Eskom	Standard	Technology

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TABLES

1. INTRODUCTION

This document supersedes Eskom specification GSP 36-804 Rev 2.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

This standard details the testing and technical requirements for gear lubricants used to lubricate tube mill girth gears and pinions installed at Arnot, Kendal, Lethabo, Majuba, Matimba and Tutuka power stations.

2.1.2 Applicability

These requirements are only applicable to gears lubricated by means of intermittent spray application systems on a total lubricant loss basis.

2.2 NORMATIVE/INFORMATIVE REFERENCES

The following document(s) contain(s) provisions that, through reference in the text, constitute requirements of this document. These documents are subject to revision and users are responsible to ensure that the most recent edition(s) of the document(s) listed below are used.

2.2.1 Normative.

[1] ISO 9001, *Quality Management Systems – Requirements*

[2] ASTM D93, *Standard Test Methods for Flash Points by Pensky-Martens Closed Cup Tester.*

[3] ASTM D217*, Standard Test Method for Cone Penetration of Lubricating Grease.*

[4] ASTM D445, *Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity).*

[5] ASTM D665, Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.

[6] ASTM D2266, Standard Test Method for Wear Preventive Characteristics of Lubricating Grease (Four Ball Method).

[7] ASTM D2509, Standard Test Method for Measurement of Load – Carrying Capacity of Lubricating Grease (Timken Method).

[8] ASTM D2596, Standard Test Method for Measurement of Extreme Pressure Properties of Lubricating Grease (Four Ball Method).

[9] ASTM D2782, Standard Test Method for Measurement of Extreme – Pressure Properties of Lubricating Fluids (Timken Method).

[10] ASTM D2783, Standard Test Method for Measurement of Extreme – Pressure Properties of Lubricating Fluids (Four Ball Method).

[11] ASTM D4048, Standard Test Method for Detection of Copper Corrosion from Lubricating Grease.

[12] ASTM D4172, *Standard* Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method).

[13] DIN 51354, Mechanical Testing of Gear Lubricating Oils in the FZG Gear Rig Test Machine.

[14] ISO 14635-3:2005, *Gears -- FZG test procedures -- Part 3: FZG test method A/2,8/50 for relative scuffing load-carrying capacity and wear characteristics of semifluid gear greases*

[15] US Steel DM 43, Test Method for Grease Mobility.

[16] US Steel DM 51, Test Method for Lubricant Retention.

[17] SRV Tester, SRV Tests for Wear, Friction and Load Carrying Characteristics of Lubricating Greases.

[18] BE@UPTRIB/T001 - FZG 12-Stage load test (Based on DIN 51354)

[19] BE @UPTROB/TOO4, *SRV Open Gear Lubricant Test*

[20] BE@UPTRIB/T006, *Grease Sprayability Test*.

[21] BE @UPTRIB/T008 – US Steel Grease Mobility Test (US Steel DM 43)

2.2.2 Informative

None

2.3 DEFINITIONS

Definition	Description
Approved supplier	A supplier that has been evaluated by a specialist audit team co-ordinated by Generation Technical Department, to an agreed set of acceptance criteria in accordance with Eskom's purchasing requirements
Asphaltic lubricants	Lubricants containing a significant amount of asphaltenes. Asphalt is a brown to black, bituminous material of high molecular weight, occurring naturally or as a residue from the distillation of crude oil. Asphaltenes are high molecular weight hydrocarbon components of asphalt that are not soluble in n-pentane. Asphaltic lubricants may employ a low flash point solvent or diluent to assist in the application of the lubricant
Compounds	A mixture of fluid lubricant (usually petroleum oil), a thickener or gelling agent (usually an organic compound or metallic soap), and a high percentage of solid lubricants (usually graphite and/or molybdenum disulfide) dispersed in the base oil (mineral, synthetic or part synthetic)
Fluids	A mixture of fluid lubricant (usually petroleum derived base oil) and a thickener or gelling agent (usually an organic compound or metallic soap) dispersed in the oil. The percentage thickener used is of the order that the base lubricant remains fluid at ambient temperatures. Fluids may contain small amounts of solid lubricants as anti-wear additives. Lubricants with thixotropic properties will be classified as fluids for purposes of this standard.
Grease	A mixture of fluid lubricant (usually petroleum oil) and a thickener (usually a metallic soap) dispersed in the oil. The lubricant is not fluid at ambient temperatures

