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ESKOM STANDARD SPECIFICATION FOR THE RE-METALLING (RE-LINING) OF WHITE METAL BEARINGS

THIS DOCUMENT HAS BEEN SEEN AND ACCEPTED BY

N Van Tonder	**Mechanical Materials and Civils Technology Manager TSI**
BNVW Sibiya	**Operational Engineering Manager**
I Redpath	**Generation Chief Technical Advisor**

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Contents

Page

1. Scope 3

2. References 3

3. Definitions 4

4. Requirements 4

4.1. Supplier qualification 4
4.2. Manufacturing requirements 5

5. Verification and tests 10

6. Documentation 10

7. Packaging 11

Annex

A Information sheet 12

1. Scope

1.1. Purpose

This specification details Eskom's technical requirements for the re-metalling of thickwall journal bearings and thrust pads used in Eskom plant. Thin walled bearings are excluded from this specification.

1.2. Obligations

Nothing in this specification shall lessen the supplier's obligations as detailed in Eskom's Conditions of Purchase or the applicable Conditions of Contract.

1.3. Responsibilities

It is the responsibility of the Power Station Maintenance Manager for the implementation of this standard at his Power Station.

It is the responsibility of the relevant system engineer to provide and verify the technical details applicable to his plant.

Generation Technical Department are responsible for the periodic review of this document and for co-ordinating vendor technical assessments in accordance with Eskom procedures.

2. References

The latest edition of the following documents shall be read in conjunction with this specification.

BS 7585: Part 1: 1992, *Metallic multilayer plain bearings*, *Method for non-destructive ultrasonic testing of bond*. (Eqvuivalent to ISO 4386-1: 1992)

BS 7585: Part 2: 1992, *Metallic multilayer plain bearings, Method for destructive testing of bond for bearing metal layer thicknesses ³ 2 mm*. (Equivalent to ISO 4386-2: 1992)

BS 7585: Part 3: 1992, *Metallic multilayer plain bearings, Method for non-destructive die penetrant testing*. (Equivalent to ISO 4386-3:1992)

ESKASAAA3, *Eskom approval of personnel performing quality related special processes on all Eskom plant.*

ESKASAAC7, *Quality requirements for stockists and agents.*

ESKASAAU7*, Quality requirements for the procurement of assets, goods and services.*

SABS ISO 9001:1994, *Quality systems — Model for quality assurance in production, installation and servicing.*

SABS ISO 9002:1994, *Quality systems — Model for quality assurance in design, development, production, installation and servicing.*

SABS ISO 695/703-1971, *South African Bureau of Standards Standard Specification for White Metals (metric units).*

Glacier Bearings, South Africa, *" A Guide to Plain Bearings", issue 2*.

3. Definitions

3.1. approved suppliers: Suppliers who have previously re-metalled journal bearings for Eskom to an acceptable quality.

3.2. new suppliers: Suppliers who have not previously re-metalled bearings for Eskom.

3.3. prototype bearings: Re-metalled bearings subject to Eskom evaluation for new supplier approval.

3.4. thickwall bearings: Bearings in which thickness of the white metal lining is greater than or equal to 1/15 of the shaft diameter for journal bearings.

4. Requirements

4.1. Supplier qualification

4.1.1. Quality management system

All suppliers shall be responsible for the implementation of the following Eskom documents:

ESKASAAC7, *Quality requirements for stockists and agents.*

ESKASAAU7*, Quality requirements for the procurement of assets, goods and services.*

4.1.2. Approved Suppliers

Only Eskom approved suppliers shall re-metal bearings for Eskom. In addition, preference shall be given to suppliers who are listed in terms of SABS/ISO 9001 to 9002.

Suppliers shall submit evidence that they are listed and that they are regularly audited by an independent specialist organisation which certifies that the company complies with the minimum requirements of SABS ISO 9001 to 9002.

4.1.3. New suppliers

New suppliers shall be subjected to a capability assessment by Eskom's Generation Technical Department. Upon successful completion of an assessment, the supplier may be required to re-metal a prototype bearing or set of bearings for an Eskom nominated application. The prototype bearing/s shall be subjected to tests and inspections reflected in clause 4.1.4.

