

 <b>Eskom</b>	<b>Standard</b>	<b>Technology</b>
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## **1. Introduction**

This specification details the requirements for medium voltage cross linked polyethylene-insulated (XLPE) for systems with nominal voltages of 11 kV, 22 kV and 33 kV in this standard are based on SANS 1339. 11 kV nominal voltage rated cables will be used for 3.3 kV and 6.6 kV nominal voltage applications. This specification details the medium voltage cable required throughout the Eskom Transmission division.

## **2. Supporting clauses**

### **2.1 Scope**

This standard covers the Eskom Transmission's minimum requirements for the selection, manufacturing, testing and supply of medium voltage XLPE cables.

The requirements for XLPE cables are based on SANS 1339 and this document.

The safety specification VC 8077 stipulates that all XLPE-insulated medium-voltage cables in South Africa shall comply with the requirements of SANS 1339.

#### **2.1.1 Purpose**

The document specifies the technical requirements for medium voltage XLPE cables to be supplied to Eskom Transmission division. It's intended use is for both tendering and technical prequalification purposes.

#### **2.1.2 Applicability**

This document shall apply within throughout the Eskom Transmission division.

## **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] ISO 9001: Quality Management Systems.
- [2] SANS 1339, Electric cables – Cross-linked polyethylene (XLPE) – insulated cables for voltages from 3,8/6,6 kV to 19/33 kV.
- [3] SANS 1411-2, Materials of insulated electric cables and flexible cords – Part 2: Polyvinyl chloride (PVC).
- [4] SANS 1411-6, Materials of insulated electric cables and flexible cords – Part 6: Armour.
- [5] SANS 1411-7, Materials of insulated electric cables and flexible cords – Part 7: Polyethylene (PE).
- [6] VC 8077, Compulsory specification for the safety of medium voltage electric cables.
- [7] D-DT-8001, Cable, 11 kV and 22 kV XLPE-insulated.

### **2.2.2 Informative**

None

## 2.3 Definitions

### 2.3.1 General

The definitions given in SANS 1339 shall apply.

### 2.3.2 Disclosure classification

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

## 2.4 Abbreviations

The abbreviations given in SANS 1339, IEC and the following shall apply.

Abbreviation	Description
Al	Aluminium
Cu	Copper
HDPE	High Density Polyethylene
IAF	International Accreditation Forum
IECEE	IEC System for Conformity Assessment Schemes for Electrotechnical Equipment and Components
ILAC	International Laboratory Accreditation Cooperation
LOA	Letter of Authority
MDPE	Medium Density Polyethylene
MV	Medium Voltage
XLPE	Cross-Linked Polyethylene

## 2.5 Roles and responsibilities

All Eskom employees and/or appointed bodies involved in the procurement of MV XLPE cables shall ensure that the product meets the requirements as specified in this document.

## 2.6 Process for monitoring

The MV XLPE cables acceptance shall be based on the relevant technical evaluation criteria at the time of tender.

## 2.7 Related/supporting documents

Not applicable.

## 3. MV XLPE insulated cable requirements

### 3.1 General requirements for MV cables

- a) All documentation shall be provided in English. Failure to do so can render a submission non-responsive and lead to disqualification.
- b) Medium voltage cables shall comply with SANS 1339 and the requirements of this specification.

- c) Where multiple cables are required of different voltage ratings, conductor sizes, cores etc. individual Technical Schedules shall be completed for each unique product in accordance with Annex B.
- d) All cable offered shall carry valid product test certification issued by an appropriately accredited and internationally recognized body being a member of an IAF/ILAC /IECEE mutual agreement scheme or a letter of authority certificate issued in accordance with VC 8077, Compulsory specification for the safety of medium voltage electric cables.
- e) A copy of all relevant type test reports and the required tender returnable documentation shall be submitted at the time of tender enquiry submissions.

