



The Kenya Power & Lighting  
Co. Ltd.

TITLE:

**SPECIFICATION FOR 66kV  
SINGLE CORE XLPE  
INSULATED COPPER CABLES  
AND THEIR ACCESSORIES**

Doc. No.	KPLC1/3CB/TSP/05/009
Issue No.	1
Revision No.	0
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### 0.1 Circulation List

COPY NO.	COPY HOLDER
1	Research & Development Manager
2	Procurement Manager
3	Stores & Stock Control Manager
4	Design & Construction Manager
5	Deputy Manager, Technical Audit

### 0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)

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## FOREWORD

This specification has been prepared by the Research and Development Department in collaboration with Design & Construction Department both of The Kenya Power and Lighting Company Limited (KPLC) and it lays down requirements for 66kV single core XLPE insulated copper cables and their accessories. It is intended for use by KPLC in purchasing the items.

The manufacturer shall submit information which confirms satisfactory service experience with products which fall within the scope of this specification.

### 1. SCOPE

This specification is for single core XLPE insulated copper cables and their accessories for operation at 50Hz ac voltages of 38.1kV between any conductor and sheath or earth, 66kV between phase conductors and maximum sustained power frequency voltage between phase conductors of 72.5kV.

The specification also covers inspection and test of the cables and their accessories as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer and submitted for tender evaluation.

The specification stipulates the minimum requirements for 66kV single core XLPE insulated copper cables and their accessories acceptable for use in the company and it shall be the responsibility of the Manufacturer to ensure adequacy of the design, good workmanship and good engineering practice in the manufacture of the cables for KPLC.

The specification does not purport to include all the necessary provisions of a contract.

### 2. REFERENCES

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

IEC 60840: Power cables with extruded insulation and their accessories for rated voltages above 30kV ( $U_m = 36kV$ ) up to 150kV ( $U_m = 170kV$ ) – Test methods and requirements.

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IEC 60228: Conductors of insulated cables.

### 3. TERMS AND DEFINITIONS

For the purpose of this specification the definitions given in the reference standards shall apply.

### 4. REQUIREMENTS

#### 4.1 SERVICE AND SYSTEM CONDITIONS

##### 4.1.1 Cable Application

- a) The cable shall be a subtransmission cable for use in outdoors installations and tropical conditions (temperature range of  $-1^{\circ}\text{C}$  to  $+40^{\circ}\text{C}$ , humidity of upto 90%).
- b) The cable shall be suitable for laying in cable ducts and directly in the ground in switching stations and between stations.
- c) The cable shall also be suitable for laying on slopes.
- d) Permissible continuous loading operating temperature shall be  $90^{\circ}\text{C}$ .
- e) Permissible emergency loading temperature shall be  $130^{\circ}\text{C}$  for at least 8 hours.
- f) Permissible short circuit temperature shall be  $250^{\circ}\text{C}$  (for short-circuit duration of 5s as per IEC 60840).

4.1.2 The cables shall be connected to underground system operating at a nominal voltage of 66kV, 50Hz and maximum system voltage of 72.5kV and are solidly earthed at the transformer neutrals.

#### 4.2. MATERIALS AND CONSTRUCTION

##### 4.2.1. Design

4.2.1.1 The cable shall be designed and manufactured to IEC 60840, IEC 60228 and the requirements of this specification.

4.2.1.2 All materials used shall be compatible and suitable for the continuous operating temperature of the cable of  $90^{\circ}\text{C}$  and short circuit temperature of  $250^{\circ}\text{C}$  (5 seconds duration).

##### 4.2.2. Conductor

The cable shall be made from stranded circular plain copper conductors that conform to IEC 60228.

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#### 4.2.3. Conductor Screen

4.2.3.1 A conductor screen consisting of an extruded layer of cross-linkable semi-conducting compound shall be applied over the conductor and cover the surface of the conductor completely.

4.2.3.2 The extruded conductor screen shall be applied in the same operation as the insulation and be fully bonded to the insulation.

#### 4.2.4. Insulation

4.2.4.1 The insulation shall be cross-linked polyethylene (XLPE) conforming to the requirements of IEC 60840.

4.2.4.2 The insulation shall be applied by extrusion and cross-linked to form a compact and homogeneous layer.

4.2.4.3 The colour of the insulation shall be such that it is easily distinguishable from the screening materials.

#### 4.2.5. Insulation Screen

4.2.5.1 There shall be an insulation screen consisting of a cross-linked extruded semi-conducting layer in combination with a metallic layer.

4.2.5.2 The extruded semi-conducting layer shall consist of a strippable semi-conducting compound capable of removal for jointing and terminating. It shall be applied in the same operation as the insulation, directly over the insulation and shall cover the surface of the core completely.

4.2.5.3 A metallic screen shall be applied around the core. The screen shall consist of helically applied overlapped copper tape.

#### 4.2.6. Water Barriers

Water barriers shall be provided to prevent water penetration between and along the various layers in the cable. A water impermeable barrier around the cable and longitudinal water barriers are required.

#### 4.2.7. Metallic Sheath

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There shall be a seamless metallic sheath consisting of corrugated aluminium.

The metallic sheath shall be impervious to water and shall be capable of carrying the earth fault current without exceeding 250°C.

The grain size of the sheath shall be uniform and the sheath shall exhibit no marked change after application, installation or in-service, particularly under extended periods of operation at elevated temperatures or under repeated cyclic variations of load.

