

	Standard	Technology
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1. INTRODUCTION

The Eskom Distribution Division requires new (unused) cable oil for the maintenance of the installed base of high-voltage, low-pressure, self-contained, oil-filled cable systems. The cable oil specification was compiled based on the recommendations of research report (RES/FR/00/11596) – compiled by Z Khuzwayo and A E Lombard in order to develop a purchase specification of new cable oil.

The failure of any component of a high-voltage cable installation generally results in significant repair cost and disruption to the power system. In order to minimise the risk of this occurring and to ensure the optimum life of oil-filled cable systems, the Distribution Division has undertaken to purchase only cable oil in accordance with this specification.

Keywords

Cable oil, cable, oil-filled cable, low-pressure, self-contained, fluid-filled, insulating oil, unused oil, hydraulic circuit

2. SUPPORTING CLAUSES

2.1 SCOPE

This specification covers the Distribution Division's requirements for new (unused) cable oil intended for use in single-core and three-core oil-filled cables for systems with nominal voltages of 44 kV, 66 kV, 88 kV and 132 kV. The test methods and requirements specified are in accordance with the recommendations made in Eskom research report RES/FR/00/11596.

2.1.1 Purpose

None

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 NORMATIVE/INFORMATIVE REFERENCES

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

2.2.1 Normative

- [1] ASTM D93, *Standard test methods for flash-point by Pensky-Martens*
- [2] ASTM D97, *Standard test method for pour point of petroleum products.*
- [3] ASTM D445, *Standard test method for kinematic viscosity of transparent and opaque liquids.*
- [4] ASTM D611, *Standard test methods for aniline point and mixed aniline point of petroleum products and hydrocarbon solvents.*
- [5] ASTM D974, *Standard test method for acid and base number by color-indicator titration.*
- [6] ASTM D4052, *Standard test method for density and relative density of liquids by digital density meter.*

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- [7] ASTM D-5864, Standard test method for determining aerobic aquatic biodegradation of lubricants or their components.
- [8] BS 5874, Method for determination of the electric strength of insulating oils.
- [9] CEC L-33-A-934 (previously CEC L-33-T-82), Biodegradability of two-stroke cycle outboard engine oils in water.
- [10] IEC 60156, Insulating liquids - Determination of the breakdown voltage at power frequency - Test method.
- [11] IEC 60247, Insulating liquids – Measurement of relative permittivity, dielectric dissipation factor ($\tan \delta$) and d.c. resistivity.
- [12] IEC 60465, *Specification for unused insulating mineral oils for cables with oil ducts*
- [13] IEC 60475, *Method of sampling liquid dielectrics.*
- [14] IEC 60628, *Gassing of insulating liquids under electrical stress and ionization.*
- [15] IEC 60814, Determination of water by automatic coulometric Karl Fischer titration.
- [16] ISO 2719, *Petroleum products – Determination of flash-point – Pensky-Martens closed cup method.*
- [17] ISO 2977, Petroleum Products and Hydrocarbon Solvents - Determination of Aniline Point and Mixed Aniline Point.
- [18] ISO 3016 Petroleum oils – Determination of pour –point
- [19] ISO 3104, Petroleum products – Transparent and opaque liquids – Determination of kinematic viscosity and calculation of dynamic viscosity.
- [20] ISO 3675, Crude petroleum and liquid petroleum products – Laboratory determination of density or relative density – Hydrometer method.
- [21] ISO 5662, *Petroleum products – Electrical insulating oils – Detection of corrosive sulphur*

2.2.2 Informative

None

2.3 DEFINITIONS

Definition	Description
Aniline point	The temperature at which a mixture of aniline and oil separates. It provides a rough indication of the total aromatic content, and relates to the solvency of the oil for materials that are in contact with the oil. The lower the aniline point, the greater the solvency effects.
Biodegradable	Biodegradable means that a material has the proven capability to decompose in the most common environment where the material is disposed of within 3 years through natural biological processes into non-toxic carbonaceous soil, water, carbon dioxide or methane.
Breakdown voltage	The minimum voltage at which electrical flashover occurs in oil. It is the measure of the ability of oil to withstand electrical stress at power frequencies without failure. A low breakdown voltage indicates the presence of contamination such as water, dirt and other conducting particles in the oil
Flash point	The minimum temperature at which heated oil gives off sufficient vapour to form a flammable mixture with air. It is an indicator of the volatility of the oil.
Gassing tendency	Two types of oils are available, namely, gas evolving and gas absorbing. The