### 3.1.1 Rated Voltages

The rated voltages of medium-voltage cables shall be:

- a) 6,35/11 kV,
- b) 12,7/22 kV, and
- c) 19.1/33 kV.

**Note:** 6.35/11 kV cables shall be used and supplied for 1.9/3.3 kV and 3.8/6.6 kV Eskom cable systems applications.

### 3.1.2 Conductors

The standard conductor shall be copper or aluminium with the equivalent cross-sectional areas specified in table below, unless otherwise specified at the time of tender:

**Table 1: Standard conductor size for medium voltage cables**

Rated voltage: 11 kV, 22 kV and/ or 33 kV	
Single Core (mm <sup>2</sup> )	3 Core (mm <sup>2</sup> )
-	50
95	95
185	185
300	300
400	400
630	630

### 3.1.3 XLPE-insulated cable construction requirements

XLPE-insulated cables shall comply with SANS 1339 and shall meet the following construction requirements:

#### 3.1.3.1 Type

The cable construction shall be type A, unless otherwise specified in schedule A.

**Note:** The MV cables are generally directly buried and are type A. The armouring is also used as an earth continuity conductor.

#### 3.1.3.2 Semi-conducting core screen

The core screen shall be strippable.

#### 3.1.3.3 Core identification

The cores of three-core cables shall be identified by the numbers 1, 2, 3, printed as numerals or words either directly on the extruded semi-conducting core screen or on the semi-conducting bedding tapes of each core, or by other acceptable means.

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#### **3.1.3.4 Bedding under armouring**

The bedding under the armouring shall comprise an extruded layer of PVC type B1 in accordance with SANS 1411-2.

#### **3.1.3.5 Outer sheath**

- a) The outer sheath shall comprise:
- an extruded layer of black PE type PS2 in accordance with SANS 1411-7, or
  - PE type PS2 outer-sheath shall be flame retardant and shall have a reduced halogen emission property.
  - Where an extruded layer of black PVC type S5 in accordance with SANS 1411-2 are required (for Generation applications), the PVC type S5 shall be halogen free.
- b) The outer sheath shall be ultraviolet (UV) radiation stabilised.
- c) The type of outer sheath required will be specified in schedule A.

#### **3.1.3.6 Fire performance requirements for PVC-sheathed cables**

The armour bedding and outer sheath of PVC-sheathed cables shall be flame retardant and, shall have a reduced halogen emission property.

#### **3.1.3.7 Water blocking**

Where water blocking is applied, the cable shall be longitudinally water-blocked in the following parts of the cable:

- a) In the region of the armouring and metal layers;
- b) In the interstices between the cores of a three-core cable;
- c) In the region of the metal screen; and
- d) Along the conductor length

The method used in order to achieve the longitudinal water blocking shall be stated in schedule B.

Suitable water blocking removal instructions shall be provided for adding it into joint and termination installation instructions.

Where no water blocking removal is required for jointing and termination of the cable, tests shall be performed and submitted to Eskom to prove that no cable de-rating or hot connections will occur for Eskom standard joints and terminations in accordance with SANS 1332.

#### **3.1.3.8 Screening and armouring requirements**

MV XLPE shall either be taped and armoured, or copper wire screened for single core cables. MV XLPE shall be taped and armoured or copper wire screened for three core cables.

##### **3.1.3.8.1 Single core MV XLPE cable**

- a) Single-core cables shall either be taped and aluminium wire armoured or shall be copper wire screened.
- b) Taped and aluminium wire armoured MV XLPE cables shall have PE outer-sheath or PVC outer-sheath.

##### **3.1.3.8.2 Outer-sheath for Single core MV XLPE cable**

- a) Copper wire screened MV XLPE cables shall have a MDPE or HDPE outer-sheath (for wind farm applications).

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### 3.1.3.8.3 Three core MV XLPE cable

- a) Three-core cables shall be taped and aluminium wire.