4.1.4. Prototype bearings

Prototype bearings shall meet the same requirements as other re-lined bearings re-lined to this specification. The following inspections and tests shall be performed on each prototype re-metalled white metal bearing:

a. Dimensional checks in accordance with clause 5.1;

b. Non-destructive examination, bond test, in accordance with clause 5.2;

c. Identification in accordance with clause 5.3;

d. Chemical analyses of the bearing material used in accordance with clause 5.4;

e. Straightness and cylindricity checks in accordance with clause 5.5;

f. Surface finish checks in accordance with clause 5.6;

g. Micrograph of white metal in accordance with clause 5.7.

4.2. Manufacturing requirements

4.2.1.Materials

a. All bearing lining materials used shall conform to SABS 695/698-1971 or an equivalent material specification. Equivalent specifications are to be submitted to Eskom for approval.

b. The bearing lining material required shall be specified in annex A - Information sheet.

c. In the absence of any material specification, the material to be used shall be selected from table 1.

d. If the application is not reflected in table 1, the material used shall be as prescribed in SABS 695-1971 WM 90 or SABS 696-1971 WM 84.

e. Only virgin white metals shall be used in applications requiring the conditions stated in SABS 695-1971 WM-90 and SABS 695-1971 WM-84.

f. Unless otherwise specified by Eskom, no lead based white metals shall be used.

Table 1 — Suggested material requirements for Eskom applications

SABS Specification Number	SABS Alloy Number	Chemical Composition	% min	% max	Typical application
SABS 695-1971	WM 90	Tin Antimony Copper Lead Nickel Cadmium Iron Zinc Aluminium Other elements (total)	88.5 6.0 2.5 - - - - - -	91.5 8.0 3.5 0.3 0.05 0.05 0.05 0.01 0.01 0.3	FD, ID and PA fan bearings.
SABS 696-1971	WM 84	Tin Antimony Copper Lead Iron Zinc Other elements (total)	82.0 9.0 5.0 - - - -	86.0 11.0 7.0 0.3 0.05 0.01 0.3	Turbine and generator bearings, thrust bearings, gearbox bearings.
SABS 697-1971	WM 80	Tin Antimony Copper Lead Iron Zinc Other elements (total)	78.0 8.0 5.0 5.0 - - -	82.0 10.0 7.0 8.0 0.05 0.01 0.3	As for WM 84
SABS 698-1971	WM 72	Tin Antimony Copper Lead Iron Zinc Other elements (total)	70.0 9.0 5.0 10.0 - - -	74.0 11.0 7.0 14.0 0.05 0.01 0.3	Motor bearings, pump bearings, compressor bearings.

4.2.2. Alternative materials

The supplier shall obtain written approval from Eskom for any alternative material to be used.

4.2.3. Dimensions and tolerances

a. Exact dimensions of the bearing base and lining shall be determined and recorded by the supplier prior to commencement of work. All the required dimensions are to be indicated on a drawing or sketch of the bearing. Where possible Eskom will supply a drawing or sketch of the bearing. If no drawing is available, the supplier shall produce a sketch of the bearing.

b. Dimensions and tolerances of all finally machined bearings shall also be recorded on a suitable drawing or sketch of the bearing. If no tolerances are available from Eskom, these shall be determined by the supplier and confirmed with Eskom.

c. The supplier shall submit, to Eskom, a size confirmation sheet, detailing all significant dimensions and features, prior to commencement of work.

4.2.4.General conditions

a. All oil ports, oil ways, holes, grooves and recesses shall be free from debris or any obstruction that may restrict oil flow.

b. All edges and corners shall be free of burrs, rags and slivers.

c. The bearing back shall be free from burrs, bruises or other damage, which may interfere with the correct seating of the bearing in the housing.

d. The lining shall be free from inclusions, porosity, blisters, blow holes and any defects which may reduce the integrity of the lining. No defects shall be allowed in the load carrying area and within 30 mm of any jacking oil ports or oil ways.

4.2.5.Surface finish

The supplier shall determine the method of machining to achieve an even surface finish free from waviness, high spots and surface defects.

4.2.6. Distortion

The supplier shall be responsible for minimising distortion of the bearing shell during the casting process. The supplier shall be responsible for ensuring that the mating faces of bearing halves are matched and that the internal circumference of the bearing is round or for elliptical bearings to the required dimensions. Where possible, the bearing housing should accompany the bearing to be re-metalled. The bearing outside diameter must be checked for conformance to original specifications.

