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Compiled by	Approved by	Authorised by
Dr. Robert Clark	**Erick van Zyl**	**Dr. Gary de Klerk**
Senior Consultant **Asset Management** **Operations and Maintenance**	**Corporate Specialist - HP Pipework** **Asset Management** **Mechanical Engineering**	**Senior Manager:** **Asset Management** **Mechanical Engineering (Acting)**
Date: 14 July 2021	Date: 14 July 2021	Date: 14 July 2021

Supported by SCOT SC

Yokesh Singh
Boiler SC

Date: 15 July 2021

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SCOT Study Committee Number/Name: **Pressure Equipment Care Group**

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1. INTRODUCTION

Thermal insulation is applied to plant operating at elevated temperatures, primarily for the following reasons:

- To protect personnel
- To conserve energy for economic and environmental reasons
- To assist in the control of process temperatures.

This Standard shall define the minimum thermal insulation and cladding requirements to be used at Eskom's coal fired power stations, in order to ensure that the primary reasons of applying lagging and cladding to a component at elevated temperatures are complied with.

2. SUPPORTING CLAUSES

2.1 SCOPE

This standard prescribes the requirements for the thermal insulation of plant and pipework operating with an outer surface temperature that is greater than, or equal to 60°C.

2.1.1 Purpose

The purpose is to provide a uniform set of requirements to ensure safety of personnel and to minimise the thermal loss through the efficient application of suitable materials. Surface finishes and quality of workmanship are addressed to achieve good functional and aesthetic results.

2.1.2 Applicability

This document shall apply to Eskom Generation, limited to the fossil fired power stations.

Power stations that were commissioned before 31 December 2001 shall have a cold face temperature of 55°C. The applicable power stations are Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Lethabo, Majuba, Matimba, Matla and Tutuka.

The cold face temperature shall not exceed 50°C for fossil fired power stations commissioned later than 31 December 2001.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

In the references below, several references are made to foreign legislation. For work on Eskom plant, the relevant South African Acts and Regulations shall be consulted and applied.

2.2.1 Normative

[1] ISO 9001, Quality Management Systems
[2] OHS ACT: 1993, Occupational Health and Safety Act and Regulations (Act No. 85 of 1993)
[3] SANS 347, Categorization and Conformity Assessment criteria for all Pressure Equipment
[4] 240-106628253 Eskom Welding Standard
[5] BS 0874, Determining thermal insulation properties & definitions
[6] BS 2972, Methods of tests for inorganic thermal insulation

[7] BS 3533, Glossary of thermal insulation terms
[8] BS 3958 Parts 1-6, Thermal insulation materials
[9] BS 5422, Methods of specifying thermal insulating materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range -40^{0}C to 700^{0}C
[10] BS 5970:2012, Thermal insulation of pipework, ductwork, associated equipment and other industrial installations in the temperature range of -100^{0}C to 870^{0}C – Code of practice
[11] BS EN 10028, Specification for flat products made of steels for pressure purposes
[12] BS EN ISO 12241, Thermal insulation for building equipment and industrial installations – calculation rules
[13] 240-56241933 Control of Plant Construction Repair and Maintenance Welding Activities Standard
[14] 240-56239129 High Energy Pipework Standard for Eskom Power Plants
[15] 240-56239133 High Pressure Pipework Support Standard
[16] SANS 10085-1 The design, erection, use and inspection of access scaffolding, Part 1
[17] 474-11722 Specification for the procurement and insulation of blanket material for steam turbine applications.

2.2.2 Informative

None

2.3 DEFINITIONS

Definition	Description
Cold face	The surface temperature of the cladding exposed to ambient conditions.
Cold joint	A cold joint is a plane of weakness caused by an interruption or delay in the application of the wet cladding material. It happens when the first batch of cladding material has begun to set before the next batch is applied.
Crinoline Rings	Rings of steel attached at intervals along pipes to keep the metal cladding at an equal distance from the pipe wall, so that a constant thickness of insulation is maintained.
Hot face	The surface temperature of the plant component to which the insulation is applied.
Insulation supports, also known as cladding supports	These are supports or support structures for insulation and cladding (as opposed to supports for plant and pipework). They are usually light structures provided to support the weight and maintain the shape, form, appearance, positioning, effectiveness and integrity of the insulating materials and the cladding.
Jennyed ridge	A jennyed ridge is the hump (ridge) with a diameter of approximately 8 mm that is rolled onto the edge of cladding. This stiffens the edge of the cladding material so as to assist with a watertight seal. It furthermore makes the edge safer from a personal protection point of view.
Major pipe system	High pressure pipework as defined in 240-56239129, High Energy Pipework Standard for Eskom Power Plants
Spelter	A zinc lead alloy of which zinc is the main constituent.
Supervisor	The Eskom representative responsible with overseeing the insulation work.

2.3.1 Classification

Controlled Disclosure: Controlled Disclosure to External Parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
MCR	Maximum continuous rating
OD	Outside diameter
QCP	Quality control plan

2.5 ROLES AND RESPONSIBILITIES

The relevant System Engineers at the power station shall ensure compliance to this Standard for current and new systems.

Asset Management, Mechanical Engineering shall update the Standard as required.

Any deviation from this Standard shall be considered via a concession, as controlled by the Engineering governance process.

2.6 PROCESS FOR MONITORING

Eskom's Documentation Management Department shall ensure that the document is reviewed as per the review date.

2.7 RELATED/SUPPORTING DOCUMENTS

This Standard shall be read in conjunction with the following Eskom documents:

[18] 240-56239129: High Energy Pipework Standard for Eskom Power Plants Standard.

[19] 240-56239133 High Pressure Pipework Support Standard.

[20] 240-158400077 High Pressure Pipework – Support Inspection & Elevation Survey Standard.

3. REQUIREMENTS

3.1 APPLICABLE TO ALL THERMAL INSULATION MATERIALS AND ACTIVITIES

1. **Authorisation:** No thermal insulation shall be applied before the Employers supervisor has authorised the application of thermal insulation, in writing. Prior to authorisation, the supervisor shall verify that the support systems of the plant and / or piping to be insulated are complete and the attachments for the insulation supports comply with this standard.
2. **Support of insulation:** All insulation materials and their cladding or finishing shall be adequately supported by properly designed insulation supports that support the weight and maintain the shape, form, appearance, positioning, effectiveness and integrity of the insulating materials, including the cladding.
3. **Asbestos:** Materials containing asbestos in any form are prohibited, and as such shall not be used.

4. **Special requirements:** Special requirements for individual plant items or process systems shall be specified by the process plant manufacturers. Examples are acoustic damping, process temperature regulation, steam traps and the prohibition of the use of incompatible materials in contact with the plant.

5. **Quality control plan:** All thermal insulation work shall be done in accordance with a Quality Control Plan that will ensure that correct and undamaged materials are used, and applied in accordance with this standard.

6. **Securing attachments:** The provision of securing attachments or supports for insulation shall be carefully considered during the design phase of the component. Attachments and supports for insulation and cladding welded directly on pressure equipment as defined in the OHS Act and on the turbine pressure casing and components shall be provided by the process plant manufacturer during manufacture of the pressure equipment or the turbine manufacturer respectively.

7. **Surface preparation:** The surfaces to be insulated shall be free from dirt, oil or other foreign matters. Pipes that have been painted to protect them against corrosion shall be cleaned with a rag without removing the anti-corrosion agent.

8. **On-site welding:** On-site welding of attachments and supports for insulation and cladding on pressure equipment as defined in the OHS Act and SANS 347 Hazard category 1 and above is not permitted unless done in accordance with weld procedure specifications provided by the pressure equipment manufacturer and for SANS 347 Hazard category 2 and above, approved by an Approved Inspection Authority. Welding shall be carried out by a certified BS-EN/ISO 3834 Part 2 welding contractor with oversight as per the welding standard (240-106628253).

   Welding on other plant hardware or structures shall only be done after consultation with the plant or structure manufacturer, and in accordance with weld procedure specifications provided by the plant or structure manufacturer or an Approved Inspection Authority.

9. **Maintenance and replacement of insulation:** Where thermal insulation is totally replaced or when maintenance work is done, necessitating repair or replacement of parts of the thermal insulation, the new insulation applied shall be of the similar overall mass and size of the original insulation system. This stipulation is made to prevent overloading of the supports and attachments, to avoid fouling due to expansion and allow for unrestricted movement of the equipment whilst in operation.

10. **Safety:** All statutory and local requirements to ensure the health and safety of personnel at the worksite shall be implemented, in particular those relating to the ingestion and/or inhalation of material and volatiles incidental to the insulation process.

11. **Protection of personnel:** Surfaces of equipment with a temperature exceeding 60°C under normal operating conditions, that would not normally be insulated for thermal efficiency, environmental or process reasons, but that are within reach from a permanent working floor level or from a permanent platform situated immediately adjacent to the hot surface, shall be insulated to a height of 2.5 m above the working floor level or that of the highest level of the adjacent platform.

12. **Prevention of oil ingress:** Any insulation on plant where there is a possibility of oil spillage or leakage or that may be subject to oil seepage shall be sealed with material that will entirely prevent oil seepage into the insulation. All plant and pipework insulated with sheet metal cladding or metal muffs that may be subject to oil spillage or leakage shall have the muff joints sealed to prevent the ingress of oil.

13. **Application of cladding and finishing materials:** Finishing materials shall be applied as soon as possible after installation of the insulation system.
14. **Cladding penetrations:** Where support rods or other penetrations pass through metal cladding, the opening shall be provided with an effective flexible seal to prevent ingress of water or other liquids.
15. **Penetrations for process control:** Where instrument lines and tapping points or similar penetrations occur, the process control equipment shall be provided with protective sleeves or removable covers to allow access for maintenance.
16. **Painting of cladding and insulation:** All galvanised metal cladding shall be left unpainted except for identifying colour bands and for permanent marks identifying removable sections. Hard-setting composition, when dry, shall be sealed with an insulation sealer and painted with two brush coats of aluminium paint.
17. **Records:** Records relating to density applied and the number of layers per plant area shall be retained and copies provided, as per the requirements in Section 3.15.
18. **Use of alternative materials:**

    a. This standard allows for alternative insulation systems, materials or methods to the original requirements as stated in Section 3.4 of this standard. The alternative options may be submitted for consideration, provided they are backed up with substantial evidence to prove that the alternative material is at least as effective and in compliance with the requirements of this standard.

    b. The proposed insulation shall also meet the following requirements:

    - Durability: The durability of the system or materials proposed shall be equal to or better than that of the standard system or materials.

      If no relevant comparison is available, the alternative system or materials shall be proven to last in the particular application, producing the specified performance, for at least 15 years.

    - Mass: The total mass of the alternative insulation system shall be within ± 5% of the existing system that it replaces.
    - Size: The system shall be of a similar overall outside diameter of the existing insulation system, thus facilitating the re-use of existing cladding without any modifications.
    - Cost: The alternative materials, systems or methods shall be cost effective compared to the standard system.
    - A Material and Safety Data Sheet (MSDS) for the alternative product will be made available to the Employer for review, before acceptance of the alternative material.

    c. **Proof of compliance**: Any proof submitted to Eskom to demonstrate compliance shall be verified by independent authoritative sources. The submission shall include details of references where the alternative insulation material has been used and proven to be effective.