### 3.1.3.8.4 Outer-sheath for three core MV XLPE cable

- a) Taped and aluminium wire armoured MV XLPE cables shall have PE outer-sheath or PVC outer-sheath.

## 3.2 Packaging, Marking and Labelling

### 3.2.1 Packaging

- a) The wood in wooden drums shall be heat treated only to prevent biological attack.
- b) Cables shall be supplied on wooden drums with a metal flanged spindle hole that is suitable for a spindle having a diameter of 80 mm.
- c) Unless otherwise specified at the time of order, standard drum lengths shall be 300 m for three-core cables and 500 m for single-core cables.

### 3.2.2 Marking of conductor

- a) Each individual conductor shall be marked with a unique and traceable identification system.

**Note:** The purpose of marking the conductor is to be able to prove ownership through traceability of the conductor using the identification system.

- b) The manufacturer shall keep a secure database of all uniquely marked conductors supplied to Eskom.
- c) The conductor identification system shall comply with the following minimum requirements:
- The identification system shall be durable and withstand the expected conditions during the manufacturing processes and operating conditions of the cable over its life. If requested, sufficient proof shall be provided that the identification system offered is chemically compatible with the various materials it may be in contact with inside the cable;
  - The identification system shall withstand, without melting or other deleterious effects, continuous conductor operating temperatures of 90°C and short-circuit conductor temperatures of at least 250°C;
  - The identification system shall not negatively impact the electrical and mechanical integrity and performance of the cable over its expected life;
  - The identification system shall not negatively impact the environment in which the cable is installed over its expected life;
  - The identification code shall consist of any of the following options:
    - Alpha-numeric -, alpha - or numeric characters,
    - Eskom name,
    - Eskom logo,
    - Coloured yarn,
    - Indented marks,
    - Etc.
  - The identification system used shall be visible to the naked eye so as to readily identify that the conductor is marked;

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- The identification code shall be marked (i.e. appear) at intervals not exceeding 500 mm if not continuous in nature;
  - Where applicable the characters used to uniquely identify the conductor shall be legible with the naked eye or, at most, with the assistance of a portable hand-held magnifying glass. The font size offered and, if applicable, the magnification factor required to read the characters shall be stated in schedule B; and
  - Where applicable for alpha-numeric characters the algorithm used to generate the identification code shall be unique for each manufacturer.
- d) Details of the proposed conductor identification system shall be submitted with the tender documentation. The system shall be subject to approval by Eskom.

### **3.2.3 Marking of cable**

Proposal and method for marking of cable, to enable unique identification and traceability, shall be submitted to Eskom for evaluation.

- a) Cable shall be marked with a unique and traceable identification system. The cable identification system location shall be stated in schedule B.

### **3.2.4 Marking of cable outer sheath**

- a) Cables shall be legibly marked in accordance with the requirements of SANS 1339, but the marking shall include the specification number to which the cable has been manufactured, the word "ESKOM", the conductor size in mm<sup>2</sup> and material e.g. Cu (copper) or Al (aluminium). A typical legend would be:

"XXXXXXXXX CABLES 2023 6.35/11 kV 95 mm<sup>2</sup> Cu ESKOM"

- b) The cable shall be sequentially marked at one metre intervals with the legend 000 m, 001 m etc. starting with 000 m at the barrel of the drum and finishing with the number indicating the length of cable on the drum at the outer end of the cable. Length marking shall be to an accuracy of better than 1 %.
- c) PVC sheathed cables shall have a colour coded stripe in accordance with SANS 1339.

