ALSTOM

Nikola Tesla

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BASIC TECHNICAL REQUIREMENTS FOR THERMAL INSULATION FOR UNIT A6

For information only

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0		11.2009	W. Gajewski	11.2009	J.Chlebowski	11.2009	J.Chlebowski
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1. INTRODUCTION

The technical requirements concern materials and elements as well as execution and acceptance of a thermal insulation for Nikola Tesla A6 turbine.
The insulation is used in order to:

- limit the heat losses up to technically and economically accepted minimum,
- prevent an excessive and non-uniform temperature gradient in the turbine casing,
- prevent the personnel from a risk of contact with hot elements,
- provide the personnel with the working conditions being conformable to the industrial safety rules.

2. RANGE OF APLICATION

This Document refers to:

1) turbine casings,
2) cut-off and control valve chambers,
3) gland steam pipelines,
4) live steam pipelines,
5) hot drain pipelines.

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3. DEFINITIONS

The definitions according to:

- **ISO 7345: 1987** Thermal insulation - Physical quantities and definitions

Abstract:

Defines physical quantities used in the field of thermal insulation, i.e. quantity of heat, heat flow rate, density of heat flow rate, thermal conductivity, thermal resistance, thermal transmittance, heat capacity, thermal diffusivity, thermal effusivity etc., and gives the corresponding symbols and units.

- **ISO 9229: 2007** Thermal insulation - vocabulary

Abstract:

Establishes a vocabulary of terms used in the field of thermal insulation covering materials, products, components and applications.

4. GENERAL INFORMATIONS AND REQUIREMENTS

4.1. General

All indoor equipment and piping with an operating temperature over 60˚ C shall be insulated by thermal insulation. This does not apply to places, which for functional reasons must be left without insulation.

Besides, in order to personnel protection, this type of insulation is applied to pipelines that are normally 60˚C or less but may reach a higher temperature as a result of abnormal condition or intermittent operation.

Insulation for personnel protection shall be applied only to sections of pipelines that are within 2.0 m above any floor, platform, or other normal walking levels, or within 0.9 m horizontally and up to 2.0 m above the edge of any walking surface.

The insulation thickness and type should follow the EU norms. The selected insulation thickness and type shall be indicated in the technical tender document.

Sheet metal lining of the piping and vessel insulation shall be used. The applicable lining material is aluminum. Turbine casings HP, IP, LP should be coated by cemented net.

The turbine insulation /protection against casing contact shall be removable blanket -mattress insulation type. The supplier shall specify used coating method.

Blankets should be similar to Microtherm products.

Thermal insulation of internal steam and drain pipes in the turbine area are out of ALSTOM delivery.

The use of asbestos or material containing asbestos, PCV and polyurethane insulation materials is strictly forbidden.

Fiberglass insulation may be used for operating temperature of 460° C and less.

Turbine blankets shall prevent heat flow between hot surfaces and environment so that no inadmissible stresses develop in the casing. It shall also protect personnel from injury.

Insulation material containing halogen or its salts must not be applied on stainless steel pipes or machine parts.

The turbine casing lower half must be minimum 25% better insulated than the upper half.

This can be achieved by a greater insulation thickness or a higher insulation material quality. In places with restricted space higher-quality insulation is to be preferred to ensure air circulation.

Thermal insulation for steam pipes and associated equipment shall prevent bearing pedestals and foundation against excessive heat radiation and protect personnel from injury. As a rule, all steam pipes and equipment with operating temperatures 60˚C must be insulated, including pipes and equipment that reach this temperature only under certain conditions, such as for example drain pipes, flash box etc.

The ambient temperature is assumed to be 30˚C and the wind velocity 0.5 m/s.

Removable blanket type insulation will be desirable, where it is possible.
The advantages of blanket insulation are:

- The blankets can be prepared before being shipped to the site-shorter assembly time.
- There are no or only minor dirt emissions during initial assembly and overhauls.
- Drying of the insulation is not required.
- The blankets can be reused.
- Quicker and better access to the flanges is ensured (for example, valves, extractions, etc).

If blanket insulation is used, it must be protected with a suitable cloth against external influences, for example:

d - dirt and dust
w - water
o - oil
w - weather factors and wind

4.2. Insulation material

The insulation mattress should be made of mineral wool blankets or cylindrical formed sections, reinforced by special material stitching or stainless steel or galvanized triple torsion hexagonal wire net 25/3.