New lubricants	Lubricants which have not previously been used to lubricate Eskom tube mill girth gears
New suppliers	Suppliers who have not previously supplied tube mill girth gear lubricants to Eskom
Specialist audit team	A team consisting of relevant representative(s) from Eskom Generation Technology Department, Generation Technology and assurance and Power Station Engineering Departments
Supplier acceptance criteria	Notwithstanding the requirements of Eskom's purchasing requirements, the acceptance criteria will be determined by the specialist audit team based on the test and service requirements detailed in this standard.
Synthetic lubricants	Lubricating fluids made by chemically reacting materials of a specific chemical composition to produce a compound with planned and predictable properties, or lubricating fluids of which the major component is synthetic base oil

2.3.1 Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
BE	Business Enterprises (university of Pretoria), P O Box 14679, Hatfield, 0028, tel +27 012 420 4245

2.5 ROLES AND RESPONSIBILITIES

a. Power Station Engineering Managers shall be responsible for the implementation of the requirements of this document.

b. Eskom's Technology Division shall be responsible for the periodic review of this document.

c. Eskom's Technology Division shall be responsible for reviewing and accepting all lubricants prior to in-service testing at any Eskom power station and for final approval of all lubricants after completion of an in-service trail

d. Eskom's Technology Division will maintain a technical database of approved lubricants and candidate lubricants suitable for an in-service trial.

e. The lubricant supplier shall be responsible for submitting all information required in this document pertaining to his lubricant to Eskom Generation Technology Department for review.

f. The Power Station Engineering Department shall be responsible for co-ordinating any in-service lubricant testing.

g. The Power Station Engineering Department shall ensure that all relevant data is collected during the trial period for in-service testing. Copies of all test data shall be forwarded to Generation Technology Department.

h. Eskom's Technology Division, Megawatt Park and the relevant Power Station Engineering Departments shall be responsible for approval of lubricant suppliers.

i. Suppliers will be required to demonstrate continued compliance to these requirements by submitting samples for retesting every 5 years. All compliance testing will be at the suppliers cost.

j. Should there be any significant change in formulation or manufacturing method, the supplier may be requested to demonstrate compliance to this standard by having the lubricant retested in accordance with this standard.

2.6 PROCESS FOR MONITORING

None

2.7 RELATED/SUPPORTING DOCUMENTS

None

3. STANDARD FOR TUBE MILL GIRTH GEAR AND PINION LUBRICANTS

3.1 LUBRICANT REQUIREMENTS

3.1.1 Lubricant compatibility

The lubricant shall be compatible with existing lubricant application systems and equipment to be lubricated.

3.1.2 Performance standards

Lubricant types have been divided into three categories detailed below. The supplier shall submit complete performance specifications for his lubricant(s) as specified in annex A. Lubricant categories are:

a. Fluids, greases and compounds

The laboratory performance requirements for this group are detailed in table 1 in annex A.

b. Synthetic lubricants

The laboratory performance requirements for this group are detailed in table 2 in annex A.

c. Asphaltic lubricants

The laboratory performance requirements for this group are detailed in table 3 in annex A.

3.1.3 Lubricant pumpability

The lubricant shall be pumpable at –10°C using existing Eskom girth gear lubricant application systems.

3.1.4 Lubricant sprayability

The lubricant shall be easily sprayable at 25°C and at an air pressure of 300 kPa using existing Eskom girth gear lubricant application systems.

3.1.5 Solvents and diluents

The supplier shall submit details of any solvents or diluents used in the product formulation.

Preference will be given to products that are free from chlorinated solvents.

3.1.6 Additive package

The supplier shall submit a description of the type of lubricant base oil, thickener or gelling agent and the type of additive package used. The supplier shall ensure that the product is lead free, and free from any other hazardous components. Should the product formulation change the supplier shall notify Eskom in writing of the change and the nature of the change.

3.1.7 Lubricant consumption rate

The supplier shall indicate the expected consumption rate of his lubricant in grams per centimetre of gear face width per hour, (g/cm/h), alternatively in kg/24 h operation.