### **3.2.5 Marking of cable drums**

In addition to requirements of SANS 1339, cable drums shall be clearly and indelibly marked with the Eskom stock (SAP) number (i.e. "Eskom SAP Number: XXXXXXXX")

All MV cable drums destined for Eskom shall be branded with the Eskom logo on one of its flat sides (the flange). The Eskom logo shall be printed in Eskom blue or black on a white-coloured background. For metal or wooden drums, a portion of the flange surface shall be painted in white to provide a rectangular background on which the signature shall be printed. The height of the white rectangular background shall be three times the diameter of the "circle" part of the Eskom logo. The printed Eskom logo shall appear centrally on the white rectangular background leaving a space equal to at least one logo "circle" before and after the Eskom logo. The Eskom logo printing shall be made using a stencil technique or other equivalent techniques which shall be demonstrated to and approved by Eskom. The dimensions of Eskom logo shall be a minimum length and height of 820 mm and 210 mm respectively. The Eskom logo and standard requirements are shown in Appendix A.

All other printing on the flange shall be positioned so as to ensure a minimum clearance of one logo circle ("circle") diameter away from the Eskom logo.

### **3.2.6 Catalogue requirements**

A catalogue, datasheets or schedules that gives the following information shall be provided for the full range of cables manufactured in accordance with SANS 1339 or equivalent:

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- a) Conductor material (i.e. copper or aluminium) and cross-sectional area.
- b) Voltage rating.
- c) XLPE insulated cable dimensional data:
  - Diameter over conductor;
  - XLPE thickness;
  - Armour wire diameter;
  - Diameter over bedding; and
  - Diameter over sheath.
- d) Maximum sustained current rating in ground, air and ducts.

**Notes:**

- The standard installation conditions assumed shall be stated.
- Both the 70°C and 90°C current ratings should preferably be provided.
- e) Short-circuit ratings.
- f) Cable mass (kg/m).
- g) Gross mass per standard drum length (kg).
- h) The 50 Hz a.c. resistance at maximum sustained conductor operating temperature (ohm/km).
- i) Reactance per phase (ohm/km).
- j) Capacitance per phase (nF/km).
- k) Zero sequence impedance and capacitance per phase at maximum sustained conductor operating temperature (ohm/km).

**Note:** The sequence impedances need only be provided for the range of cables required by this specification.

- l) The cable thermal time constant (seconds).

### **3.3 Tests**

Testing of XLPE-insulated medium-voltage cable shall be in accordance with SANS 1339 respectively.

### **3.4 Tender documentation submissions**

The following documentation must be submitted, in English, as part of tender returnables.

#### **3.4.1 Technical schedules and test schedules**

The full Technical Schedules B (including the Deviation Schedules) shall be completed and submitted to Eskom together with the Technical Schedules A for approval at the time of tendering.

#### **3.4.2 Drawings**

The following drawings shall be submitted:

- Cable construction and dimensional drawings.

#### **3.4.3 Test Certification**

Valid product test certification issued by an appropriately accredited and internationally recognized body being a member of an IAF /ILAC /IECEE mutual agreement scheme or a letter of authority(LOA) certificate issued in accordance with VC 8077, Compulsory specification for the safety of medium voltage electric cables.

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### 3.4.4 Test reports

All required type test reports (complete type test reports) shall be submitted to Eskom, in English, by the manufacturer at the time of tendering and/ or pre-qualification.

### 3.4.5 Cable ampacity ratings

Cable load and fault current rating data at 70°C operating temperature for buried in ground (2D spacing, 1m buried), in-air (trefoil) and duct (trefoil) installations shall be submitted for load current and fault current ratings.

## 4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Bheki Ntshangase	Senior Manager: Asset Management: SED
Matome Mathladisa	Corporate Specialist: HV Plant
Vusi Phiri	Chief Engineer: Asset Management Strategy
Boitumelo Modise	Senior Engineer: Substation Engineering
Nkateko Khoza	Senior Engineer: Asset Management Strategy
Sanele Miya	Engineer: Asset Management: SED
Sihle Msweli	Engineer: Asset Management: SED

## 5. Revisions

Date	Rev	Compiler	Remarks
Sept 2023	1	F Witbooi	Document revised for Transmission specific requirement Revised product certification requirements in line with VC 8770 (March 2017) Document is an extract from and aligned with 240-56063792 for MV XLPE cables.