The material has to meet the following requirements:

Density (at loose state)	80-90 kg/m³
Maximum operating temperature	565°C
Maximum permitted temperature	700°C
Chlorides	< 6ppm
pH value	7-7.5
Sulphates	< 0.1 wt %

The material shall be non-flammable and resisted to cause corrosion of the surfaces to be insulated. It shall have good mechanical strength to withstand physical damage and good

acoustic properties.

The supplier defines the insulation thickness taking into account the following:

- Operating temperature of the part to be insulated.
- Temperature of the insulation external surface must not exceed 60°C
- Heat loss must not exceed 150W/m² (except for pipes that are not permanently in operation, such as for example bypass lines or drains).
- The minimum thickness of hot and cold insulation shall be 30 mm.

Where supports or spacers are required for the insulation, they can be made from carbon steel or eventually stainless steel.

If the insulated surface temperature is below 400°C Cr-Mo steel should be used.

4.3. Mounting the insulation

The surfaces to be insulated must be free from dirt, oil or other foreign matters. Use caution during cleaning the surfaces to prevent from removing the anticorrosion agent. Flanges, bolting and fittings of systems that are subjected to a pressure test should be insulated after the test.
Mats should be installed without gaps. If gaps are unavoidable, they must be filled with loose insulating material of the same type. Openings must be cut out neatly around the pipe supports.
The prescribed insulation thickness shall not deviate by more than ± 10mm. Insulation can be applied in one, two or more layers. Staggered joints are required if the layer thickness is exceeded of deliverer requirements.
Direct welding of insulation supports to the pipes or fittings is forbidden.

4.4. Preparations for mountings the blankets

The number of holding pins is given by the number of cast-on lugs or threaded holes. Welding operations on turbine casings, valves or pipes may be carried out only at the foreseen locations. Direct welding of fasteners to turbine casings, valves or pipes is forbidden.
Holders for the blankets are arranged in such a way that the parting flange screws can be removed without dismantling the holders.
All fasteners, discs, pins, clamps, wire hooks and wires must be made of stainless steel.

4.5. Application to measuring points, pipe support and flanges

Openings should be cut in the cladding around the measuring points on the turbine and pipelines, so that maintenance work is possible without dismantling the complete cladding.
Openings should be closed with a funnel-type sheet or flat hood.
Openings in the area of pipe supports must be closed with beaded sheets.

5. BASIC ASSUMPTIONS FOR INSULATION DESIGN

5.1. Guidelines for turbine insulation

Temperature distribution in HP, IP and LP turbine area – document no. ZTGD877500.

Proposal forms of the turbine thermal insulation are shown at the Fig. 1.
Welded discs at the turbine casing are shown at the Fig. 2.
The preferred solutions for multi-layer insulation assembly are shown at the Fig. 3 and 4.
Fig. 5 shows example design solution of fixing pins.
Fig. 6 shows multi layer insulation and holding pins.