3.2 DESIGN REQUIREMENTS

1. All plant and equipment listed in the scope that will have a hot face temperature of 60°C or higher shall be insulated. Hot face temperatures shall be based on continuous operation at MCR conditions and an ambient temperature of 30ºC. (Note that systems requiring insulation for protection of personnel shall consider all operating conditions and worst ambient temperatures).
2. The insulation shall be designed so that the resulting cold face temperature of the surface material of the insulation shall be 50ºC or less at an ambient temperature of 30ºC for fossil-fired power stations commissioned later than 31 December 2001.
3. The design cold face temperature shall be 55°C or less at an ambient temperature of 30°C for Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Lethabo, Majuba, Matimba, Matla and Tutuka power stations.
4. For financial break-even calculations, the assumed lifetime of the insulation shall be taken as fifteen years.
5. The total mass of the thermal insulation system comprising insulating materials, cladding or finishing materials, fixings, attachments and integral insulation support structures shall be made available to the process plant contractor. This will allow the process plant contractor to make allowances for this additional mass in the design calculations.
6. When changes to the manufacturer and/or characteristics of the insulation are made to achieve the desired cold face temperature, one must take into consideration the impact that these changes will have from a mass perspective. This will include a stress analysis model and/or Engineering calculations.

3.3 PERFORMANCE TESTS

1. To confirm the performance of the insulation systems, readings of cold face or process temperatures shall be taken twelve hours after full operational temperature and highest possible load has been reached. Process plant suppliers shall identify the required positions for test readings. No tolerance above the design temperature as stated in this standard is permitted.
2. Cold face readings on the cladding shall be taken at random points on the plant, as determined by the Employer. At least three cold face readings shall be taken on each horizontal and each vertical straight run of each major pipe system on each boiler unit. At least six cold face readings shall furthermore be taken on each boiler wall at locations representative of conditions at the bottom, middle and top of the boiler furnace casing, and at each platform level.
3. The temperatures together with sketches or check sheets showing the location of the readings shall be recorded and the actual position of the readings shall be permanently marked on the plant and numbered to correspond with references on the sketches.
4. Cold face temperatures that are higher than the maximum design cold face temperature are not acceptable and require investigation to determine the appropriate rectification measures to ensure compliance with this standard. There is no deviation permitted above the maximum temperature stated in this standard.
5. The ambient temperature reading for all tests shall be measured at a representative position within close proximity of where the cold face temperature is measured. The cold face temperature may not surpass the prescribed parameters in this Standard, even if the ambient temperature in the area is in excess of 30°C.

6. An assessment shall be performed by an independent testing authority on samples for each type of insulation to be used at the applicable hot face temperature. The supplier shall provide the material certificates for all insulation material used on the plant to the Client. The tests are required to confirm the maker's claimed value of thermal conductivity. The samples shall be drawn from the stocks of material to be used for the proposed work.

3.4 MATERIALS

1. All materials shall be adequate for the conditions to which they will be subjected during normal operation of the plant at MCR, and be suitable for insulation at the operational hot face temperatures.
2. Damaged insulation materials shall not be used.
3. Pre-formed insulation shall be of the correct size and fit snugly against the plant being insulated.
4. Insulation materials shall be selected that will not have any damaging effect on the plant or surfaces to which they are applied.
5. The various insulation materials shall not exceed the below mentioned hot face temperatures:
   - Glass Wool (Maximum hot face temperature: 400°C)
   - Rock Wool (Maximum hot face temperature: 550°C)
   - Calcium Silicate (Maximum hot face temperature: 650°C)
6. The following minimum bulk densities are required for various services. A tolerance of +/- 15% will be permitted on the nominal values given in the tables below. Products specified for any given temperature range may be used at the lower temperature ranges in the table.

Hot face temperature	**Mineral wool**	**Calcium silicate**
(°C)	Kg/m³	Kg/m³
	<200 mm	
0-400	145	
401-550	145	
551-650	-	220-265

7. Boards, blankets and mattresses

Hot face	**Mineral wool**	**Calcium silicate**
(°C)	Kg/m³	Kg/m³
0-250	80	
251-400	100/80*	
401-500	120	
501-550	160	220-265
550-650	-	220-265

N.B: 80* is only applicable to rigidly supported systems (i.e. Not supported by variable spring or constant load supports). The maximum cold face temperature specified in the standard must still be met and the current cladding material that is installed must be re-used without any modifications.

For ease of identification in the stores and at the Contracts Works, the lagging density shall be easily identifiable whilst within the plastic wrapping and shall be marked on both ends of the lagging roll with paint. The colours shall be as follows:

Density of the lagging (Kg/m^3)	Identification colour
160	Black
120	Blue
100	Red
80	Green

3.5 PIPEWORK

3.5.1 Insulation of all pipework and bends

1. No insulation shall be applied until the support systems of the plant or piping to be insulated and the attachments for insulation supports have been checked. The application of thermal insulation has to be authorised in writing by the Employers supervisor.
2. All surfaces of piping and fittings to be insulated shall be thoroughly cleaned and be free from dirt, oil, moisture or other foreign matter before application of any insulation.
3. The necessary precautions shall be taken to ensure that no arc strikes on piping, especially alloy steel pipe, occur. It is essential to ensure that piping is not nicked, scratched, marked or damaged during the insulation process. Should any arc strikes or other damage occur, it shall be reported to the plant engineer who shall decide on the necessary corrective action.
4. The insulation shall meet the relevant requirements set out in 240-56239129 (High Energy Pipework Standard for Eskom Power Plants) except for the 55ºC cold face temperature requirement applicable to the older power stations.
5. Removable muffs and insulation sections shall be provided at all welds on major pipework to allow access for inspection and testing. When removed, the clear space between the faces of the fixed insulation shall be a minimum of 500 mm on each side of the weld. The position of these inspection access sections shall be clearly and permanently marked.
6. For pipe sizes up to 250 mm nominal bore, pre-formed pipe sections may be used for the inner layer of insulation.
7. Where insulation on piping and bends that will be finished with a hard-setting composition is adjacent to insulation to be finished with sheet metal cladding, the thickness of insulation shall be the same as that required for the sheet metal finish. The finished diameter over the hard-setting composition will therefore be slightly greater than the finished diameter over the sheet metal on the adjacent piping.

8. For insulation diameters less than or equal to 250 mm, the insulation shall be secured with galvanised binding wire at 300 mm pitch. For insulation diameters greater than 250 mm, 20 mm wide galvanised strips shall be used at 300 mm pitch.
9. Insulation over 50 mm thickness shall be applied in multiple layers with staggered joints.
10. For horizontal pipes, insulation supports shall be provided at 3 metre centres. A recommended insulation support ring design is shown in Appendix B. Mattresses shall be installed with the wire mesh on the outside.
11. Vertical pipes and pipes inclined at an angle greater than 45° to the horizontal shall be provided with spider clamps as shown in Appendix B.

    The spacing and materials for the spiders on vertical and inclined pipes shall be:

Hot face Temperature (^{0}C)	**Spider Material**	**Spacing**
Up to 350	Carbon steel	6 metres
351-500	304 Stainless Steel	5 metres
501-570	304 Stainless Steel	4 metres
571-650	304 Stainless Steel	4 metres

12. The insulation of bends shall be as specified for the adjacent straight piping but mitred to suit the radii of the bend. Where insulation is applied in multiple layers, all joints shall be staggered. Insulation supports shall be provided to ensure the integrity of the insulation. The material of the supports shall be as for straight piping.

3.5.2 Cladding and finishing of pipework and bends

3.5.2.1 Piping and bends up to and including 300 mm nominal bore

Piping and bends up to and including 300 mm nominal bore, including those bends insulated with preformed pipe sections, may be finished with hard-setting composition or galvanised sheet metal. The hard-setting composition finish shall consist of a trowel coat between 6 and 10 mm thick, reinforced with 25 mm mesh galvanised wire netting. Cladding of galvanised sheet metal shall be as specified for pipes and bends above 300 mm outside diameter.

3.5.2.2 Piping and bends greater than 300 mm nominal bore

Piping and bends greater than 300 mm OD shall be finished with 0.8 mm galvanised sheet metal muffs or lobster back sections. Circumferential joints on bends shall be provided with a jennyed ridge and overlapped as far as possible, consistent with a neat appearance. Axial joints shall overlap by 50 mm. All joints shall be arranged to shed water or other falling liquids.

3.5.2.3 Muffs

Straight pipes shall be finished with galvanised sheet metal muffs. See Drawing 0.00/3960 (Appendix B).

The circular joints shall have a length wise overlap of 75 mm. This overlap shall be maintained by one circumferential jennyed ridge positioned 75 mm from one end of each muff.

The straight longitudinal joints shall be positioned alternately at "3 o'clock" and "9 o'clock". These joints shall overlap by 50 mm and be secured by pop rivets or screws, inserted at a maximum pitch of 150 mm. There shall be no rivets or screws inserted in the longitudinal seam under the circular overlap.

The muff joints shall be secured by pop rivets or 4 mm diameter x 10 mm self-tapping screws. Alternatively, muffs may be held in place by purpose-designed circumferential straps of galvanised iron or stainless steel.

The thickness of the galvanised sheet metal for muffs shall be:

- 0.5 mm for pipes having a gross diameter over the insulation of less than or equal to 250 mm.
- 0.8 mm for pipes having a gross diameter over the insulation of 250 mm or more.

3.5.2.4 Shedding of liquids

All muffs and other sheet metal finishes shall be installed according to the slope of the pipe with the circular or axial overlaps arranged to shed water or other falling liquids.

3.5.2.5 Supports for cladding and other finishes

Insulation supports shall be provided to maintain the shape, form, appearance, positioning, effectiveness and integrity of the cladding and other finishes. The material of the supports shall be as for straight piping.

On vertical pipes and pipes inclined at a slope greater than 45^{o} to the horizontal, each muff or cladding section shall be supported from the insulation supports or from an adjacent muff with appropriate provision for expansion. The jennyed ridge shall ensure that fluid ingress into the lagging is not possible.

3.5.3 Clustered tubes - insulation

1. Clustered tubes operating at temperatures varying by not more than 15% from the hottest to the coldest tube may be insulated together. The calculation of insulation thickness shall be based on that of the tube operating at the highest temperature of any tube in the cluster, and of a diameter equal to that of the smallest circle enclosing all the tubes.
2. Vertical and inclined clusters of tubes shall be provided with adequate insulation supports at the same intervals specified for single vertical pipes. To prevent any chimney effect, gaps between the pipes shall be completely sealed with insulation material at each insulation support.
3. The finish for clustered tubes insulated together shall be as for pipework. Cladding shall be adequately supported.
4. If the largest dimension measured over the insulated cross section is less than 500 mm, the finish shall be of hard-setting composition as for pipework and bends. Expansion joints shall be provided at 3m intervals. These shall be neat circumferential breaks in the hard-setting composition.
5. Where the largest dimension is 500 mm or more, the finish shall be by means of 0.8 mm galvanised sheet iron strapped around the insulation. The galvanised metal shall be secured at 300 mm pitch with 20 mm wide galvanised straps. If this finish is not practical, for instance because of concave surfaces in the insulation, hard-setting composition shall be used.
6. Steam traced pipes shall be insulated as for clustered tubes.

3.5.4 Valves and flanged joints

1. Insulation of valves and fittings may be carried out in a variety of ways, i.e. lined boxes, laced muffs or oversize sections but in all cases, the following criteria shall apply:
    - The insulation shall be the same thickness as the adjacent pipe insulation.
    - It shall be readily removable without disturbing the main pipe insulation.
    - Insulation shall be kept clear of the stuffing box gland, and the surrounding valve actuator hand wheel and accessories.
    - The insulation on piping adjacent to flanges shall be stopped short and neatly chamfered to permit removal of the flange bolts without disturbing the piping insulation.
    - Insulation and cladding shall not hinder the functioning of radial and axial expansion joints.
2. A 10 mm tell-tale drainage hole shall be provided in the insulation below each flanged joint.