## 6. Development team

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

- F Witbooi

## 7. Acknowledgements

The author acknowledges the team which developed the first revision of the document.

## Annex A – Eskom Logo: Printing Guide And Format (Normative)

### A.1 The Eskom logo printing guide and format

The logo circle (“circle”) and the logo word (the word “Eskom”) shall always appear together as one unit.

#### A.1.1 Colour specifications

The Eskom logo shall appear in the Eskom corporate blue or in black. The Eskom corporate blue is as follows:

- Pantone 287C
- 100%C + 70%M + 0%Y + 10%K

#### A.1.2 Relationship between the logo circle (“circle”) and the logo word (the word “Eskom”)

The relationship between the logo circle (“circle”) and the logo word (the word “Eskom”) shall always be followed as indicated in the graphic. The measurement between the logo circle (“circle”) and the logo word (the word “Eskom”) is twice the line-width of the “circle”.

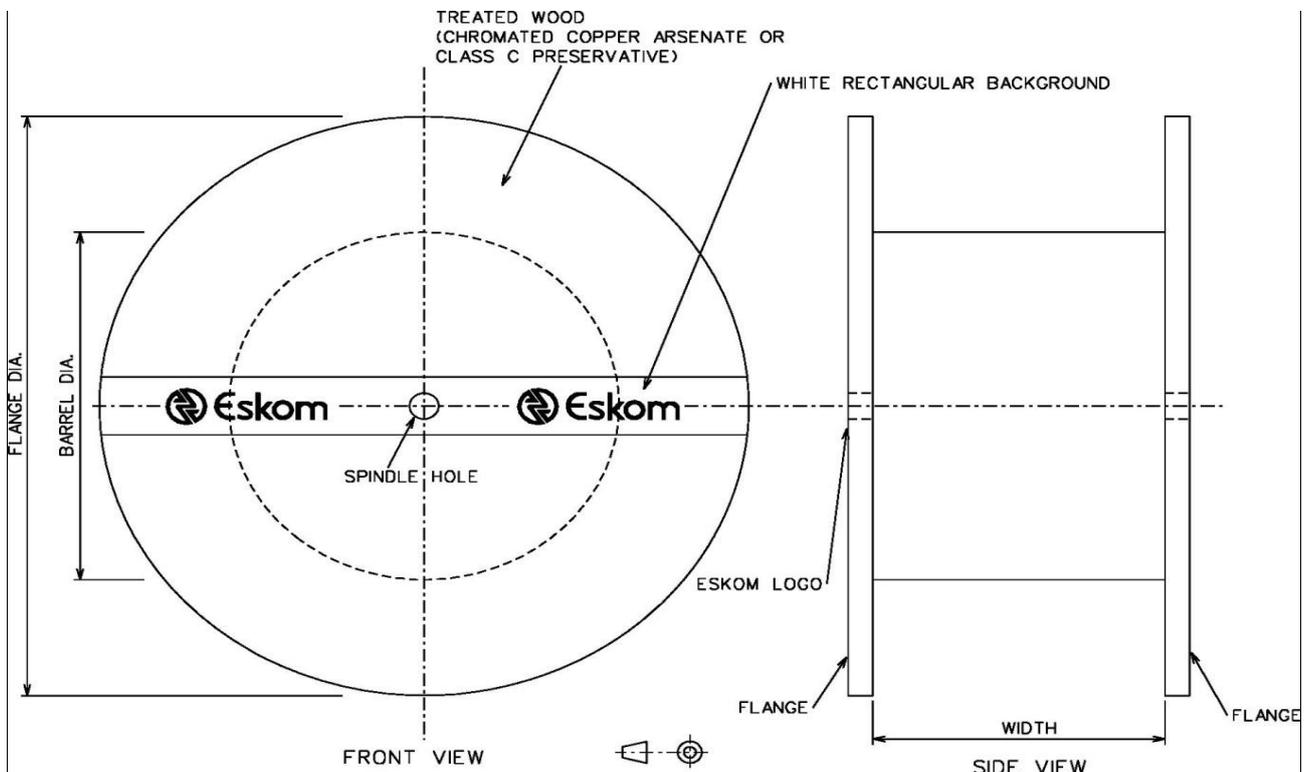


Figure A.1: Typical wooden drum showing Eskom logo branded flange



Figure A.2: The Eskom logo format

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**Annex B – Generic Technical A and B Schedules for MV XLPE Cables**

1	2	3	4	5
Item	Description		Schedule A	Schedule B
1	<b>Item and system description</b>			
1.1	SAP No		_____	
1.2	Drawing number		xxxxxxxxxx	
1.3	Symmetrical fault level rating	kA	_____	
1.4	Nominal system voltage	kV	_____	
1.5	Earth fault level rating	kA	_____	
2	<b>Cable Design and Construction</b>			
2.1	Voltage rating (U)	kV	11, 22 or 33	
2.2	Conductor Size	mm <sup>2</sup>	Item Specific	
2.3	Number of cores (1- Core or 3- Cores)		1 or 3	
2.4	Screening of cables		Item Specific	
2.5	Semiconducting core screen		Item Specific	
2.6	Core identification		Item Specific	
2.7	Bedding under armouring		Item Specific	
2.8	Armouring / copper wire screened		Item Specific	
2.9	Rated frequency ( $f_r$ )	Hz	50	
2.10	Type of outer sheath		Item Specific	