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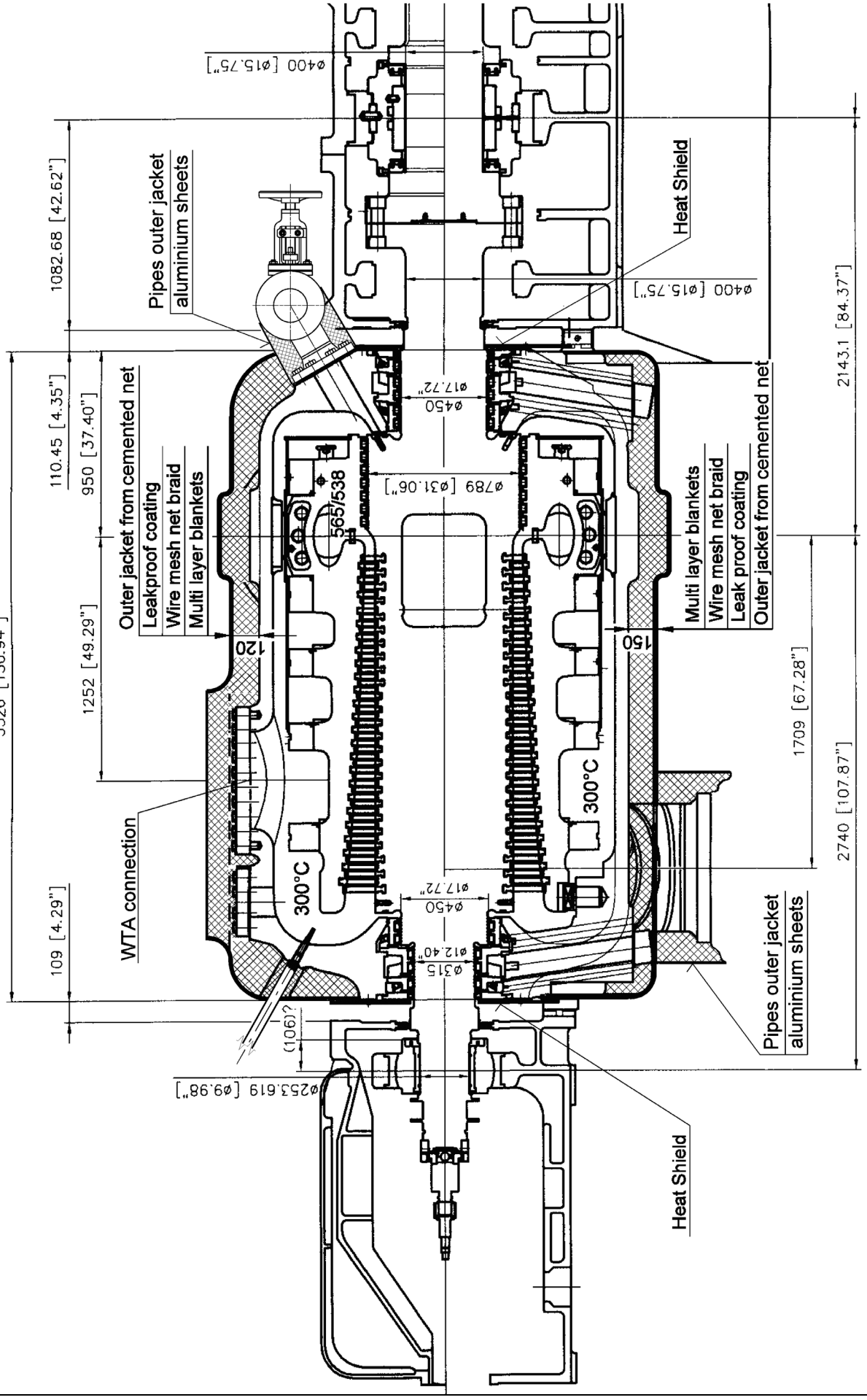

Fig 1. Example for multi blanket insulation of HP Turbine Casing

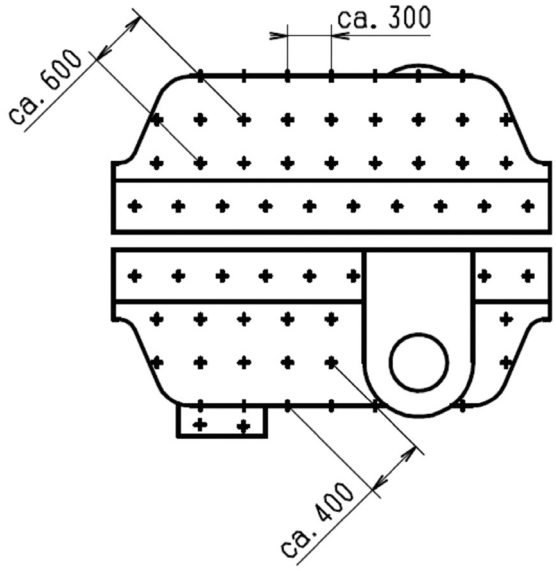

Fig. 2. Example of welded-on discs at Turbine HP casing.