3.5.5 Pipework outside station building

1. The insulation of any piping buried in the ground shall be coated with bitumen followed by a layer of glass membrane applied while the bitumen is still wet. A further coat of bitumen shall then be applied.
2. Any pipework outside the power station building shall be insulated in such a manner that freezing of the contents does not occur. This requirement shall be specified by the Design Engineer.

3.6 INSULATION OF BOILERS

The thickness of insulation shall be based on a cold face temperature as specified in this Standard.

3.6.1 Boiler walls - insulation

1. Where applicable, insulation fixing studs shall be welded to the membrane strip between the boiler wall tubes at a maximum of 450 mm square pitch. All welding shall be in accordance to Eskom Welding Standard 240-106628253. The first layer of insulation is to be impaled on the studs with joints firmly butted together. To prevent insulation settlement and convection, Z-shaped mild steel sections shall be installed at vertical intervals of 3 metres. Where there is no membrane strip, the tubes shall be plastered with hard-setting composition and the boards or mattresses secured to stringers welded to the channel tie bars, or steelwork fixed to the tube walls.

    For sections of plant where an inner skin casing covers the plastered tubes, the inner skin casing shall be seal welded to prevent tramp air ingress before an outer layer of insulation is added.
2. The second layer of insulation shall be positioned with joints overlapping those in the first layer by at least 100 mm and secured with spire clips and 0.8 mm binding wire laced in a diagonal pattern and looped around the studs, behind the clips. The entire section shall be covered with 40 mm wire mesh, pulled taut and tied back to the binding wire and spire clips.
3. If wired mattresses are used, the integral mesh shall be on the outside so that no further wire mesh covering is needed.
4. Buckstays shall not be insulated.

3.6.2 Boiler walls - finish

1. The preferred finish is galvanised 0.8 mm profiled sheet metal cladding fixed to mild steel angle iron stringers. The stringers shall be welded to the channel tie bars and / or membrane strip and must not be larger than 40 mm x 40 mm section.
2. All sheets shall overlap sufficiently to allow for the expected vertical expansion, plus 40 mm.
3. Around all burners, inspection doors, corners, and other discontinuities or penetrations, the edges shall be neatly flashed with 0.8 mm thick galvanised sheet metal.

3.6.3 Boilers, drums, headers, etc.

1. No welding, drilling or other interference on the boiler drum, headers or other pressure parts is permitted. If the insulation system requires direct attachments to the boiler drum, headers or other pressure parts, these attachments shall be welded on at the manufacturer's works prior to stress relieving and in accordance with Eskom's Welding Standard 240-106628253.
2. Galvanised wire or galvanised strapping shall be used to support the insulation. If wired mattresses are used for insulation, clamped-on crinoline rings shall be provided. The finish shall be 0.8 mm galvanised mild steel sheeting fixed to allow for expansion.
3. Drum slings and sling rods shall be insulated to provide protection for personnel to a height of 2.5 metres above the highest level of any adjacent floor or permanent working platform.
4. The insulation on protruding ends of the boiler drum, headers, or other pressure parts shall be covered with 0.8 mm galvanised sheet metal, fabricated to follow the surface and fitted with jennyed ridge overlapping joints.
5. Removable prefabricated covers shall be fitted over manhole doors. They shall consist of 1.6 mm galvanised mild steel, lined with the same thickness of insulation as the area where it is fitted.

3.6.4 Heaters, tanks and vessels

1. **Horizontal vessels:** Insulation shall be secured with 20 mm wide galvanised strapping or binding wire followed by a layer of 40 mm mesh galvanised wire netting, pulled taut. If wired mattresses are used, it will not be necessary to use the 40 mm mesh netting. Support rings shall be provided with all types of insulation material.
2. **Vertical vessels:** These vessels shall be supplied with insulation support rings. There shall be one insulation support ring not more than 50 mm above the weld between the shell and lower head. Other rings are to be provided, as for piping.
3. **Finishes:** The preferred finish is galvanised sheet metal with thickness of 0.8 mm, applied with jennyed ridge overlapping circumferential and longitudinal joints, secured with pop rivets or 4 mm x 10 mm self-tapping screws at 150 mm pitch. Horizontal vessels shall have mild steel crinoline rings at every circumferential joint. The additional heat loss per unit area through the surface at the crinoline rings or other insulation supports shall not exceed 6% of the average heat loss through the balance of the insulation of the vessel.

   The sheet metal on domed or dished ends shall be fabricated and installed in a petal leaf construction formation, with jennyed ridge overlapping joints, and secured as detailed above.

4. **Blowdown vessels:** Blowdown vessels shall be insulated to a height of 2.5 metres above floor level or the level of the highest platform immediately adjacent to the vessel. The top of the insulation shall be neatly finished off with hard-setting composition, chamfered at 45°.

3.7 INDOOR DUCTING AND AIR HEATERS

3.7.1 Insulation

1. The insulation shall be impaled over insulation studs welded at 450 mm square pitch to the casing. The first row of studs shall begin 75 mm from any flange or stiffener. After the studs have been welded in position, the metal local to the studs shall be cleaned and painted with a compatible primer.
2. The insulation shall be secured with spire clips and 1.8 mm galvanised binding wire laced in a diagonal pattern around the studs and behind the clips. The ends of the studs shall be bent at 90° after the clips are installed. A layer of 40 mm mesh galvanised wire shall be laced to the diagonal binding wires.
3. Stiffeners that protrude from the surface of the insulation, or are flush with the insulation are to be insulated. If stiffeners are below the insulation, there shall be a minimum of 25 mm of insulation above an angle iron stiffener and 10 mm above the narrow edge of a flat bar stiffener. If not, the insulation thickness is to be increased, or the insulation is to be humped over the stiffeners.
4. The additional heat loss per unit area through expansion joints in the insulation or through the finished surface at the insulation and cladding support frameworks shall not exceed 6% of the average loss through the plain insulated surfaces.
5. The insulation on straight sections and bends shall be finished with 0.8 mm thick galvanised sheet metal, applied in staggered panels with jennyed ridge overlapping joints and fixed with pop-rivets and / or self-tapping screws to a mild steel insulation support framework.

   Alternatively 0.8 mm profiled sheeting may be used, galvanised with a spelter (commercially crude smelted zinc) of 275 g/m^2.

   The insulation support framework shall be welded to the duct face and to the intermediate stiffeners. The framework shall be such that the cladding passes in a straight line over the main support frames of the ducting.
6. The duct expansion joints are to be covered with fabricated 0.8 mm thick galvanised sheet metal boxes, lined with insulation. The box is to be supported on brackets and sealed over the adjacent finished insulation.
7. The insulation on the straight sections and the bends shall be finished with 0.8 mm thick galvanised sheet metal muffs applied with overlapping jennyed ridge joints and fixed with pop-rivets and / or self-tapping screws to mild steel crinoline rings that are welded to the duct surface.

3.8 OUTDOOR DUCTING, GAS CLEANING SYSTEMS AND FANS

3.8.1 Insulation

Insulation shall be the same as indoor ducting, with a minimum thickness of 40 mm.

3.8.2 Finish

The finish shall be mounted on a framework as for indoor ducting, the material being either 0.8 mm galvanised profile sheeting or 0.8 mm pre-coated post formed profiled sheeting. Galvanised sheeting shall have a spelter of 650 g/m^2.

3.9 FLUE GAS CLEANING PLANT

3.9.1 Casing surfaces and ducting

The insulation and finish on casing surfaces and ducting shall be the same as for outdoor ducting.

3.9.2 Electrostatic precipitator and fabric filter plant roofs

The insulation is to be inserted between the internal equipment and the casing roof. Where the roof casing is to serve as cladding for the insulation, the casing shall be of non-slip mild steel plate and suitably protected from corrosion as per the Design Engineers requirements.

3.9.3 Hoppers

The insulation of hoppers shall be finished with galvanised profiled sheeting having a spelter of 650 g/m^2.

3.9.4 Thickness of insulation

Apart from conforming to the criterion of the required cold face temperature at 30°C ambient, the insulation shall be:

- Not less than 40 mm thick.
- The gas temperature decay through the flue gas cleaning plant is not more than 4°C or as stated in the specification for the gas cleaning plant.

3.9.5 Chimney flues

The vertical flues within the windshield of the stack shall be insulated as for outdoor ducting, but no cladding is necessary where the flues are protected from external weather conditions. The cold face temperature of the ducting insulation after the flue gas cleaning plant shall not exceed 55°C for old and new power stations, at an ambient temperature of 30°C.

3.10 FAN CASINGS

Fan casings are to be insulated as for outdoor ducting, with the following stipulations:

- Insulation quality and thickness may be determined by acoustic requirements and shall be specified by the plant supplier.
- A gap of 50 mm shall be left between the concrete base in which the fan is mounted and the insulation of the fan casing.

3.11 TURBINE CASINGS AND ANCILIARIES

3.11.1 Materials

The insulation contractor, in consultation with the turbine manufacturer are to specify the insulation material. The requirements in this Standard shall be complied with. As a cost saving measure, blanket insulation can be applied on turbine components as per specification **474-11722**

Insulation materials containing asbestos in any form are strictly forbidden. If such insulation is detected or if its use is suspected, work shall be stopped immediately and the responsible Site Manager for the insulation contract shall be informed.

The insulation materials shall be compatible with the materials of casings and pipe work. Insulation material containing halogen or its salts shall not be applied on stainless steel pipes or machine parts.

3.11.2 Design basis

The hot face temperature shall be the inlet steam temperature. The mean diameter of the turbine casing shall be used in calculating the thickness. This same insulation thickness shall be applied to steam valves, upper cylinders and steam chests. Lower halves of cylinders shall have an extra 25% of insulation applied. The insulation thickness shall not be tapered to allow for metal temperature gradient on the valves, steam chests or cylinders.

3.11.3 Components Application Guidelines

3.11.3.1 General

1. Fix the spray insulation with holding pins, diameter 10mm, at the foreseen locations and with self-retaining locking discs, pushed on when applying the insulation, in order to ensure tight contact with the turbine casing and prevent sagging on the lower side. Armour the spray insulation with a wire mesh.
2. Variations of the insulating material thickness of -10 % to +20 % are permitted for equalising transitions if they are symmetric to the centre line. The insulation on the lower half shall be 25% thicker.
3. Provide a minimum air gap of 25 mm between the bearing pedestal and turbine casing, taking into account turbine expansions during operation.
4. Apply the insulation in the area of the instruments, balancing hole cover, temperature probe and flanges of the cross-over pipes so that it can be removed, i.e. manufacture boxes with insulating wool and aluminium sheet cladding. Place the abutting joints of the cladding so that no spray or dripping oil can enter the insulation (upper parts overlapping lower parts, longitudinal joints of horizontal pipes at bottom, of vertical pipes in turbine centre).
5. Apply the spray insulation in such a way that the bearing pedestal cover can be removed without damaging the insulation.
6. Ensure when applying the insulation that as little water as possible is used.
7. Apply and fasten the insulation so that it can be removed from the turbine parting joint flange area without damaging the complete insulation.
8. Welding work on turbine casings, valves or pipework may only be carried out at the specified locations. Direct welding of fasteners to turbine casings, valves or pipework is forbidden.