2.11	Does outer sheath comply with the requirements?		Yes	
2.12	Does the armour bedding and outer sheath cables have flame retardancy and reduced halogen emission property ?		Yes	
2.13	Longitudinally Water blocking requirements for conductor and cable		Yes	
2.14	Method used to achieve water blocking requirements		xxxxxxxxxx	

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2.15	Instruction provided for water blocking removal in conductor when jointing or termination		Yes	
2.16	Hole for wooden drums for a spindle if not 80mm (minimum).	mm	Yes	
2.17	Drum lengths	m	Item Specific	
2.18	Are conductor identification system details supplied and compliant?		Yes	
2.19	Is marking of cable identification system details supplied and compliant?		Yes	
2.20	Cable identification system location		xxxxxxxxxx	
<b>3</b>	<b>Current ratings and parameters</b>			
3.1	Maximum sustained current rating at 70°C in:			
a	Ground (2D spacing, 1m buried depth)	A	xxxxxxxxxx	
b	Air (trefoil)	A	xxxxxxxxxx	
c	Ducts (trefoil)	A	xxxxxxxxxx	
3.2	Short circuit rating (Buried in ground)	kA	xxxxxxxxxx	
3.3	Cable mass	kg/m	xxxxxxxxxx	
3.4	Gross mass per standard drum length	kg	xxxxxxxxxx	
3.5	Resistance at max conductor temperature	Ω	xxxxxxxxxx	
3.6	Reactance per phase	Ω/m	xxxxxxxxxx	
3.7	Capacitance per phase	nF/m	xxxxxxxxxx	
3.8	Zero sequence impedance and capacitance per phase	Ω/m	xxxxxxxxxx	
3.9	Cable thermal time constant	s	xxxxxxxxxx	
<b>4</b>	<b>Tender returnables</b>			
4.1	Are construction and dimensional drawings of cable submitted?		Yes	
4.2	Are product test certifications or LOA certificates submitted		Yes	
4.3	Are copies of type tests reports and applicable certificates submitted?		Yes	
4.4	Are load current and fault current ampacity ratings for various installation conditions and at 70°C operating temperature submitted?		Yes	

**Annex C – Deviation Schedule**

**Deviation schedule**

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost-effective than that specified by Eskom.

Item	Clause	Proposed deviation