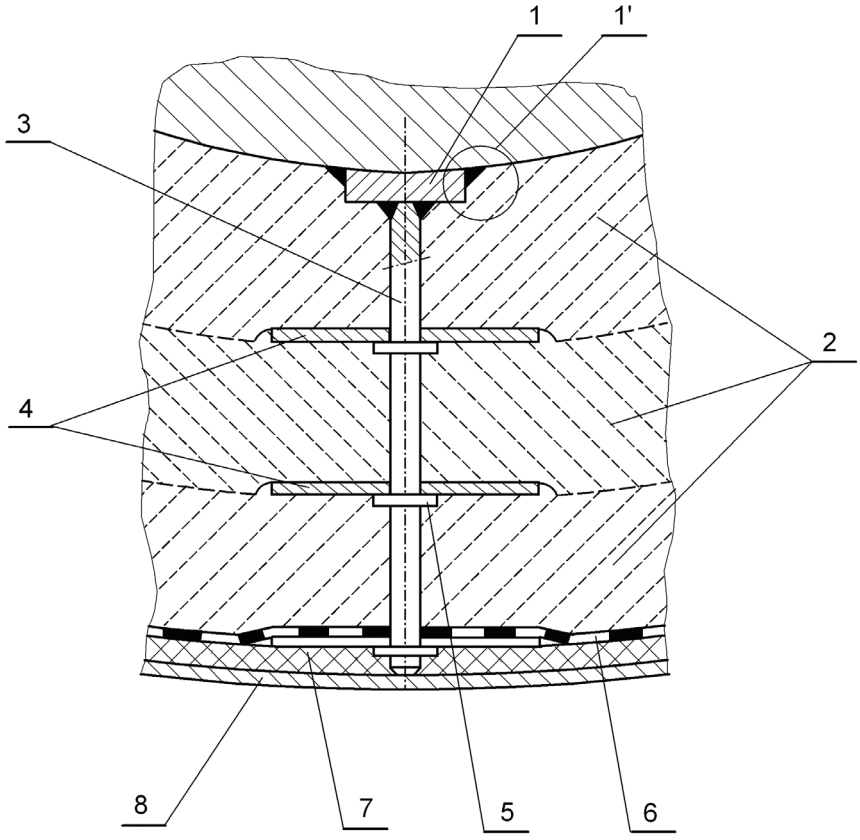

Fig. 3. The preferred solution for multi-layer insulation assembly

Legend:

1. welded disc
2. insulating material
3. fixing pin
4. blocking washer
5. protective washer
6. wire mesh net braid (if required)
7. protective jacket of cement
8. paint layer

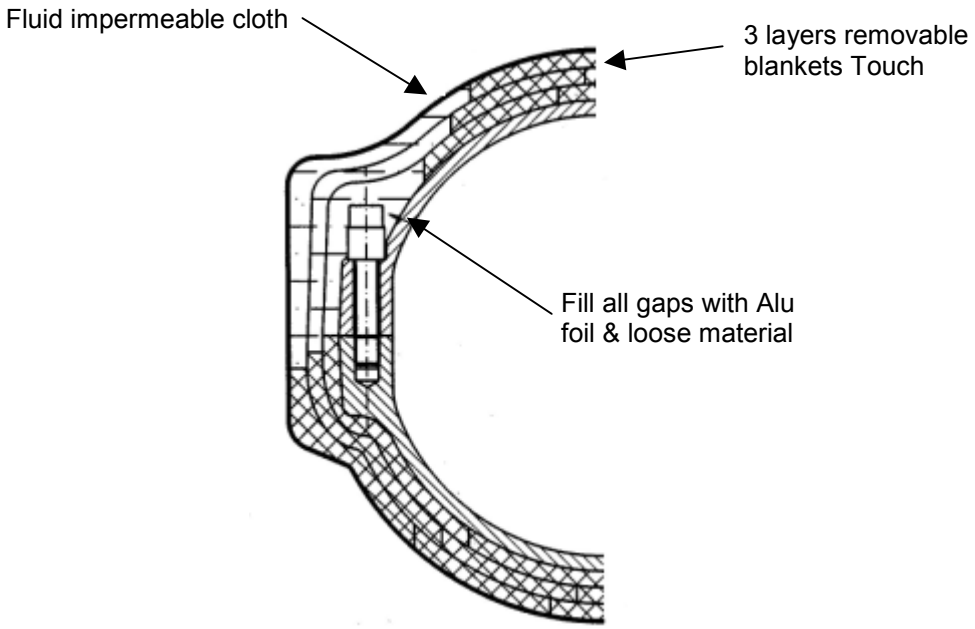

Fig. 4. Example of three- layer blanket insulation with displacement of blanket edges in successive layers