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	gassing tendency will depend on the structure of the oil and this property is a function of the capacity of the oil to absorb the hydrogen formed by electrical discharges.
Low pressure oil-filled cable	A self-contained (static), fluid-filled, paper-insulated, metal-sheathed cable which operates with a minimum static pressure of between 20 kPa (0,2 bar) and 300 kPa (3,0 bar) inclusive, a maximum static pressure of not more than 800 kPa (8,0 bar) and a minimum transient pressure of not less than 20 kPa (0,2 bar). (The quoted pressures are above atmospheric pressure.)
Neutralisation value:	The neutralisation value of an oil is a measure of the amount of acidity or alkaline materials present. As oil age in service, the acidity and the neutralisation number increases. Used oil having a high neutralisation number indicates that the oil is oxidised or contaminated. The basic neutralisation number results from an alkaline contaminant in the oil. High acidity levels will promote the degradation of the paper and will induce corrosion in the cable. The presence of acids is normally an indication of oxidation of the oil.
New cable oil	Virgin or unused cable oil that complies with this specification
Pour point	The lowest temperature at which the oil will just flow. A low pour point is important, particularly in cold climates, to ensure that the oil will circulate and serve its purpose as an insulating medium.
Viscosity	The resistance to flow under specified conditions

2.3.1 Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
CEC	Co-ordinating European Council

2.5 ROLES AND RESPONSIBILITIES

None

2.6 PROCESS FOR MONITORING

None

2.7 RELATED/SUPPORTING DOCUMENTS

None

2.8 BIBLIOGRAPHY

Eskom Research Report RES/FR/00/11596 – compiled by Z Khuzwayo and A E Lombard (ERID, Eskom Corporate Services, Rosherville)

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3. NEW (UNUSED) INSULATING OIL FOR CABLES STANDARD

3.1 REQUIREMENTS

3.1.1 Specification

New (unused) cable oil shall comply with the requirements given in Table 1.

Table 1: Specification for new (unused) Cable Oil

1	2	3	4
Property	Unit	Requirement	Reference / test method
Physical:			
Oil type		Alkyl Benzene	
Appearance		Clear, no suspended matter or sediment	IEC 60465
Odour		Mild hydrocarbon odour	
Flammability		Non-flammable	
Explosive properties		Not explosive	
Biodegradability		Readily Biodegradable	CEC L-33-A-934 / ASTM D5864
Density @ 20 C	g/cm ³	≤ 0,9	ISO 3675 / ASTM D4052
Kinematic viscosity @ 40 C	mm ² /s	≤ 6,0	ISO 3104 / ASTM D445
Flash point (closed cup)	°C	≥ 130	ISO 2719 / ASTM D93
Pour point	°C	≤ -45	ISO 3016 / ASTM D97
Chemical:			
Neutralisation value	mg KOH/g	≤ 0,03	IEC 60465 / ASTM D974
Moisture content	mg/kg	Bulk: < 30 Drum: < 40	IEC 60814
Corrosive sulphur		Non-corrosive	ISO 5662
Electrical:			
Breakdown voltage	kV	Bulk: ≥ 40 Drum: ≥ 30	IEC 60156 / BS 5874
Dissipation factor @ 90 C, 50/60 Hz		≤ 0,002	IEC 60247
Gassing tendency, absorption	mm ³ /min	≥ 2	IEC 60628 – Method A
Aniline point	°C	63 to 84	ISO 2977 / ASTM D611

3.1.2 Quality Management System

- The supplier (deemed to be an organization that undertakes any manufacturing or assembly operation shall have a formally documented and implemented quality management system (QMS) that as a minimum meets with the requirements of the international code of practice for quality systems ISO 9001. Eskom reserves the right to audit quality management systems for suitability and effectiveness, and to verify all goods for conformance prior to delivery
- Foreign and third party manufacturers shall, in addition, hold valid certification of their quality management system. Such certification shall be from a national quality systems certification body (Registrar), duly accredited by a QMS accreditation body, which is signatory to a mutual recognition agreement with South Africa.
- Additional quality requirements may apply when Eskom enters into a term contract. Specific requirements will be specified therein.