No re-metalling shall be carried out if doubt exists that the bearing can be refurbished without excessive distortion.

4.2.7. Bonding

All bearings shall meet the following requirements with respect to bonding:

a. four classes of bonding are detailed in table 2;

b. the bonding class required for the bearing application shall be specified by the purchaser in annex A – Information sheet;

c. in the absence of any specification the requirements of table 2 shall apply;

d. applications not reflected in table 2 shall be bonded to at least class B bond.

e. For cast iron bearings where bonding is difficult, the supplier shall ensure that the shell is thoroughly cleaned and tinned to achieve maximum bond strength.

Table 2 — Bond classes and their application

Bond Class	Requirements	Applications
Class A	All areas of the lining shall be 100% bonded. No defective areas shall be permitted.	High speed or highly loaded bearings. Turbine and generator bearings, turbo compressor bearings.
Class B	A total bonded area of 95 % shall be achieved. All joints, edges and loaded areas shall be 100 % bonded. No one area of bad bonding shall exceed more than 3 % of the total area of the bearing surface.	PA, FD and ID fan bearings. Boiler feed pumps.
Class C	A total bonded area of 90 % shall be achieved. All joints, edges and loaded areas shall be 100 % bonded. No one area of bad bonding shall exceed more than 5 % of the total area of the bearing surface.	Medium loaded bearings. Pumps compressors, gearboxes, electric motors.
Class D	A total bonded area of 80 % shall be achieved. No defective bonding shall be permissible at the joints or edges. No one area of bad bonding shall exceed 10 % of the total bearing area.	Tube mill trunnion bearings, bearings with dovetail grooves.

4.2.8. Shell cleaning and preparation

The following minimum steps are suggested for the preparation of a bearing shell prior to relining. Should the manufacturer's method differ significantly, this shall be brought to Eskom's attention for approval prior to relining.

Prior to tinning, the shell shall be thoroughly degreased with a suitable solvent degreaser. If size permits the shell should be degreased in a solvent tank.

Old white metal shall be removed by immersion in a melting off pot if size permits, alternatively using a blowpipe.

Old oil or grease should be burned out with a blowpipe if the surface remains contaminated after the above treatments.

Any portions of the surface, which remain contaminated or highly polished, should be filed or ground.

Parts, not to be relined, should be protected, by coating with whitewash or washable distemper and drying. Bolt holes, water jacket apertures, lubrication ports etc, should be plugged with a removable filler and dried before relining.

4.2.9. Tinning

Pure tin shall be used for tinning steel and cast iron surfaces.

Surfaces to be tinned shall be fluxed with "killed spirit" or a suitable propriety flux.

For cast irons, surface graphite and all old oil shall be thoroughly removed prior to fluxing. It may be necessary to flux repeatedly to tin satisfactorily. A molten salt bath may be necessary to eliminate surface graphite.

4.2.9.1. Tin baths

a. Where size permits, a bath of pure tin held at a temperature of 280°C to 300°C or solder at 270°C to 300°C should be used.

b. Flux and skim the surface of tinning metal and immerse the bearing only long enough to attain the temperature of the bath. Prolonged immersion should be avoided as this will impair bond strength of the lining and cause contamination of the bath.

c. Flux and skim the surface of the bath to remove dross, etc., before removing the bearing.

d. The bearing surface should be examined. If there are any areas which have not tinned completely, these areas should be wire brushed, refluxed and re-immersed.

4.2.9.2. Stick tinning

a. If a bearing is to large, or a tinning bath is not available, the bearing or shell should be heated by blowpipes or over a gas flame as uniformly as possible.

b. A stick of pure tin, or a 50/50 solder is dipped in a suitable flux and applied to the surface to be lined. The tin or solder should melt readily, but excessively high shell or bearing temperatures should be avoided, as this will cause discoloration and oxidation of the tinned surfaces, resulting in impaired bond strength.