9. Arrange the supports for the spray insulation in such a way that the parting joint bolting can be removed without dismantling the supports.
10. All fasteners, such as discs, pins, clamps, wire hooks and wires shall be made from stainless material.
11. Before applying spray insulation on the turbine casing and valve casings, cover all sensitive parts with plastic foil. This applies especially to bearing pedestals, sliding elements, rotor, valve stems, instruments and equipment that is installed below the turbine. Make sure that as little dust as possible is generated.
12. Spray insulation shall be allowed to dry after being applied. Apply the hard case only after the insulation is completely dry, preferably after admitting steam to the turbine for the first time.
13. Depending on the requirements, provide the spray insulation with a zinc-plated steel wire mesh, mesh size: 13-16 mm and a hard case, approximately 6 to 10 mm thick, using a trowel.
14. Subdivide the hard case into fields using a joint tape or including expansion joints. Select the field size so that no expansion cracks develop in operation. Close the joints with permanently elastic joint filler after approximately fourteen days of operation. Apply an oil-resistant, water-proof coat in accordance with the latest information on fire protection.
15. Clean the place of work and the machine parts located below after every work step.
16. Take particular care in the case of rotating or moving parts, such as rotor, valve stems, sliding elements, in order to ensure that they are clean and free from any insulation material. Remove all scaffolds etc. after applying the insulation.

3.11.3.2 Turbine pipework

1. Similar to the turbine, the inlet pipes can be spray-insulated and provided with a hard case and protective coat.
2. Mat insulation with cladding is permitted for the inlet pipes and crossover pipes, if applied in accordance with Section 3.5
3. Regardless of the insulation type used, it shall be ensured that that the flange bolting of the pipes can be removed with little dismantling work. The pipe supports are to be accessible.

3.11.3.3 Heat shield

Heat shields shall be installed at the face sides of the HP and IP turbines between the bearing pedestal and turbine. The heat shield shall meet the following requirements:

1. The heat shield shall be made from 3 mm thick aluminium sheet metal.
2. It shall be reinforced by angle iron at the top and laterally.
3. It shall be manufactured in such a way that installation from the top is possible.
4. Attachment points shall be provided for installation and removal (for example, bores for shackle or threads for eyebolts).
5. Accessibility to the balancing hole shall be ensured; provide an opening if necessary.
6. The clearance between the heat shield and rotor shall be at least 20 mm.
7. The heat shield shall be bolted laterally to the casing claws.
8. At the bearing pedestal end, the heat shield shall be provided with high performance insulation.
9. The distance between the heat shield and bearing pedestal shall be at least 40 mm.
10. An opening shall be provided for the instruments (differential expansion sensor, if installed).

3.11.4 Exception for turbine steam exhaust systems

The requirement for insulation does not apply to turbine exhaust systems except where personnel may come into contact with surfaces exceeding 60°C. In particular, the exhaust ducts leading to air cooled condensing systems and the air cooled condenser itself shall not be insulated.

3.11.5 Finish

The entire insulated surface shall be finished with a trowel coat of hard setting compound, reinforced with 40 mm mesh galvanised wire netting. The plaster shall be between 6 to 10 mm thick. When dry, the plaster shall be sealed with material that will prevent oil seepage into the insulation.

1. Cross-over piping shall be insulated and finished, as for all other piping.
2. Turbine glands shall not be insulated.

3.12 BLANKET INSULATION MATERIAL FOR STEAM TURBINES

Users of this Standard are to refer to the specification “474-11722 Specification for the procurement and insulation of blanket material for steam turbine applications”.

This specification applies to all steam turbines in the Eskom fleet that opt to use blanket insulation. The specification in question is supplementary to the current Thermal Insulation Standard 240-56247004. This specification was compiled to assist technical, procurement and managerial personnel in procuring blanket insulation according to BS 5970:2012. The turbine systems where blanket insulation can be applied are as follows:

a) Top and bottom HP Cylinder Casing and Gland Steam Pipes
b) Top and bottom IP Cylinder Casing and Gland Steam Pipes
c) Top and Bottom HP and IP T-Pieces from Horizontal to Vertical Flanges
d) HP and IP Steam Chests, Steam Inlet and Outlet Leak-off Legs
e) Left and Right Hand Cross-Over Flanges and Bellows
f) HP and IP Forced Air Cooling Pipes
g) Left and Right Hand Cold Reheat Non Return Valves and Pipe
h) HP and IP, Front and Rear Cylinder Ends
i) HP and IP Front and Rear Gland Boxes
j) HP and IP Rotor Simulating Probes
k) Turbine cross-over piping

3.13 SPRAYED COATINGS

1. The coating shall consist of mineral or ceramic fibre. The coating shall be homogeneous and shall set without the application of heat.
2. The probe and collar method shall be used to determine the thickness of the spray coating, both during and after the application.

3. Preparation for application. The parts to be insulated shall have pins or nuts for studs, welded on at a square pitch not larger than 300 mm. The welding shall be done by the Turbine contractor in accordance with the Eskom Welding Standard 240-106628253. The pin or stud diameter should be 10 mm and the length shall be the same as the insulation thickness, before the application of the finishing coating.
4. All surfaces to be insulated shall be thoroughly cleaned and be completely free from grease and oil.
5. Materials shall be prepared with potable water.
6. All bolts and nuts, instrument lines and tapping points or similar penetrations shall be covered with glass fibre cloth, aluminium foil or a tubular protective sleeve before the application of the sprayed insulation.
7. All adjacent plant and surfaces shall be protected from dust, splashes, falling materials or other harmful effects of the insulation process.
8. The application of the insulation shall be a continuous process to completion. Cold joints are not permissible.
9. The initial layers of insulation shall adhere fully to the surface being sprayed, particularly to the underside of the turbine cylinders.
10. The insulation shall be applied in 25 to 40 mm thick layers. While spraying, the insulation is to be regularly pushed down to ensure constant density throughout.
11. The insulation shall be applied between courses of 40 mm mesh galvanised wire netting, fixed to the retaining pins or studs with spire clips or similar. The courses of wire mesh shall be no more than 100 mm apart, measured from the surface of the turbine casing.
12. The thermal insulation shall be applied separately to the top and bottom halves of turbine cylinders. The insulation shall stop short of flanged joints and finished with a layer of non-inflammable jointing, fixed to the edges of the insulation with a trustworthy heat resistant adhesive. The joints shall then be sprayed with insulation to the required thickness.
13. A reference sample of the insulation sprayed into a wooden mould (610 x 610 x 100 mm) and tamped to the correct density is to be retained for a minimum period of six months, or until released. The sample is to be permanently marked with the date of preparation, turbine number and the location where the material was applied.
14. The entire insulated surface shall be finished with a trowel coat of hard setting composition, reinforced with 40 mm mesh galvanised wire netting. The plaster shall be between 6 and 10 mm thick. When dry, the plaster shall be sealed with material that will prevent oil seepage into the insulation.

3.14 DRAWINGS: FIGURES 1-11

Figure	Drawing	Description
1	0.00 / 3960	Eskom Standard. Thermal insulation. Fig 1: Sheet steel muffs on horizontal and vertical lines
2	0.00 / 3961	Eskom Standard. Thermal insulation. Suggested design of cladding support

3	0.00 / 3962	Eskom Standard. Thermal insulation. Spider clamps for vertical pipes up to 99 mm O/D
4	0.00 / 3963	Eskom Standard. Thermal insulation. Spider clamps for vertical pipes 100 – 499 mm O/D
5	0.00 / 3964	Eskom Standard. Thermal insulation. Spider clamps for vertical pipes 500 – 1499 mm O/D
6	0.00 / 3965	Eskom Standard. Thermal insulation. Insulation support for vessels above 1500 mm O/D
7	0.00 / 3966	Eskom Standard. Thermal insulation. Insulation of clustered tubes
8	0.00 / 3967	Eskom Standard. Thermal insulation. One method of valve insulation
9	0.00 / 3968	Eskom Standard. Thermal insulation. Insulation of boiler walls
10	0.00 / 3969	Eskom Standard. Thermal insulation. Insulation of boiler walls
11	0.00 / 3970	Eskom Standard. Thermal insulation. Ductwork insulation

Note: On all drawings:

D1 = OD (or largest dimension) of pipe or vessel.
D2 = OD (or largest dimension) of first layer of insulation.
D3 = OD (or largest dimension) of completed insulation.

3.15 RECORDS

The following records shall be retained by the organization doing the thermal insulation work for a period of five years after completion of the work:

1. Authorisations from the Eskom Supervisor to proceed with insulation work.
2. Quality control plans.
3. Authorisations to proceed with welding and fixing of attachments, together with the relevant Weld Procedure Specifications and other formal procedures for fixing of attachments.
4. Design basis - All calculations and tables are to be retained.
5. Performance tests - All records are to be retained.
6. All applicable drawings from the Contractor for the work performed on the power plant.

Copies of these records or portions thereof, shall be made available to Eskom in the quantity, format and medium prescribed by the Eskom Engineer or Supervisor.

4. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
All members as at March 2021	Turbine Study Committee
Erick Van Zyl	Corporate Specialist: Asset Management. Mechanical Engineering
Duduzile Ramasimong	Corporate Specialist: Asset Management. Turbine Engineering
Dr Gary de Klerk	Turbine Study Committee chairperson
Lebo Serekwa	Senior Consultant: Asset Management. Mechanical Engineering
Andrew Downes	Chief Metallurgist: Research, Testing and Development
Muhammad Laher	Engineer: Asset Management. Mechanical Engineering
Thobile Tyeke	Senior Engineer. Asset Management
All members as at May 2021	Pressure Equipment Care Group
Nathi Mazibuko	Boiler Engineering Manager:
Michael Richter	Senior Engineer. Asset Management. Duvha Power Station
Bhavesh Naran	Chairperson: Pressure Equipment Care Group
Dr Robert Clark	Senior Consultant: Asset Management. Operations and Maintenance

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0.1		Draft Document for review created from 36-978
October 2013	1		Final Document approved for Publication. Document approved by TDAC ROD 16 July 2013
September 2015	1.1	SG Mthimkhulu	Document updated, final draft for Comments Review.
December 2015	1.2	SG Mthimkhulu	Updated all additional comments after review.
March 2016	1.3	SG Mthimkhulu	Updated Draft Document
March 2016	1.4	SG Mthimkhulu	Final Updated Draft Document
March 2016	2	SG Mthimkhulu	Final Rev 2 Document for authorisation and Publication
July 2017	2.1	SG Mthimkhulu	Removal of obsolete standards
July 2017	3	SG Mthimkhulu	Final Rev 3 Document for Authorisation and Publication
June 2021	3.1	Dr RM Clark	Document revised and included blanket insulation material for steam turbine applications and Turbine Study Committee comments.
June 2021	3.2	Dr RM Clark	Final Draft after Comments Review Process
June 2021	4	Dr RM Clark	Final Rev 4 Document for Authorisation and Publication

6. DEVELOPMENT TEAM

Pressure Equipment Care Group team

7. ACKNOWLEDGEMENTS

A special thanks to all pressure equipment care group members and turbine engineering members for their valued comments.

APPENDIX A: CLAUSES FOR WORKS INFORMATION

1. Employer to provide

1. A schedule of the plant and areas to be insulated.
2. Purpose of insulation for each area, either:
    - To achieve the specified cold face temperatures or,
    - To control process temperatures or,
    - Acoustic damping or,
    - To protect personnel.
3. Operating conditions and hot face temperatures of each area to be insulated.
4. Special service requirements. (Resistance to damage, compression, fire, abnormal vibration, etc.).
5. Programme of work.
6. Power station site regulations and conditions, including Eskom's cardinal rules.
7. Areas of insulation to be sealed against the ingress of oil.
8. Location of test points for operational performance of applied insulation. Eskom reserves the right to test at other positions, in order to ensure compliance to this standard
9. Schedule of performance tests to be done on insulation materials.
10. State whether scaffolding shall be supplied by the insulation contractor, or others.
11. Any additional requirements or requirements that differ from this standard (240-56247004) in respect of the following:
    - Design ambient temperatures.
    - Preparation of surfaces required.
    - Types of fittings and supports.
    - Types of insulation to be applied.
    - Types of surface covering (finishes) and cladding.
    - Requirements for access during testing, inspection and maintenance of plant.