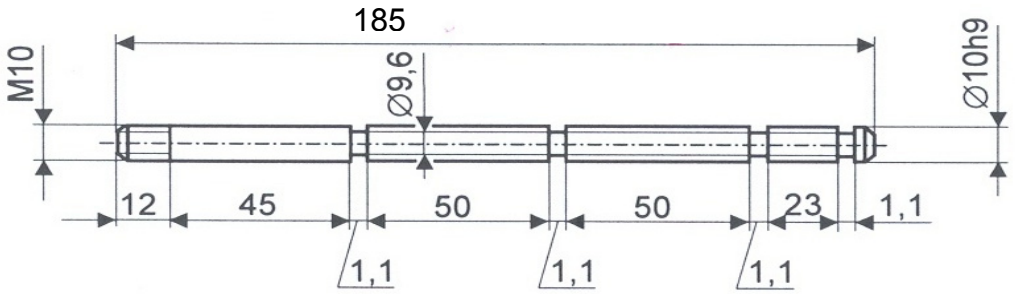

Fig. 5 Design solution of fixing pins-example

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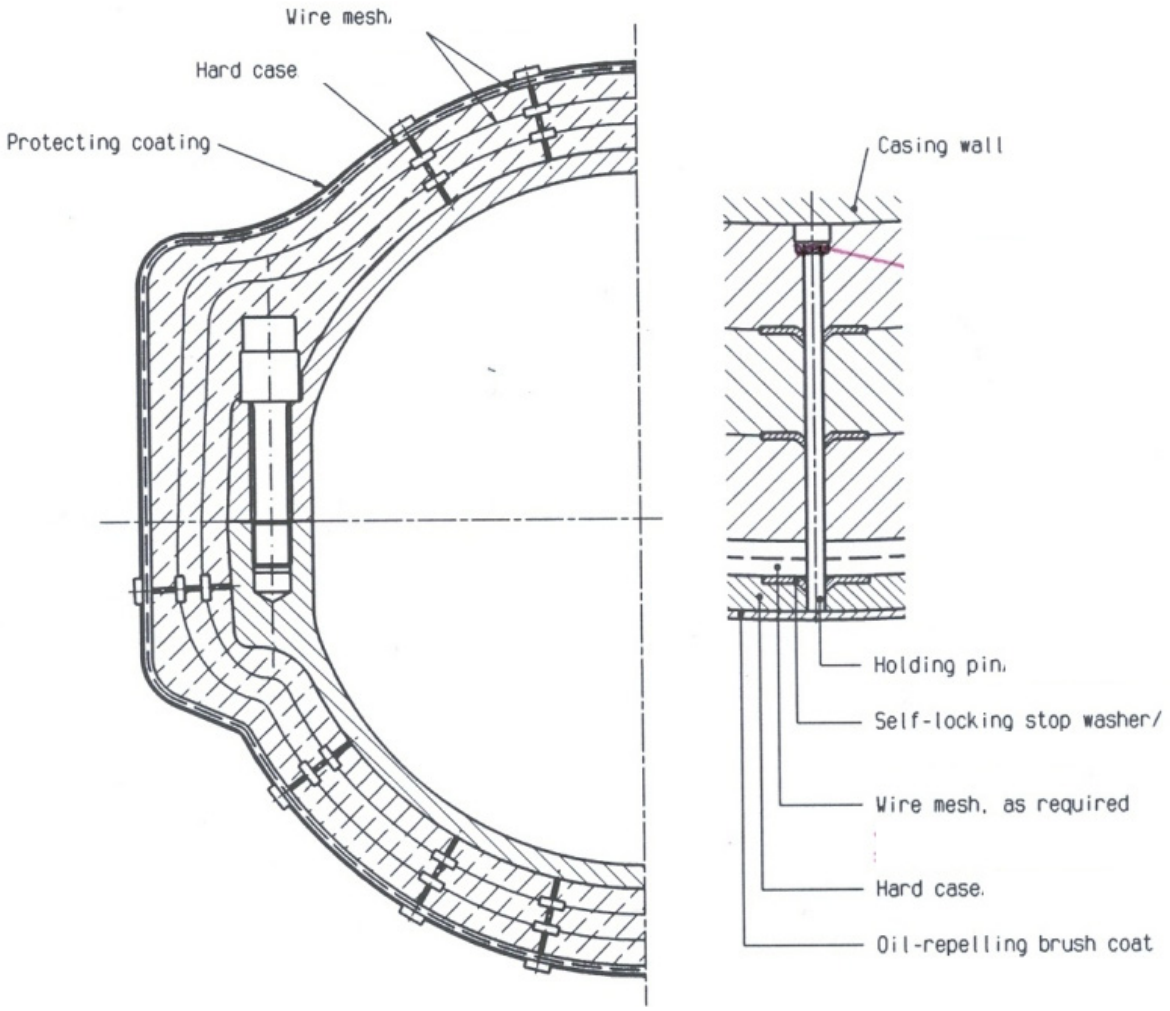