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3.2 TESTS

- a. New cable oil complying with this specification shall meet the limiting values specified in column 3 of Table 1 when tested in accordance with the corresponding test methods given in column 4 of Table 1. These values apply only to unused oil, as delivered, prior to its introduction into cable.
- b. The oil supplier shall guarantee that the oil delivered complies with this specification. The guarantee shall be in the form of a certificate. Records shall be traceable and shall be kept for auditing purposes.
- c. Sampling shall be carried out in accordance with the procedure described in **IEC 60475**.

3.3 MARKING, LABELING AND PACKAGING

3.3.1 Marking and labelling

Each cable oil drum shall be indelibly labeled showing the following information:

- a. Manufacturers name;
- b. type of cable oil;
- c. volume of oil (l); and
- d. drum mass (kg);

Cable oil delivered to Eskom shall be accompanied by a certificate guaranteeing that the oil complies with the requirements of this specification (see Table 1 and Appendix A). Records shall be traceable and shall be kept for auditing purposes.

Cable oil delivered to Eskom shall be supplied with a material safety data sheet.

3.3.2 Packaging

Cable oil shall be supplied in sealed drums of 210 liters.

3.4 STORAGE

Cable oil shall be stored in a cool place away from sources of heat and out of direct sunlight to avoid pressure build up. Cable oil should not be stored near oxidizing agents / materials such as liquid chlorine, concentrated oxygen, sodium hypochlorite, calcium hypochlorite, peroxides, etc. as this may present an explosion hazard.

3.5 DOCUMENTATION

The tenderer shall complete the technical schedule B (see annex A) for the cable oil offered. By doing this, the tenderer will be stating compliance with this specification and will provide the information the purchaser has requested.

4. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
	This Document has been approved by TDAC ROD 13 February 2013

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0.1		Draft Document for review created from 34-1495
June 2013	1		Final Document approved for Publication

6. DEVELOPMENT TEAM

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7. ACKNOWLEDGEMENTS

- None

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APPENDIX A : TECHNICAL SCHEDULES A AND B FOR NEW CABLE OIL**Schedule A: Purchaser's specific requirements****Schedule B: Guarantees and technical particulars of cable oil offered**

Item	Sub- Clause	Description	Schedule A	Schedule B
		Physical:		
1	4.1	Oil type Appearance	Alkyl Benzene Clear,no suspended	
2	4.1		Matter or sediment	
3	4.1	Odour	Mild hydrocarbon	
4	4.1	Flammability	Non-flammable	
5	4.1	Explosive properties	Not explosive	
6	4.1	Biodegradability	Biodegradable	
7	4.1	Density @ 20 °C g/cm ³	≤ 0,9	
8	4.1	Kinematic viscosity @ 40 °C mm ² /s	≤ 6,0	
9	4.1	Flash point (closed cup) °C	≥ 130	
10	4.1	Pour point °C	≤ -45	
		Chemical:		
11	4.1	Neutralisation value Mg	≤ 0,03	
12	4.1	Moisture content mg/kg	Bulk: < 30 Drum: <	
13	4.1	Corrosive sulphur	Non-corrosive	
		Electrical:		
14	4.1	Breakdown voltage kV kV	Bulk: ≥ 40 Drum: ≥ 30	
15	4.1	Dissipation factor @ 90 50/60 Hz	≤ 0,002	
16	4.1	Gassing tendency, absorption mm ³ /min	≥ 2	
17	4.1	Aniline point °C	63 to 84	

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