2. Contractor to provide

a. Schedule of insulation

The contractor shall submit full details of the proposed methods of insulation. The Contractor shall provide a schedule showing the type of insulation to be applied to each plant item, thickness to be installed, finishing arrangements and the calculations, schedules and sketches that confirm that the proposed installation will comply with 240-56247004. In addition the contractor shall complete the schedules called for in the enquiry documents. These schedules shall be binding on The Contractor unless changes are approved by the employer in which case revised schedules shall immediately be submitted.

b. **Insulation total mass**

The contractor shall communicate the mass of the thermal insulation system comprising insulating materials, cladding or finishing materials, fixings, attachments and integral insulation support structures to the process plant contractor to the allow the process plant contractor to make allowance for this additional mass in design calculations.

c. **Quality control plan**

The contractor shall provide a Quality Control Plan that will ensure that correct materials are used and applied in accordance with specification 240-56247004. The QCP shall be submitted to the employer 21 days before the start date. The QCP shall contain, at least, a schedule of materials to be applied in specific locations, the dimensions, work procedures, hold points, nature and detail of checks during work progress, and safety requirements.

d. **Supervision**

Site work shall be under the continuous supervision of a sufficiently trained supervisor employed by the contractor who shall ensure that the work meets the requirements of the QCP.

e. **Supply of materials**

The contractor shall supply all the necessary materials to complete and install the insulation to comply with Eskom Standard 240-56247004. These materials include, but are not limited to, the insulation, insulation and cladding supports, fixing pins and fasteners, sheet metal cladding and beading, galvanised wire netting, fibreglass membrane, hard setting composition, sealants and weatherproofing, binding wire and strapping and any other material necessary to complete the works.

The contractor shall provide facilities for the storage of insulation material and erection materials such that the materials are completely protected from the weather and deleterious conditions. Insulation which suffers damage in any form shall not be used.

f. **Scaffolding**

The contractor shall ascertain whether the employer will engage others to supply the scaffolding required for the thermal insulation work. If so, the contractor shall comply with the provisions of SANS 10085 regarding the use, reporting and maintenance of the scaffolding and cooperate with the scaffolding contractor. If the contractor is required to supply scaffolding, this shall be designed, erected, used, inspected, maintained and dismantled in accordance with the provisions of SANS 10085.

g. **Site cleanliness and clearing**

The contractor shall keep the working areas free of hazards, debris, materials and ensure that at least once each week all insulation debris, scrap materials and redundant equipment are removed from the work areas and disposed of in accordance with the employer's environmental requirements. At completion of the contract all unused materials and equipment shall be removed from site.

8. **Inferior lagging and cladding.**

Any section of insulation which is found to be below the specified thickness shall be replaced. The contractor shall amend all damages to the insulation incurred after erection but before completion.

3. Testing

The contractor shall provide samples and bear the costs of testing of materials and performance tests of the installed insulation systems. The contractor shall submit to the employer results of any tests carried out on, or in relation to, materials to be used on the Works.

a. Tests of materials

The contractor shall provide samples drawn from the stocks of each type of insulation to be used for the Works for tests to be done by an independent testing authority. The tests are required to confirm the claimed value of thermal conductivity for the material at the applicable hot face temperature at which it will be used. At least one test shall be done for each type of insulating material at the applicable hot face temperature. Tests on compressibility and vibration resistance may also be called for by the employer.

b. Tests of applied insulation

The employer shall determine the positions of points on the plant where readings of cold face temperatures are to be taken, or where process temperatures are to be compared. The readings taken shall be communicated together with sketches showing the location of the readings and the actual positions shall be permanently marked on the plant and numbered to correspond with references on the sketches. Comprehensive reports of the readings, locations and markings shall be handed to the supervisor.

If the insulation does not meet the performance requirements, the reason shall be investigated and remedial measures taken by the contractor to correct the deficiencies. Temperature readings shall be repeated after remedial work. The result of the subsequent set of tests shall be submitted to the employer. If the performance requirements are still not met the contractor shall investigate the insulation system including the design, material properties, installation, workmanship and finish, and submit proposals to the employer to rectify the deviations.

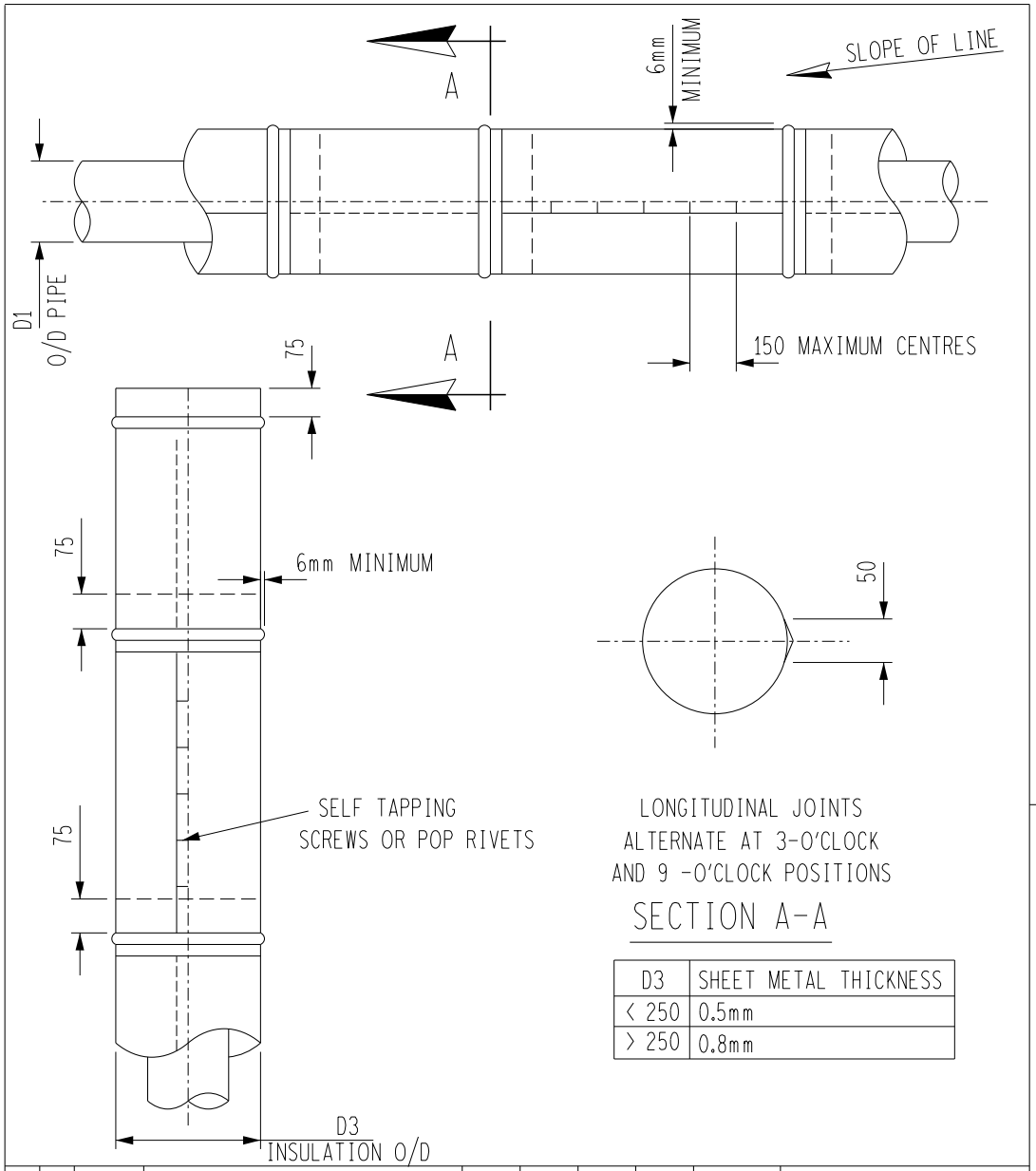
Any section of insulation which after erection is found to be below the specified thickness or specified quality shall be replaced by the contractor.

c. Additional tests by the employer

The employer may at any time take additional cold face readings or select additional samples of materials for thermal conductivity tests, compression tests, vibration tests or any other tests detailed in the British or EN Standards applicable to the material selected. Samples may be selected at the insulation manufacturer's working areas or after installation on the plant. Failure to meet the requirements of the relevant British Specification will mean rejection of all the material.

In the case of sprayed insulation, the employer may instruct the contractor to spray a sample of the insulation tamped to the correct density into a mould for test purposes. The sample is to be marked, dated and retained until released by the employer.

APPENDIX B: DRAWINGS



D3	SHEET METAL THICKNESS
< 250	0.5mm
> 250	0.8mm

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CHKD BY	Feb2015	RP	ESKOM HOLDINGS SOC Ltd. REG No 2002/015527/30
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SCALE	TYPICAL		

ESKOM STANDARD
THERMAL INSULATION
FIG 1: SHEET STEEL MUFFS ON HORIZONTAL AND VERTICAL LINES

Eskom

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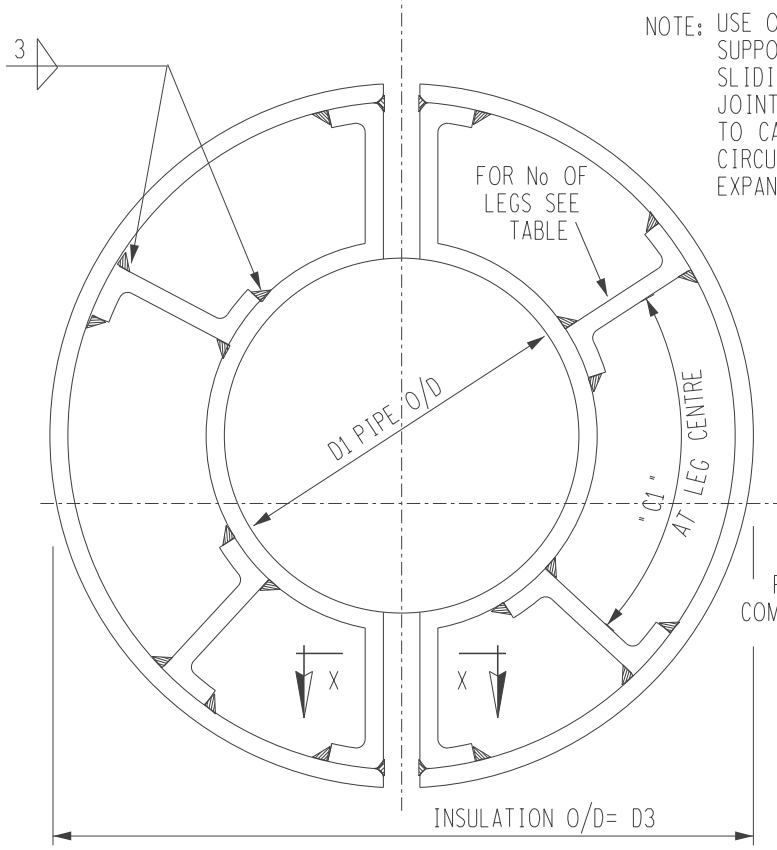
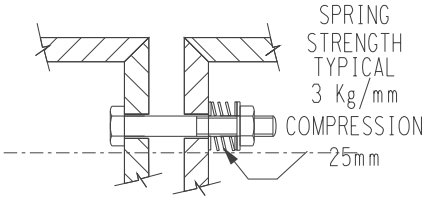