Fig. 6. Example of multi layer insulation and holding pins

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6. CALCULATION OF THE INSULATION THICKNESS

The Supplier supplies the complete insulation in accordance with the insulation drawing, which has been submitted in the tender phase. This document includes the Customer requirements as well as thermal requirements. The Supplier is fully responsible for the insulation quality, calculation of the insulation thickness and material selection. If the **ALSTOM** insulation drawing and the Table 1 shows an insulation thickness, it is for information only and not strictly binding for the supplier. The insulation thickness must be such that the heat loss does not exceed (150 W/m²)

The insulation shall prevent temperature differences between ambient air and outer insulation material surface in excess of 20°C. An ambient temperature of 30°C can be assumed.

The turbine casing lower half must be 25% better insulated than the upper half. This can be achieved by a greater insulation thickness or a higher insulation material quality. In plants with restricted space higher-quality insulation is to be preferred to ensure air circulation.

7. HEAT SHIELD

Heat shield shall be installed at the face front and back side of the HP and back side of IP casings.

The heat shield has the following tasks:

- to reduce the thermal influence on the bearing pedestals,
- to ensure the required air gap between turbine casing and bearing pedestal so that air circulation is always possible.

The insulation supplier manufactures the heat shield locally. The heat shield shall have the following features:

- Easy installation as at Fig. 7.
- The 3mm thick aluminium sheet metal should be reinforced by channel. Attachment points for installation/removal shall be foreseen.
- At the bearing pedestal ends, the high performance heat shield shall be provided, up to 10 mm thick insulation (for example Microtherm). (Fig. 7)
- It shall be reinforced by rolling.
- It shall be manufactured in such a way that installation from the top is possible.
- Attachment points shall be provided for installation and removal (for example, bores for shackle or threads for eyebolts)
- Accessibility to the inspection hole shall be ensured; provide an opening if necessary.
- The distance between heat shield and bearing pedestal shall be at least 40 mm. (Fig. 8)
- The heat shield shall be fastened to the turbine casing arms and holes at the frontal sides of the casing (Fig. 8)
- Adequate clearance in the rotor section (at least 20 mm) shall be ensured. (Fig. 7)
- Accessibility to the instruments shall be ensured.