3.1.8 Health and safety

The supplier shall submit a material safety data sheet to Eskom.

3.1.9 Lubricant cleanliness

The lubricant shall be free from abrasive materials, dirt and grit. In addition all asphaltic and synthetic lubricants shall be pre-filtered prior to filling in containers. The maximum filter size shall have a maximum nominal rating of 250 μm.

3.1.10 Used lubricant removal

The lubricant shall drain readily to the bottom of the guard to facilitate easy removal.

3.2 USED LUBRICANT DISPOSAL

The supplier shall recommend the best method of disposal of the used lubricant in compliance with environmental regulations.

3.3 DOCUMENTATION

The following documentation shall be kept by the supplier and made available to Eskom on request.

a. Batch certificates of all products supplied to Eskom.
b. Detailed test reports for all tests listed in the tables in annex A showing the date and the laboratory that carried out the test.
c. All in-service monitoring reports specified in 4.1.5.
d. Detailed procedures of test methods submitted to Eskom in accordance with tests listed in Annexure A.

3.4 EXAMINATION AND TESTS

3.4.1 In-service testing

3.4.1.1 Test duration

Due to the relatively slow wear rates experienced in-service, all lubricants selected for test by Eskom shall be subjected to an in-service test on a single mill for at least 7 500 operating hours.

Where possible, at least three gear sets should be used to evaluate the performance of a single lubricant. The test should be started on a single gear set for the first 2 500 hours of operation. The second and third gear sets can be introduced should initial performance on the first set be positive. Provisional lubricant approval may be given after any 2 of the gear sets have completed 5 000 hours each. Full approval will be given only when at least two gear sets have successfully completed in excess of 7 500 hours on the test lubricant.

3.4.1.2 Monitoring parameters

The supplier shall be responsible for the in-service monitoring of the lubricant for the duration of the test period. The parameters to be monitored and the frequency of monitoring shall be mutually agreed between Eskom and the supplier. The parameters detailed below shall constitute a minimum requirement. The supplier shall submit to Eskom a detailed in-service test procedure for his lubricant prior to commencement of the test.

a. Pinion bearing temperatures

b. Drive-end (DE) and non-drive-end (NDE) pinion bearing temperatures shall be taken every hour for the first 24 h or until the lubricant film is stabilised, thereafter every 4 h for the next 24 h and thereafter twice daily for the first week. Pinion bearing temperatures shall then be recorded weekly for the duration of the test period. In addition the ambient temperature in the vicinity of the gear shall be recorded. As the test progresses, monitoring intervals may be extended to two weekly intervals, if agreed to with the relevant Power Station Engineering department.

c. Pinion and gear tooth flank temperatures

d. Temperatures shall be taken at the DE, Centre and NDE of the gear and pinion using a suitable instrument. Temperatures shall be taken every hour for the first 24 h or until the lubricant film is stabilised, thereafter every 4 h for the next 24 h and thereafter twice daily for the first week. Gear flank temperatures shall then be recorded every week, for the duration of the test period. As the test progresses, monitoring intervals may be extended to two weekly intervals, if agreed to with the relevant Power Station Engineering department.

e. Vibration readings

f. Readings shall be taken on both pinion bearings in at least three directions namely the horizontal, vertical and axial directions. Readings shall be taken every hour for the first 24 h or until the lubricant film is stabilised, thereafter every 4 h for the next 24 h and thereafter twice daily for the first week. Vibration readings shall then be recorded weekly for the duration of the test period. The equipment used shall be capable of recording specific frequencies such as gear mesh frequencies. All vibration readings shall be recorded and trended. As the test progresses, monitoring intervals may be extended to two weekly intervals, if agreed to with the relevant Power Station Engineering department.

g. Stroboscopic inspections of running gears

h. The supplier shall check the gear weekly and record whether there is sufficient lubricant coverage of the gears. As the test progresses, monitoring intervals may be extended to two weekly intervals, if agreed to with the relevant Power Station Engineering department.