APPLICATION: PIPLINES USING WIRED MATTRESS. ALL VESSELS

HOT FACE TEMPERATURE C	MATERIAL STEEL TO BS EN 10028	MAX SPACING 'X' BETWEEN RINGS
UP TO 350	CARBON STEEL	6m
351-500	304 STAINLESS STEEL	5m
501-570	304 STAINLESS STEEL	4m
571-650	304 STAINLESS STEEL	4m

BOLT DIA	PIPE O/D D1	MATERIAL: CROSS SECTION	No LEGS	"C 1"
8mm	250-500	3x25	8	–
12mm	OVER 500	3x25	–	350-400



BOLTING DETAIL X-X

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ESKOM STANDARD
THERMAL INSULATION SUGGESTED DESIGN OF CLADDING SUPPORT

Eskom

0.00/3961

REV 4

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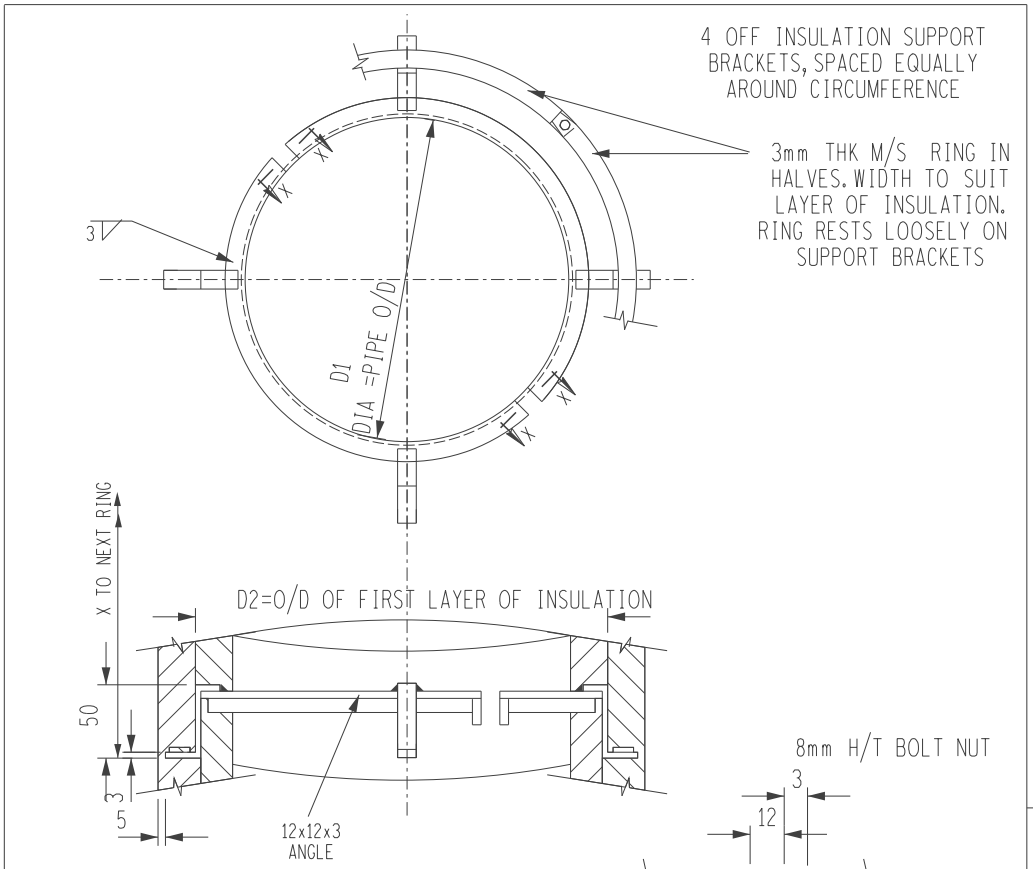

BOLTING DETAIL X-X

NOTE: FOR SINGLE LAYER INSULATION OMIT SUPPORT BRACKETS & OUTER RING

BOLTS: HIGH TENSILE 8.8 AND SPACING

HOT FACE TEMPERATURE C	MATERIAL STEEL TO BS EN 10028	MAX SPACING 'X' BETWEEN RINGS
UP TO 350	CARBON STEEL	6m
351-500	304 STAINLESS STEEL	5m
501-570	304 STAINLESS STEEL	4m
571-650	304 STAINLESS STEEL	4m

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ESKOM STANDARD
THERMAL INSULATION
SPIDER CLAMPS FOR VERTICAL PIPES UP TO 99mm O/D

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REV 2

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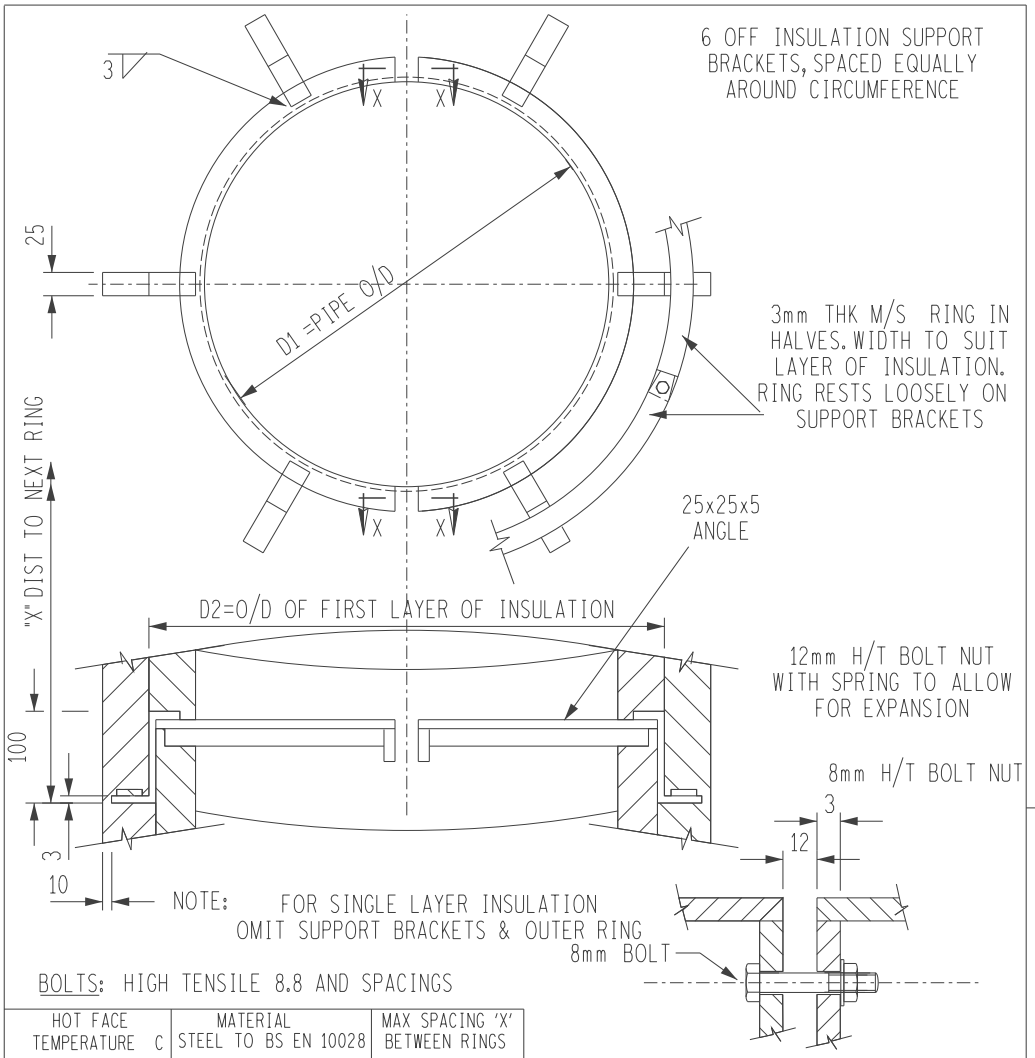

BOLTS: HIGH TENSILE 8.8 AND SPACINGS

HOT FACE TEMPERATURE C	MATERIAL STEEL TO BS EN 10028	MAX SPACING 'X' BETWEEN RINGS
UP TO 350	CARBON STEEL	6m
351-500	304 STAINLESS STEEL	5m
501-570	304 STAINLESS STEEL	4m
571-650	304 STAINLESS STEEL	4m

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APPROVED BY : EvZ Feb 2015

AUTHORISED BY :

ESKOM HOLDINGS SOC Ltd.
REG No 2002/015527/30

ESKOM STANDARD
THERMAL INSULATION
SPIDER CLAMPS FOR VERTICAL PIPES 100-499mm O/D

Eskom

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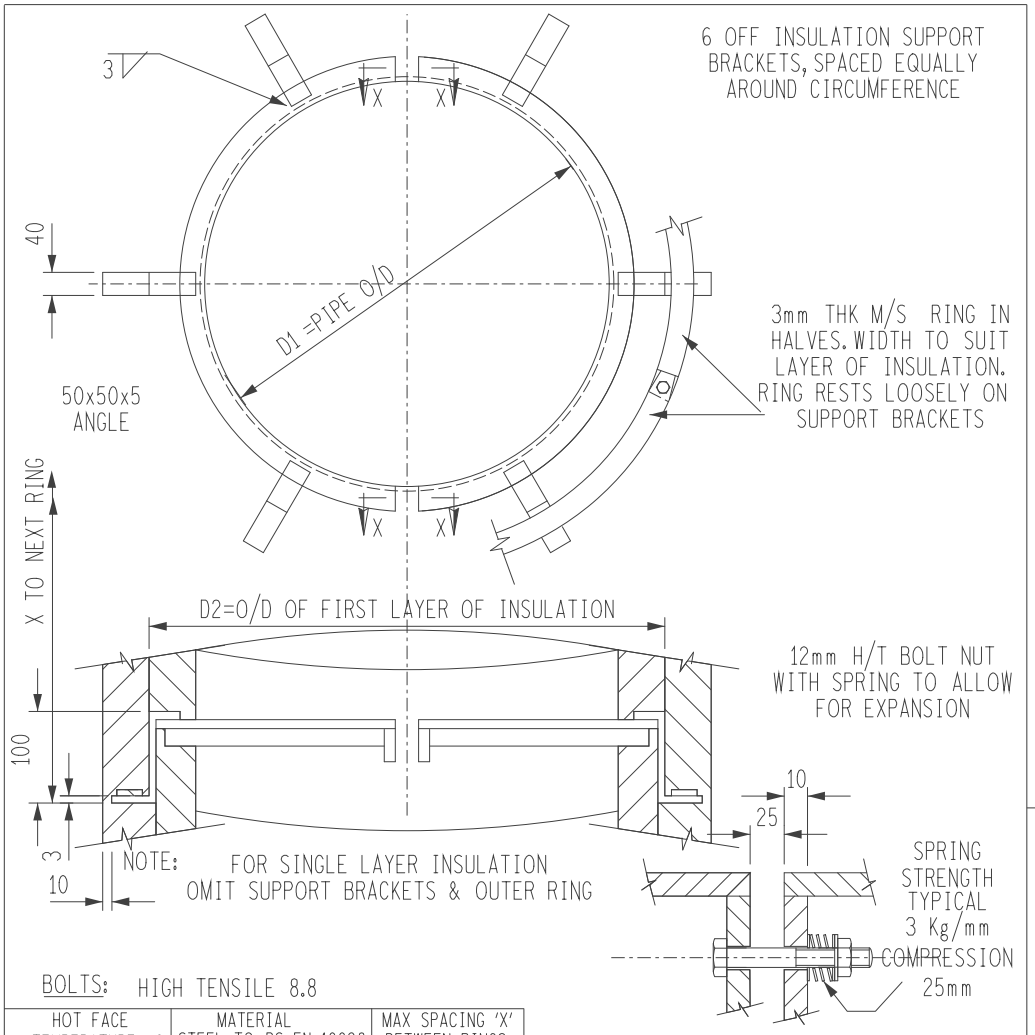
REV 2

