dismountable items of equipment shall be thermally insulated with removable boxes.

The thickness of the sheathing shall be the same as that of the large-diameter piping.

The thickness of the thermal insulating material shall be the same as that of the adjacent pipe or component.

Fibrous insulating materials shall be in the form of mattresses with wire netting. The lugs that hold the insulating material in place shall be fixed to the sheet of the box by pop rivets.

The supplier may suggest an alternative solution with dismountable mattresses like CALONAT, WANNIMAT or equivalent. In that case care shall be taken in order to seal the insulation against introduction of rain water.

### 5.8. Steam tracing

Before the thermal insulation is put in place, the piping or the equipment together with the tracing pipes shall be fully wrapped in a sheet laced with tied wire. Small tracing single pipe may be surrounded by corner shape frame and fixed in the same manner.

### 5.9. Electric tracing

For thermal insulation of pipework, a mattress extralength or a preformed pipe section of a diameter a little greater than that of the pipe may be used because of the over-thickness due to the tracing.

### 5.10. Pipe supports installed outdoor

A collar cut out from a sheet shall be tightened by a strip around the circular-section supports for tightness purposes.

### 5.11. Wall - and wall-cladding penetrations

Tightness shall be ensured by an impregnated glass cloth fixed by a strip on the thermal insulation of the pipe and secured on the wall or the wall-cladding by strip plus screws or strip plus rivets. This sheath shall be so shaped as to be capable of following the pipe expansions.

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