i. Spray pattern checks

j. The spray pattern shall be checked by means of a board placed 250 mm to 300 mm, or a distance equal to the nozzle to gear gap, from the spray nozzles. The resultant pattern shall show complete coverage of the entire gear face width. The spray pattern may be recorded by photographing the spray pattern. The test shall not commence until the correct spray pattern is achieved. The spray pattern should be checked, with the gear set stationary, at least once a month for the duration of the test, or as required by the Power Station Engineering department.

k. Photographic records

l. The condition of the gear and pinion shall be recorded by colour photography, using a suitable or a high resolution digital camera, before commencement of the test. Photographic records shall be taken at 0h, 2 500h, 5 000h, 7 500h and 10 000h. Copies of the photographs shall be included in reports submitted to Eskom

m. Replicasts of pinion gear

n. Gear tooth replicas to monitor gear tooth condition and wear shall be taken at 0h, 2 500h, 5 000 h, 7 500h and 10 000h. Replicasts should be taken on a representative set of gears every 7000 hours thereafter.

o. The material used shall be “Hexcell F16 Fast cast Resin”, or any equivalent material agreed to by Eskom. The procedure for casting the replicast shall be in accordance with annex B. No silicone based materials shall be used for replicasts. If an alternative material is chosen, it shall be submitted to Eskom for approval. The material chosen shall give an accurate representation of the gear tooth dimensions and surface condition. Replicasts shall be taken using the same material and casting procedure for the duration of the in-service test period.

p. Replicasts shall be taken on the same set of gear teeth each time. Replicasts shall be taken in at least three positions, namely, drive-end, centre- and non-drive end. The gear teeth chosen shall be clearly marked in a non-destructive manner. All replicasts shall be clearly marked with the date, gear running hours and the mill identification.

q. Replicasts shall be sectioned and the profile measured using a shadow graph technique. The lubricant shall be considered acceptable, in terms of wear, if the amount of wear measured is considered to be negligible and no significant profile change has occurred.

r. Physical lubricant consumption checks

s. Physical lubricant consumption checks shall be carried out prior to commencement of the test and after any change in application system settings. The result shall be compared to that calculated from the application system setting and reported in the monthly reports. The consumption shall be reported in kg per 24 h.

3.4.1.3 System condition

The supplier shall inspect the nominated gear and associated equipment with the responsible Eskom representative and shall record the condition of the gear and equipment prior to the commencement of any test. No test shall be started unless the application system is in good working order and gear alignment has been checked and recorded in accordance with the gear manufacturer’s recommendations. The supplier shall confirm in writing to Eskom that they are satisfied with the condition of the gearing and application system prior to the commencement of testing.

3.4.1.4 System settings and layout

The supplier shall familiarise himself with the relevant application equipment and shall submit any recommendations regarding the settings and layout of the equipment to Eskom in writing before commencement of the test. Any deficiencies which may adversely affect the proper application of the lubricant shall be recorded in writing and submitted to the responsible Eskom delegate.

3.4.1.5 Reporting

A detailed report shall be submitted to Eskom, including all measurements taken, on a monthly basis. Site inspection reports and findings shall be submitted to the responsible Eskom representative on the day of the inspection. The supplier shall be responsible for immediately

informing Eskom of any findings that may adversely affect the gear or the lubricant application system.

3.4.1.6 Assessment of results

Generation Technical Department, Megawatt Park, together with the relevant Power Station Engineering department will evaluate the results of any in-service test prior to final lubricant approval.

3.5 HANDLING, PACKING AND TRANSPORTATION

The supplier shall provide details of the proposed methods of packaging and transportation. These shall be selected to prevent lubricant damage or deterioration, by mechanical or environmental means, during transportation and storage.

All packages shall be clearly marked with the following:

a. The lubricant brand name;
b. The date of manufacture;
c. The batch number; and
d. Any relevant symbols indicating hazardous material or flammable material.

4. RECORDS

a. Test Certificates: Copies of all test results showing compliance to the relevant tables in this standard will be kept by Generation Technology Department.
b. Material Safety Data Sheets: Copies of Material Safety Data Sheets shall be kept by Eskom's Technology Division.
c. In Service Test Data: Copies of all data recorded during in-service existing of lubricants for approval shall be kept by Eskom's Technology Division.

5. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
	Document Approved by SCOT Power Plant Technical Committee for update to extent Expiry date

6. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0.1	JJ Bester	36-804
November 2012	1	JJ Bester	Final Document approved
January 2016	2	J.J. Bester	No Changes Expiry Date Extension as Approved by Power Plant Technical Committee

7. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- None

8. ACKNOWLEDGEMENTS

None

APPENDIX A- REQUIREMENTS

Table 1: Requirements for Girth Gear Fluids, Greases and Compounds

Test method	Property/characteristic	Units	Eskom requirements
	Lubricant type		**GREASES COMPOUNDS & FLUIDS**
	COLOUR AND APPEARANCE		
	Colour		Report
	Appearance		Report
	Thickener or gelling agent type		Report
	Diluent type and percentage		Report
	Diluent content	%	Report
	BASE OIL CHARACTERISTICS		
	Base oil type		Report
ASTM D445	Kinematic viscosity at 40 °C, min.	mm^2/s	2500
ASTM D217	Worked penetration at 25°C	(1/10 mm)	>355
ASTM D93	Flash point of base oil	°C	report
ASTM D665	Rust preventing characteristics		Pass
ASTM D4048	Copper strip corrosion rating		1b
	PUMPABILITY & SPRAYABILITY CHARACTERISTICS		
BE@UPTRIB/T006	Sprayability at 300 kPa at 25 °C Overall assessed rating.	level	3
US Steel DM 43	Grease mobility test at -10 °C	g/min	>0.5
US Steel DM 43	Grease mobility test at 0 °C	g/min	>5
US Steel DM 51[1]	Lubricant retention.	min	Report
	LOAD & WEAR CHARACTERISTICS		
ASTM D2509	Timken EP test, OK load	kg	>20
ASTM D2266	Four ball wear test, scar diameter	mm	<0,8
ASTM D2596	Four ball EP test, load wear index	kg	>70
ASTM D2596	Four ball EP test, weld load	kg	>400
DIN 51354 (A/2.76/50)	FZG, load stage pass.	load stage	12
DIN 51354 (A/2.76/50)	FZG, total mass loss over 12 load stages	mg	<120
DIN 51354 (A/2.76/50)	FZG, specific mass loss.	mg/kwh	<1.0
DIN 51354 (A/2.76/50 30 hrs at load stage 10)	FZG, extended wear test, mass loss.	mg	<120
SRV tester	SRV friction characteristics at 25 °C	μ	<0,11
SRV tester	SRV friction characteristics at 55 °C	μ	<0,11
SRV tester	SRV friction characteristics at 80 °C	μ	<0,11
SRV tester	SRV tester film life at 60 °C	min	> 60
SRV tester	SRV wear scar at 25 °C, max.	mm	0,9
SRV tester	SRV wear scar at 55 °C, max.	mm	0,9
SRV tester	SRV wear scar at 80 °C, max.	mm	0,9
SRV tester	SRV load at 25 °C, min.	N	600
SRV tester	SRV load at 55 °C, min.	N	550
SRV tester	SRV load at 80 °C, min.	N	450

Note:

1. A value of greater than 30 minutes would be preferred.

Annex A
(Continued)