SIZE GROOTTE A4L



HOT FACE TEMPERATURE C	MATERIAL STEEL TO BS EN 10028	MAX SPACING 'X' BETWEEN RINGS
UP TO 350	CARBON STEEL	6m
351-500	304 STAINLESS STEEL	5m
501-570	304 STAINLESS STEEL	4m
571-650	304 STAINLESS STEEL	4m

D.O.	REV	DATE	REVISION / INDEX REFERENCE	REV BY	CHKD BY	AUTH BY	KKS APP	REFERENCE DRAWINGS
	2	11-07-07	REDRAWN ON CAD	RSL				
	1	26-02-96	DRG.SCANNED& NEW TITLE BLOCK	KN				
00	0		FIRST ISSUE					

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AUTH BY			
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DRAWN BY	11 07 07	RSL	
SCALE	TYPICAL		

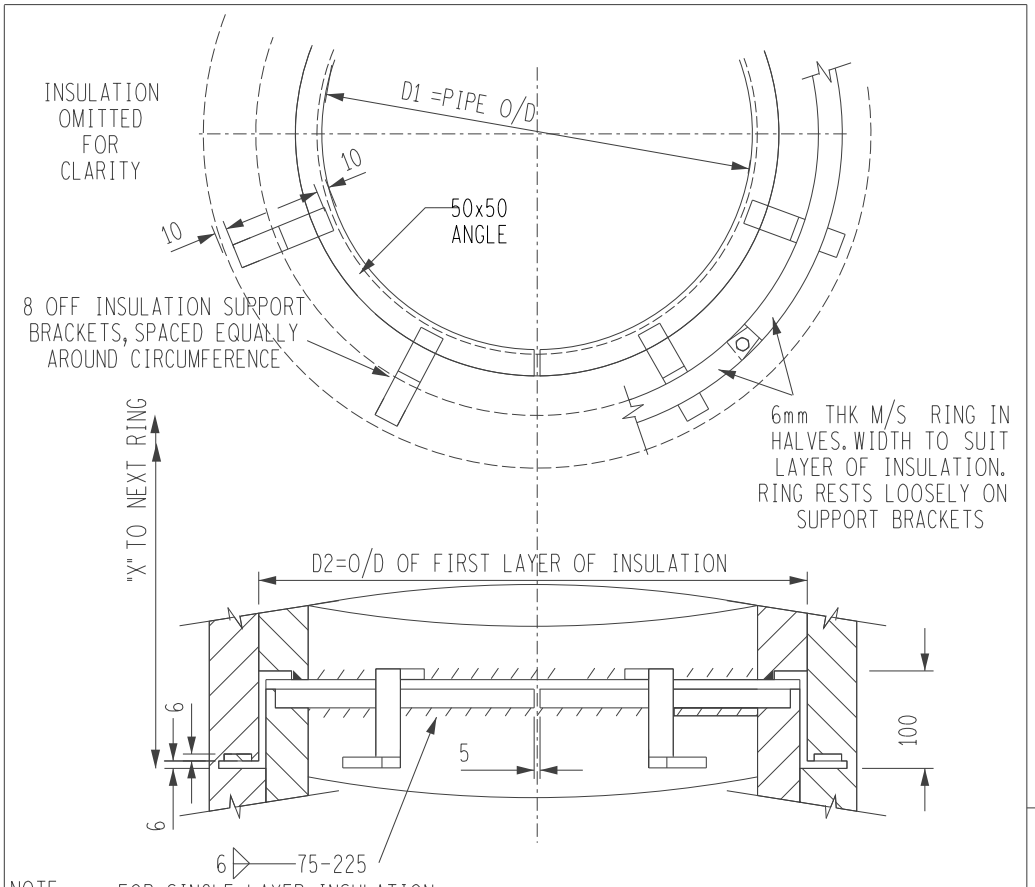
ESKOM STANDARD
THERMAL INSULATION
SPIDER CLAMPS FOR VERTICAL PIPES 500-1499mm O/D

Eskom

0.00/3964

REV 2

SIZE GROOTTE A4L



NOTE: FOR SINGLE LAYER INSULATION
OMIT SUPPORT BRACKETS & OUTER RING

MATERIAL: COMPATIBLE WITH VESSEL & TEMPERTURE CONDITIONS
FOR GUIDANCE SEE TABLE

HOT FACE TEMPERATURE C	MATERIAL STEEL TO BS EN 10028	MAX SPACING 'X' BETWEEN RINGS
UP TO 350	CARBON STEEL	6m
351-500	304 STAINLESS STEEL	5m
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REG No 2002/015527/30

ESKOM STANDARD
THERMAL INSULATION
INSULATION SUPPORT FOR VESSELS ABOVE 1500mm O/D

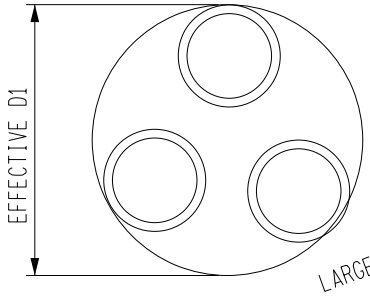
Eskom

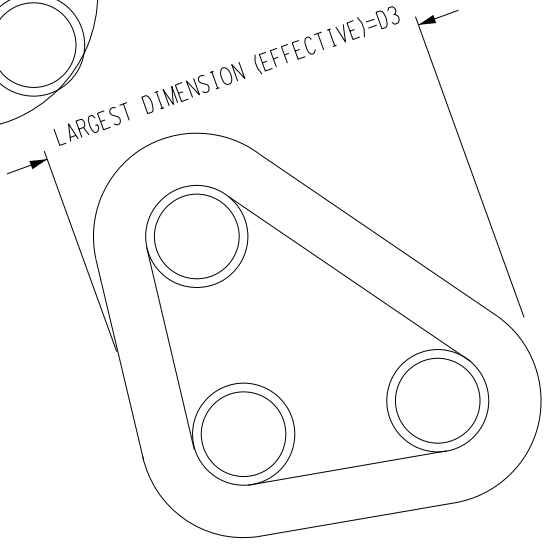
0.00/3965

REV 2

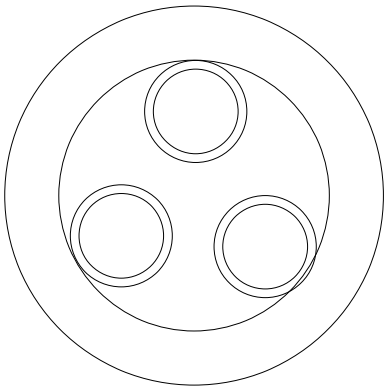
SIZE GROOTTE A4L

BASE CALCULATION OF INSULATION THICKNESS ON DIAMETER OF SMALLEST ENCLOSING CIRCLE AND TEMPERATURE OF HOTTEST TUBE





METHOD 2 BLANKET



METHOD 1 PIPE PREFORMED SECTION
(FINISH AS FOR SINGLE PIPES)

"D 3"	FINISH
< 500 mm	HARDSETTING COMPOSITION 6-10mm THICK
500 mm +	0.8mm GALVANISED SHEET STRAPPED AT 300mm PITCH WITH 20mm WIDE GALVANISED STRAPS