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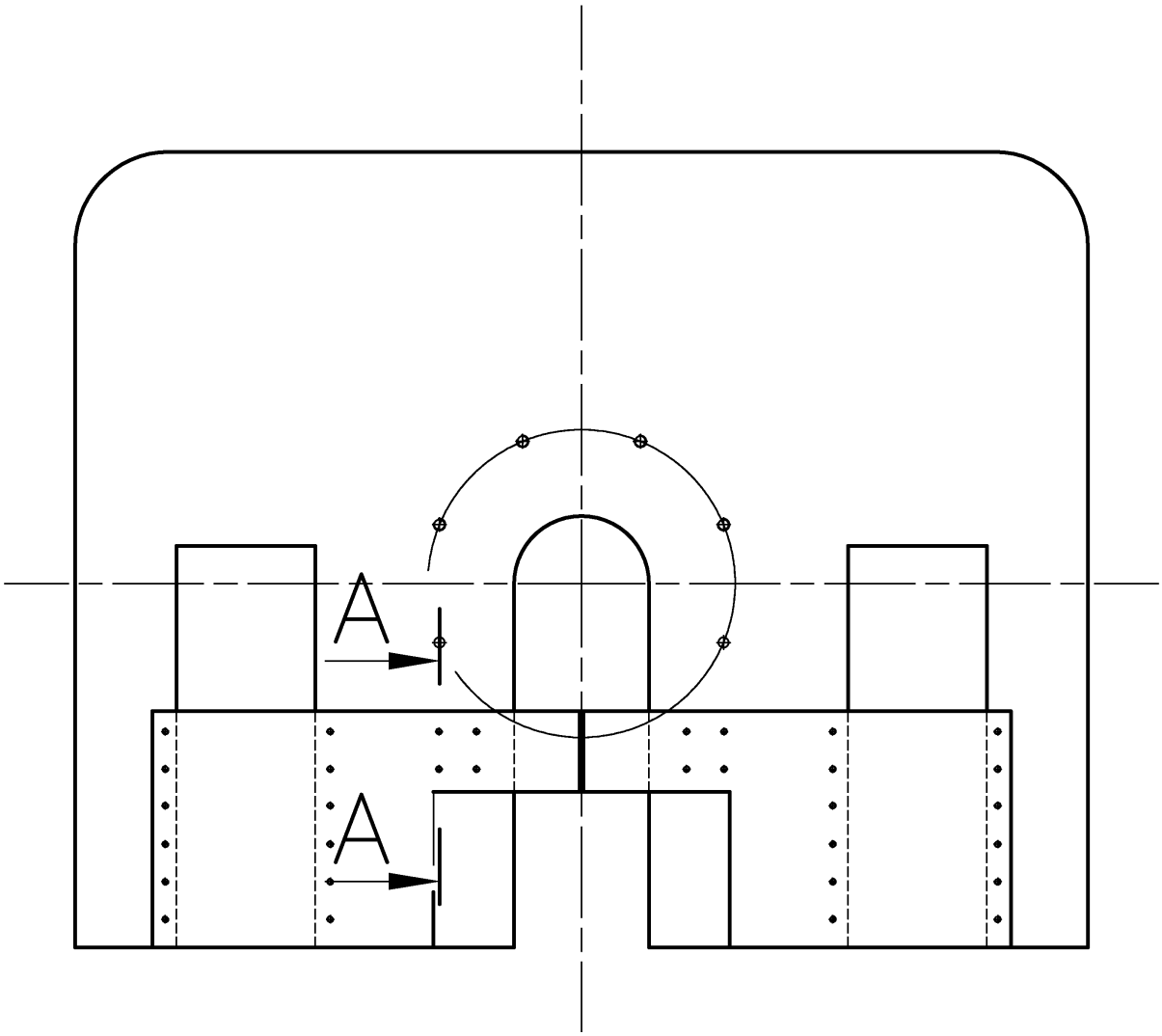
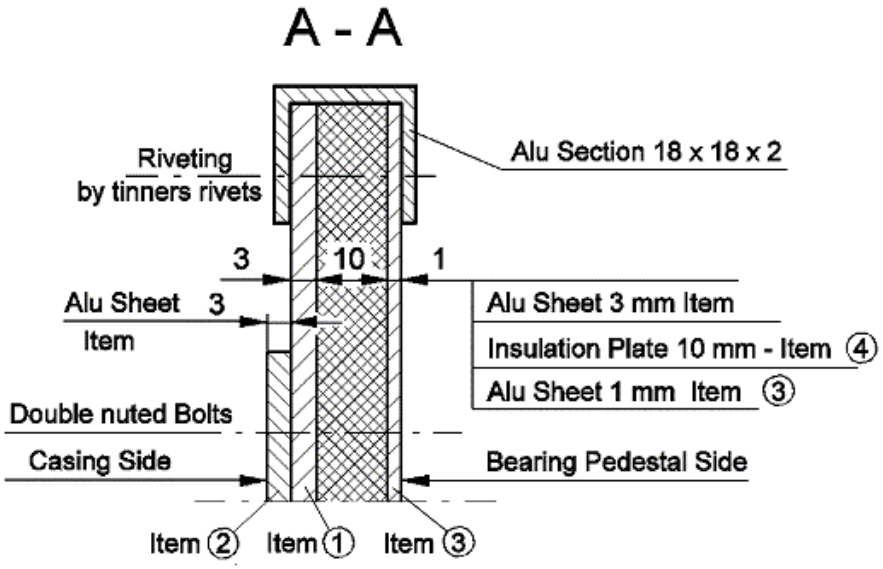


Fig. 7. Assembly of Heat Shield



Remark:

Sheets Item ①, Item ③ & insulation plate - Item ④ should be riveting by flat head rivets at necessary places