Table 2: Requirements for Synthetic Girth Gear Lubricants

Test method	Property/characteristic	Units	Eskom requirement
	Lubricant type		**SYNTHETIC OIL**
	COLOUR AND APPEARANCE		
	Colour		Report
	Appearance		Report
	Thickener type		Report
	Diluent type		Report
	Diluent content	%	Report
	BASE OIL CHARACTERISTICS		
	Base oil type		Report
ASTM D445	Kinematic viscosity at 40 °C	mm^2/s	2500 min.
ASTM D93	Flash point	°C	>200
ASTM D4048	Copper strip corrosion rating		1b
ASTM D665	Rust preventing characteristics		Pass
	PUMPABILITY AND SPRAYABILITY CHARACTERISTICS		
BE@UPTRIB/T006	Sprayability at 300 kPa at 25 °C, Overall assessed rating.	level	3
US Steel DM 43	Grease mobility test at -10 °C	g/min	>0.5
US Steel DM 43	Grease mobility test at 0 °C	g/min	>5
US Steel DM 51[1]	Lubricant retention.	min	Report
	LOAD AND WEAR CHARACTERISTICS		
ASTM D2782	Timken EP test, OK load	kg	>20
ASTM D4172	Four ball wear test, scar diameter	mm	<0,8
ASTM D2783	Four ball EP test, load wear index	kg	>70
ASTM D2783	Four ball EP test, weld load, min.	kg	400.
DIN 51354 (A/2.76/50)	FZG, load stage pass.	load stage	12
DIN 51354 (A/2.76/50)	FZG, total mass loss over 12 load stages	mg	<120
DIN 51354 (A/2.76/50)	FZG, specific mass loss, A/2.76/50	mg/kwh	<1.0
DIN 51354 (A/2.76/50 30 hrs at load stage 10)	FZG, extended wear test, mass loss.	mg	<120
SRV tester	SRV friction characteristics at 25 °C	μ	<0,11
SRV tester	SRV friction characteristics at 55 °C	μ	<0,11
SRV tester	SRV friction characteristics at 80 °C	μ	<0,11
SRV tester	SRV tester film life at 60 °C	min	> 60
SRV tester	SRV wear scar at 25 °C, max.	mm	0,9
SRV tester	SRV wear scar at 55 °C, max.	mm	0,9
SRV tester	SRV wear scar at 80 °C, max.	mm	0,9
SRV tester	SRV load at 25 °C, min.	N	600
SRV tester	SRV load at 55 °C, min.	N	550
SRV tester	SRV load at 80 °C, min.	N	450

Note:

1. A value of greater than 30 minutes would be preferred.

Annex A
(Continued)

Table 3: Requirements for Asphaltic Girth Gear Lubricants

Test method	Property/characteristic	Units	Eskom requirement
	Lubricant type		**ASPHALTIC**
	COLOUR AND APPEARANCE		
	Colour		Report
	Appearance		Report
	Diluent type		Report
	Diluent content	%	Report
	BASE OIL CHARACTERISTICS		
	Base oil type (e.g. mineral, synthetic)		Report
ASTM D445	Kinematic viscosity at 40°C without diluent.	mm^2/s	Report.
ASTM D445	Kinematic viscosity at 40°C with diluent.	mm^2/s	1500 min.
ASTM D445	Kinematic viscosity at 100°C without diluent.	mm^2/s	400 min.
ASTM D93	Flash point	°C	report
ASTM D4048	Copper strip corrosion rating		1b
ASTM D665	Rust preventing characteristics		Pass
	PUMPABILITY AND SPRAYABILITY CHARACTERISTICS		
BE@UPTRIB/T006	Sprayability at 300 kPa at 25 °C	level	3
US Steel DM 43	Grease mobility test at -10 °C	g/min	>0.5
US Steel DM 43	Grease mobility test at 0 °C	g/min	>5
	LOAD AND WEAR CHARACTERISTICS		
ASTM D2509/ D2782	Timken EP test, OK load	kg	>20
US Steel DM 51[1]	Lubricant retention.	min	Report
ASTM D2266	Four ball wear test, scar diameter	mm	<0,8
ASTM D2596	Four ball EP test, load wear index, min.	kg	70
ASTM D2596 and ASTM D2783	Four ball EP test, weld load, min.	kg	400
DIN 51354 (A/2.76/50)	FZG, load stage pass.	load stage	12
DIN 51354 (A/2.76/50)	FZG, total mass loss over 12 load stages	mg	<120
DIN 51354 (A/2.76/50)	FZG, specific mass loss, A/2.76/50	mg/kwh	<1.0
DIN 51354 (A/2.76/50 30 hrs at load stage 10)	FZG, extended wear test, mass loss.	mg	<120
SRV tester	SRV friction characteristics at 25 °C	μ	<0,11
SRV tester	SRV friction characteristics at 55 °C	μ	<0,11
SRV tester	SRV friction characteristics at 80 °C	μ	<0,11
SRV tester	SRV tester film life at 60 °C	min	> 60
SRV tester	SRV wear scar at 25 °C, max.	mm	0,9
SRV tester	SRV wear scar at 55 °C, max.	mm	0,9
SRV tester	SRV wear scar at 80 °C, max.	mm	0,9
SRV tester	SRV load at 25 °C, min.	N	600
SRV tester	SRV load at 55 °C, min.	N	550
SRV tester	SRV load at 80 °C, min.	N	450