4.2.10. Lining methods

a. The supplier shall determine the method of casting and heat treatment or cooling to achieve the desired material properties and ensure bond integrity

b. Wherever possible and economically viable, centrifugal lining methods are preferred to static lining methods.

c. Where static lining methods are used, the mandrel should be given a coating of graphite or similar paste to prevent adhesion of the white metal to the mandrel. In addition the mandrel should be preheated prior to assembly in the lining fixture used.

d. Local repairs to lining materials by patching or by spraying defective areas are not permitted

4.2.11. Pouring temperatures

a. In general the minimum pouring temperature shall be not less than 80°C above the liquidous temperature of the white metal grade used. For tin base alloys, the minimum pouring temperature shall be 440°C, for lead base the minimum pouring temperature shall be 480°C. For propriety brands of white metal, the manufacturer's guides should be followed.

b. The objective is to pour at the minimum temperature consistent with adequate feeding of the lining to minimise shrinkage porosity and segregation during the long freezing range characteristic of many white metals.

c. Prior to pouring, the white metal shall be thoroughly mixed, without agitation. The surface of the white metal should be fluxed and cleared of dross immediately before ladling or tapping. Pouring shall be carried out as soon as possible after assembly of the preheated shell or jig.

d. **Puddling:** In the case of large statically lined bearings, puddling of the molten metal with an iron rod to assist the escape of entrapped air, and to prevent the formation of contraction cavities, may be necessary. Puddling must be carried out with great care, to avoid disturbance of the structure of the

freezing white metal. Freezing should commence at the bottom and proceed gradually upwards. The progression of solidification of the white metal may be felt by the puddler. When freezing has nearly reached the top of the assembly, fresh molten metal should be added to compensate for the thermal contraction during solidification, and any leakage that may have occurred.

e. **Cooling:** The method of cooling and the application thereof shall be such that it promotes directional solidification of the white metal, minimises shrinkage porosity and maximises adhesion.

5. Verification and tests

5.1. The supplier shall record all the relevant dimensions and features of the bearing on a drawing to be submitted together with the finished bearing.

5.2. The supplier shall determine the degree of bonding by means of an ultrasonic method complying with BS 7585 Part 1, or equivalent method. Personnel performing ultrasonic testing shall be qualified in terms of Eskom Standard ESKASAAA3.

5.3. The supplier shall hard stamp the bearing with the relevant bearing or job number.

5.4. Prior to pouring, the supplier shall carry out detailed chemical analyses of the bearing material used by means of a suitable spectrometric test method.

5.5. The supplier shall check the bearing for straightness and cylindricity by means of a suitable method/s. The findings are to be recorded on the dimensional verification sheet.

5.6. The supplier shall inspect the surface finish and record the condition on the dimensional verification sheet.

5.7. For all turbine bearings, boiler feed pump bearings and prototype bearings, a controlled sample using the same melt shall be poured and metallographically examined. The micrograph is to be recorded and included as part of the quality documents.

6. Documentation

6.1. The following documentation shall be supplied with each re-metalled bearing:

a. Detailed bond test certificate.

b. Detailed chemical analysis certificate showing actual analysis of the cast and the requirements of the material specification.

c. A drawing and dimensional verification sheet indicating all relevant final machined dimensions and machined clearance.

d. A completed information sheet (Annex A).

e. Where required, a micrograph of the control sample for turbine bearings, boiler feed pump bearings and prototype bearings.

f. The *as* cast metal temperature shall be recorded.

g. A completed quality control plan certificate.

7. Packaging

The supplier shall ensure that the bearing is properly packaged to prevent damage or deterioration during transportation, handling and storage.

Annex A
(informative)

INFORMATION SHEET (To be completed by responsible Eskom delegate)

Eskom order number		Date	
Power Station			
Address			
Contact name		Telephone number	
Bearing number and location			
Actual shaft diameter (mm):			
Service conditions	Bearing temperature (C)		
	Shaft speed (rpm)		
Lubricant data	Brand name. (eg. Energol THB)		
	Viscosity grade (cSt)		
	Supplier		
Bearing data	Bearing clearance required (if known)		
	Must supplier determine clearance	YES	NO
	Bearing material. (refer to table 1)		
	Bonding class required (refer to table 2)		
Drawing Number			
Supplier information (fax back to Eskom after verifying these details)	Address:		
	Contact name of responsible person.		
	Date		
	Signature		
Supplier comments			
Eskom comments			