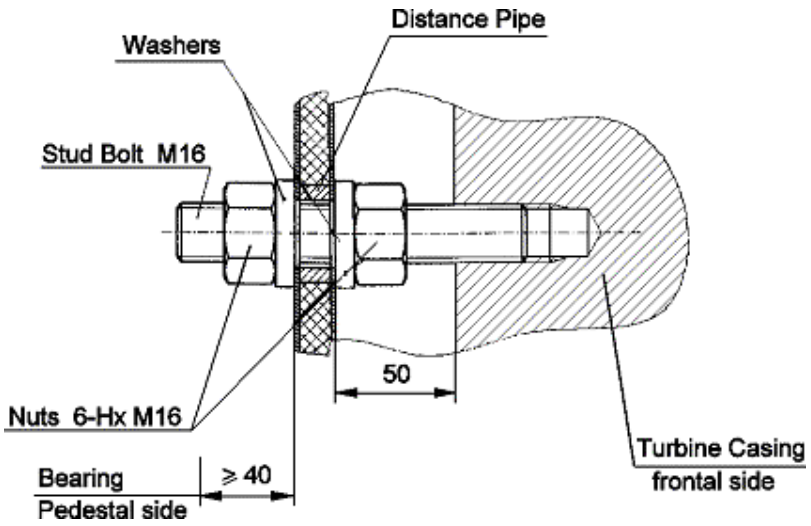


Fig. 8. Assembly and fixing of Heat Shield

8. PROTECTION AGAINST NOISE EMISSIONS

8.1. Basic assumptions for the turbine

The acoustical data provided in this document are valid for normal operation.

The acoustical data are not valid for the following operation modes/ locations:

- Start up and shut down of the steam turbine.
- Synchronization speed / no load conditions.
- Peak load operation.
- Erection and commissioning.
- Unit trips.
- Areas within acoustical enclosure.

The average A-weighted sound pressure level at distance of 1 m from the respective equipment acoustic enclosure and 1.5m above ground personnel platform will not exceed 85 dB(A).

The sound pressure level will be measured according to ISO3746 standard.

8.2. Noise guidelines

1) Steam Turbine

The following sound power level of steam turbine should be considered.

Sound Power Level

f/oct	31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	Σ A
dB	78	88	87	82	800	77	76	72	66	83

2) Generator

The following sound power level of the generator should be considered.

Remark: For generator there should be walk able sound shield applied.

Sound Power Level

f/oct	31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	Σ A
dB	80	88	82	80	78	75	74	70	64	81

3) Normal insulation

Insulation materials, metallic lining 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).

Attenuation in dB

Insulation thickness	**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

4) Acoustic type insulation

- Some equipment like bypass valves and their connecting steam pipes may be insulated with acoustic type insulation.
- The mats isolation material is rock wool or glass wool with a minimal density of 70 kg/m³.
- One layer of antivibration heavy material will be applied between two coats of rock wool or on the inside part of the external sheet. Furthermore, special attention shall be taken to avoid vibrations through supports and connections.
- Acoustic type insulation shall achieve the following minimal sound absorbing 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 100mm.

Remark.
If the thermal insulation of the Turbine will be insufficient to attenuate machine noises, to achieve the sound level 85 of dB(A), then a sound fencing enclosure should be taken into consideration.

9 RELEVANT DOCUMENTS AND STANDARDS

1) EN 13467:2001 Thermal insulating products for building equipment and installations. Determination of dimensions, square ness and linearity of performed pipe insulation.

2) EN 13468:2001 Thermal insulating products for building equipment and installations. Determination of trace quantities of water soluble chloride, fluoride, silicate, sodium ions and pH

3) EN 13469:2001 Thermal insulating products for building equipment and industrial installations. Determination of water vapour transmission properties of performed pipe insulation.

4) ISO 8497:1994 Thermal insulation-Determination of steady-state thermal transmission properties of thermal insulation for circular pipes.

5) ISO 7345:1987 Thermal insulation-Physical quantities and definitions.

6) ISO 9229:2007 Thermal insulation-Vocabulary

7) ISO 3746:1995 Acoustics-Determination of sound power levels of noise sources using sound pressure. Survey method using an enveloping measurement surface over reflecting plane.

10 SUPPLEMENTS-AUXILIARY LITERATURE

1) ZTGD877500 Temperature distribution in HP, IP and LP turbine area.