Note:

1. A value of greater than 30 minutes would be preferred.

APPENDIX B- REPLICAST PROCEDURE

9. PROCEDURE FOR TAKING REPLICASTS OF GIRTH GEAR AND PINION TEETH USING HEXCELL F16 FAST CAST POLYURETHANE RESIN

9.1 BACKGROUND

The following procedure outlines the steps required for taking replicasts of girth gear and pinion teeth for surface roughness or profile measurements. This procedure is specific to Hexcell F16 Fast cast Polyurethane Resin. The Hexcell F16 resin is made up of the following constituents:

- Part A, which is a milky white liquid composed of polyol;
- Part B, which is a dark brown liquid composed of isocyanate; and
- Part C, mineral filler powder.

Parts A and B shall be mixed in a 1:1 ratio by weight or in a 1:0.9 ratio by volume. For surface replicasts, no filler powder (part C) is required. When taking a replicast for determining the tooth profile, filler powder shall be used as this reduces the shrinkage of the replicast significantly. Filler powder shall be added to both Parts A and B in a ratio of 1.5:1 by weight. Since the filler is a powder, it shall be weighed, as the required volume is difficult to estimate. Surface detail is not well reproduced when filler powder is added to the resin mixture.

The procedure outlined below shall be followed as closely as possible to ensure that reproducible results are obtained each time. The procedure outlines the volume of Parts A and B needed, as well as the mass of filler powder required. Ideally, the quantities required shall be measured off-site prior to casting. This will ensure accuracy in measuring and avoid contamination.

9.2 PRE-CASTING PROCEDURE

NOTE: This shall be carried out off-site.

9.2.1 Equipment and materials required

a. Volumetric cylinders for measuring Part A and Part B and a suitable scale to weigh the filler powder.
b. Protective gloves and protective glasses for working with chemicals.
c. Clean wooden spatula or a stainless steel spatula for stirring mixtures of Part A + Filler or Part B + Filler.
d. NOTE The mixture should be stirred gently to avoid air bubble entrapment. Ensure good ventilation when working with the resin.
e. Hexcell F16 Part A, Part B, Mineral Filler Powder and Aluminium End Plates.

9.2.2 Taking profile measurement replicasts

a. Measure out 120 ml (or 120 g) of Part A into a clean, sealable paper or plastic container.
b. Measure out 110 ml (or 110 g) of Part B into a separate clean, sealable paper/plastic container.
c. Weigh out 180 g of filler powder into Part A, stir until powder dissolves and seal.
d. Weigh out 180 g of filler powder into Part B, stir until powder dissolves and seal.

e. Parts A and B are now ready for final mixing on-site just prior to casting.

9.2.3 Taking surface roughness replicasts

a. Measure out 190 ml of Part A into a clean, paper or plastic container and seal.

b. Measure out 210 ml of Part B into a separate clean, paper or plastic container and seal.

c. Parts A and B are now ready for final mixing on-site just prior to casting.

9.3 CASTING PROCEDURE

NOTE: This applies for both castings with and without filler.

a. Ensure tooth surface is clean of all grease and dirt.

b. Ensure that protective gloves and glasses are worn.

c. Use a measuring tape to mark the distance from the tooth edge where the replicast is to be taken.

NOTE: This distance must always be the same to ensure that the replicast is taken in the same position each time for accurate results to be obtained.

d. Place aluminium end pieces, with plasticine or moulding clay at the bottom of the plates, between the gear teeth, ensuring that it is firmly pressed against the gear, to seal any gaps between the plates and the gear tooth surface.

e. Pour Part A into Part B and stir with a spatula in open air, do not shake.

NOTE: Keep the containers away from your face when stirring or pouring.

f. After stirring the mixture for a maximum of 1 min, pour the mixture gently into the centre of the mould until the entire mould is filled.

NOTE: The resin must be poured within 1.5 min after mixing.

g. Allow the casting to set in the mould for at least 30 min before removing it.

h. Wipe the replicast, label and store in a protective box/cover after removal.

i. Clean the tooth surface after replication.