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SCALE	TYPICAL		

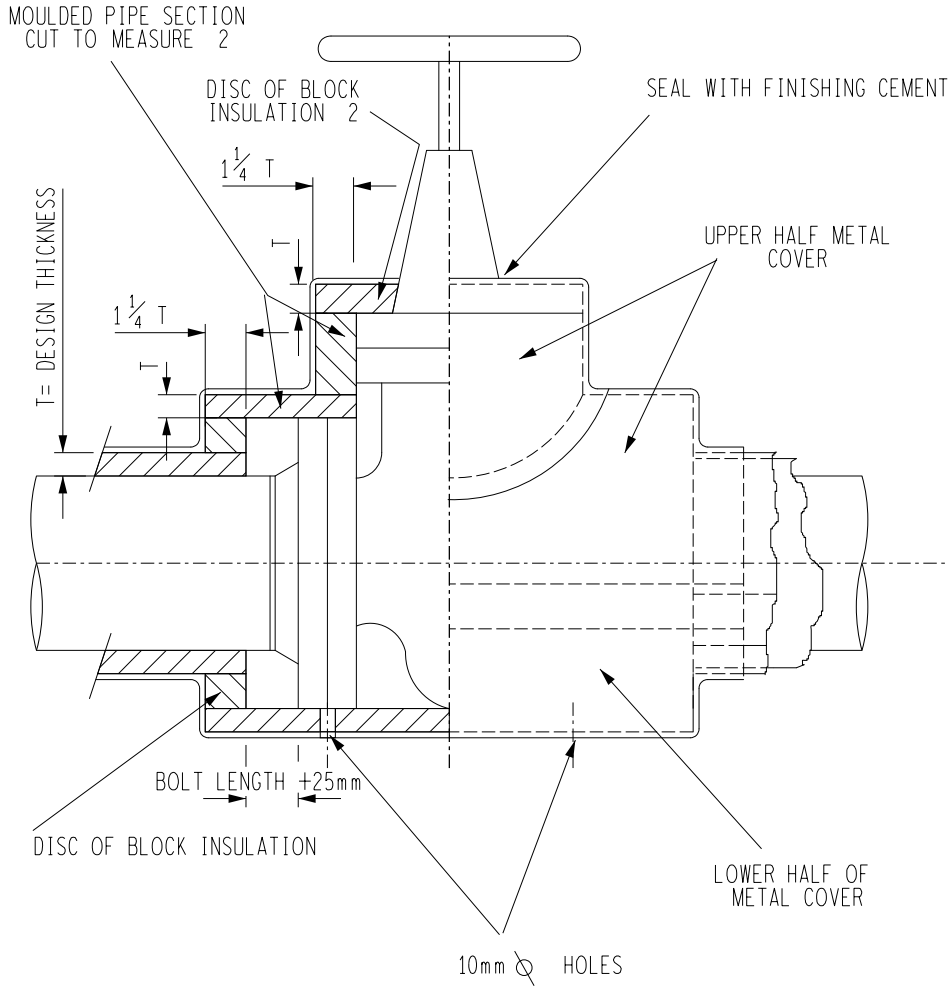
ESKOM STANDARD
THERMAL INSULATION
INSULATION OF CLUSTERED TUBES

Eskom

0.00/3966

REV 2

SIZE GROOTTE A4L



1. DO NOT INSULATE PACKING GLAND
2. CEMENTED TO INSIDE OF COVER
3. T= DESIGN THICKNESS

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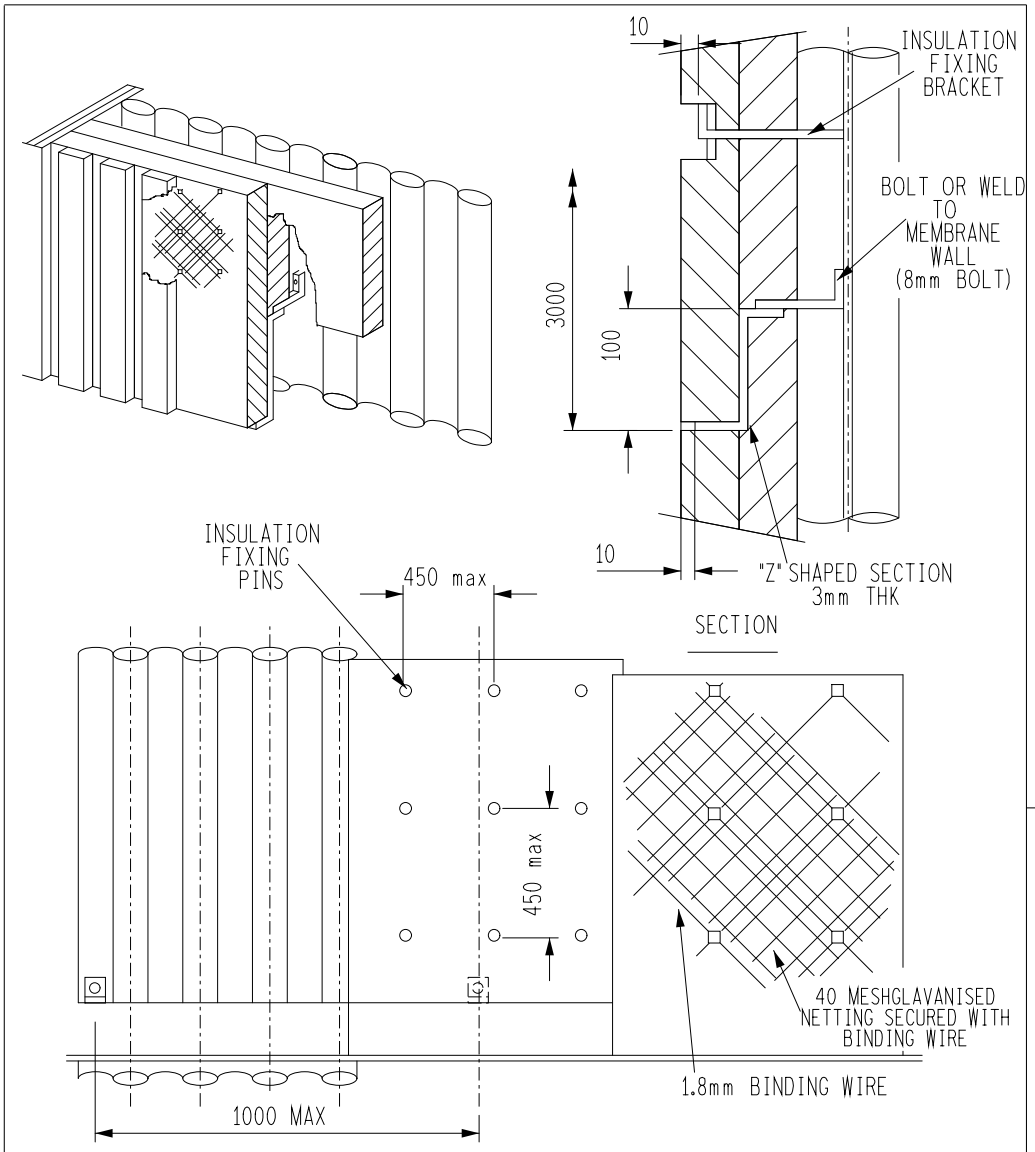
SCALE	TYPICAL		Eskom	0.00/3967

ESKOM STANDARD
THERMAL INSULATION
ONE METHOD OF VALVE INSULATION

REV: 2

SIZE GROOTTE A4L



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SCALE	TYPICAL		

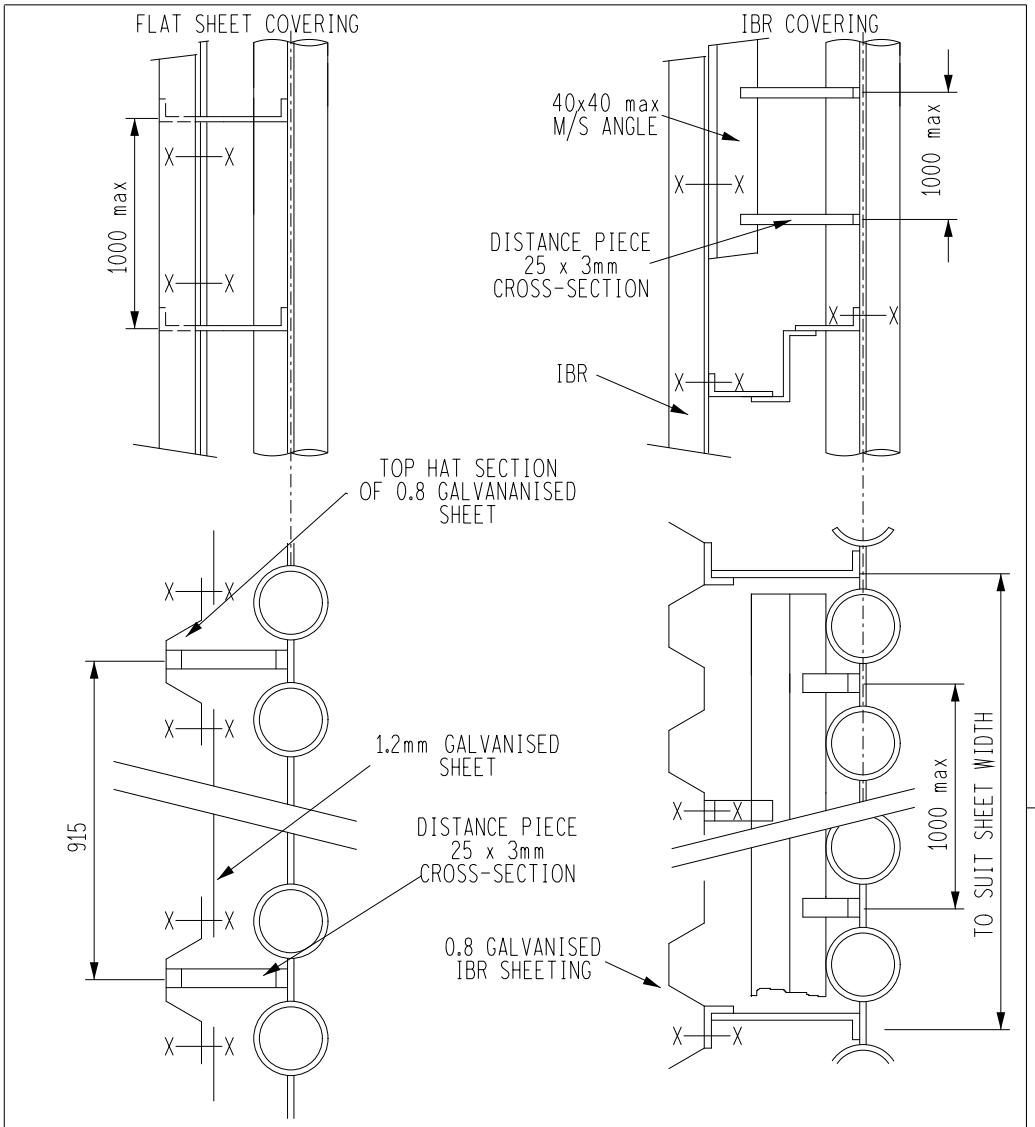
ESKOM STANDARD
THERMAL INSULATION
INSULATION OF BOILER WALLS

Eskom

0.00/3968

REV 2

SIZE GROOTTE A4L



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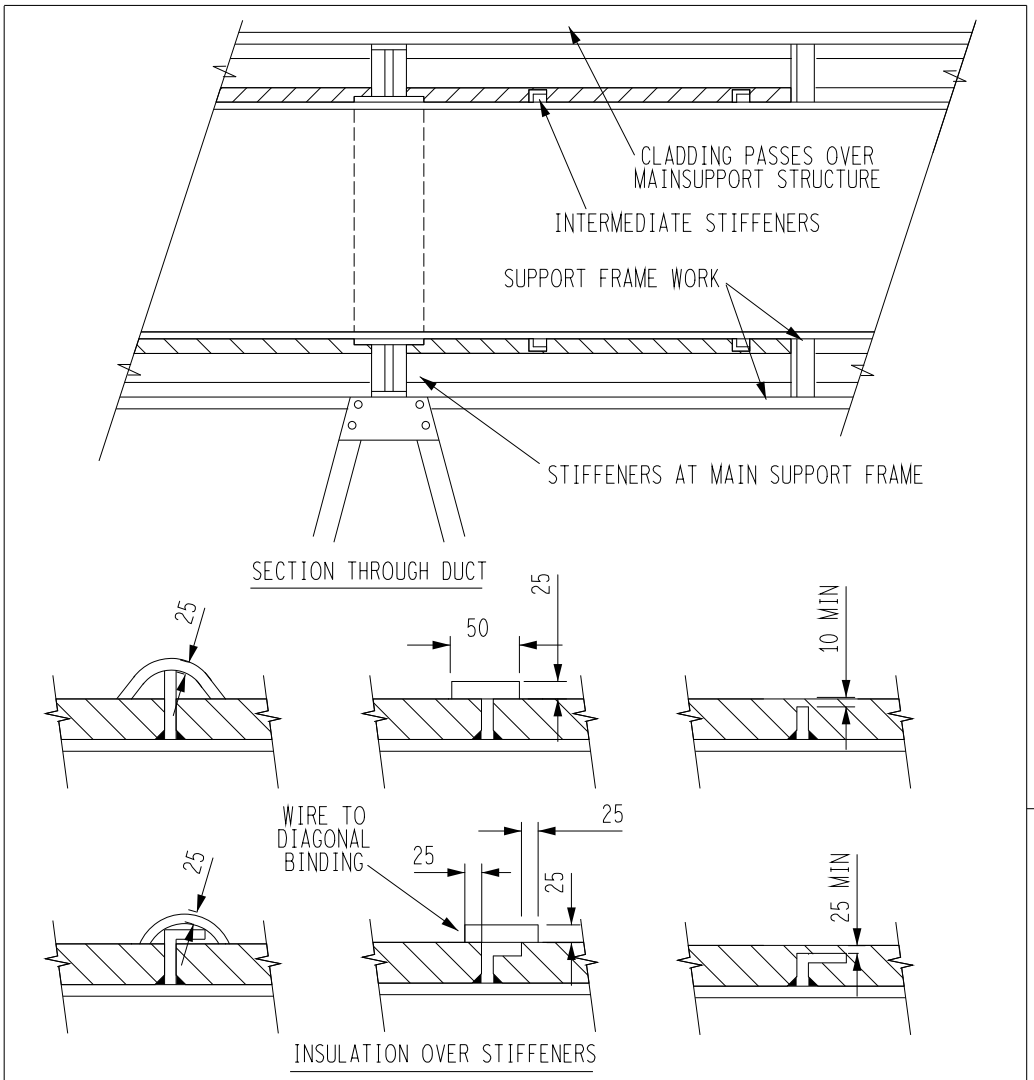
ESKOM STANDARD
THERMAL INSULATION
INSULATION OF BOILER WALLS

Eskom

0.00/3969

REV 2

SIZE GROOTTE A4L



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SCALE	TYPICAL			

ESKOM STANDARD
THERMAL INSULATION
DUCTWORK INSULATION

Eskom

0.00/3970

REV 2

SIZE GROOTTE A4L