#### 4.2.8. Oversheath

4.2.8.1 There shall be an extruded oversheath of suitable material for intended service conditions in 4.1.1.

4.2.8.2 The cable shall be embossed with the following information throughout the length of the oversheath.

- (i) 66000 VOLTS XLPE POWER CABLE PROPERTY OF KPLC;
- (ii) Name of manufacturer;
- (iii) Year of manufacture;
- (iv) The number of cores, type and nominal area of conductors;

Letters and figures shall be raised and consist of upright block characters. Minimum size of characters shall be not less than 15% of average overall cable diameter and the distance between one set of markings and the next shall not exceed 500mm. All markings shall be clear and permanent. An indelible marking shall also be given at every one meter interval to assist field personal in cutting required length.

#### 4.3. STANDARD SIZES AND CHARACTERISTICS

The standard sizes and characteristics of the cables shall be as follows:

Conductor nominal cross-sectional area	mm <sup>2</sup>	185	300	400
Voltage Designation U <sub>0</sub> /U (Um)	kV	38.1/66(72.5)		
Conductor shape		stranded, compacted round		
Impulse withstand voltage & power frequency withstand voltage for cable	V <sub>peak</sub> V <sub>rms</sub>	1.2/50μs dry: 325kV peak 50Hz wet (60s): 140kV rms		
Impulse withstand voltage & power frequency withstand voltage for terminations	V <sub>peak</sub> V <sub>rms</sub>	1.2/50μs dry: 380kV peak 50Hz wet (60s): 150kV rms		
Maximum resistance of conductor at 20°C	Ω/km	0.0991	0.0601	0.0470

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**Note:** *The thickness of insulation, thickness of metallic sheath, thickness of oversheath and the current carrying capacity of the cable underground and in air shall be stated by the manufacturer in the Guaranteed Technical Particulars as per Annex A. The declared values shall be verified during factory testing as per IEC.*

#### 4.4. QUALITY MANAGEMENT SYSTEM

- 4.4.1 The bidder shall submit a quality assurance programme (QAP) that will be used to ensure that the cable design, material, workmanship, tests, service capability, maintenance and documentation, will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2008.
- 4.4.2 The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 certificate shall be submitted with the tender for evaluation.
- 4.4.3 The bidder shall indicate the delivery time of the cables, manufacturer's monthly & annual production capacity and experience in the production of the type and size of cable being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers outside the country of manufacture for exact or similar rating of cables sold in the last five years shall be submitted with the tender for evaluation.

#### 4.5. CABLE ACCESSORIES

Jointing and terminating accessories for the single core cables covered by this specification shall satisfy the requirements of IEC 60840 and the following:

##### 4.5.1 Cable straight through joints

4.5.1.1 Straight through joints shall be suitable for the cable specified and shall contain all materials required to:

- mechanically connect the type and size of conductor specified;
- electrically connect the conductor specified;
- provide the necessary level of insulation and stress control within the joint;
- restore the integrity of the core screen ;
- restore the integrity of the aluminium sheath with regard to water imperviousness and current carrying capabilities;
- provide an insulated outer housing that is completely filled and that meet the insulation requirements specified in IEC 60840.

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4.5.1.2 Straight through joints shall be of cold or heat shrinkable material suitable for use in terminating XLPE cables with conductors of stranded copper.

4.5.1.3 The jointing material shall have an internal insulating tubing and compression connector component, which shall provide adequate insulation and connection over the conductor at the cable joint.

4.5.1.4 The jointing material shall have a stress control-tubing component, which shall provide proper electrical stress control at the operating voltage over the insulated cable cores at the joint.

4.5.1.5 The jointing material shall have anti-tracking tubing, which shall provide resistance to tracking and erosion of the material.  
The joints shall be designed and manufactured to ensure that all components and materials shall be suitable for use in the service conditions specified.  
The complete components and materials shall be free from defects, which would be likely to cause them to be unsatisfactory in service.  
The components and materials shall be manufactured to ensure high moisture sealing capacity, resistance to fungal and insect attack.

4.5.1.6 Specialized tools that are required during the jointing process shall be stated and the costs shall be quoted for separately.

**4.5.2 Outdoor cable terminations**

- a) shall be of heat shrinkable silicon rubber based and suitable for use in terminating XLPE cables with conductors of stranded copper.
- b) shall have a stress control tubing component which shall provide proper electrical stress control at the operating voltage over the insulated cable cores at the termination.
- c) shall have an anti-tracking tubing which shall provide resistance to tracking and erosion of the material.
- d) shall be designed and manufactured to ensure that all components and materials shall be suitable for use in the specified service conditions.
- e) the complete components and materials shall be free from defects which would be likely to cause them to be unsatisfactory in service.
- f) the components and materials shall be manufactured to ensure high moisture sealing capacity, resistance to fungal and insect attack.
- g) Outdoor terminations shall be of specific creepage distance of 31mm/kV and shall be provided with sheds for creepage extension.

Specialized tools that are required during the terminating process shall be stated and the costs shall be quoted separately.

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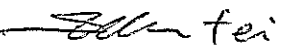
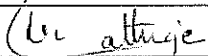
The supplier shall provide the installation procedures and instructions for the straight through joints and termination kits to be used as accessories of the cable specified.

## 5. TESTS AND INSPECTION

- 5.1 The cable shall be inspected and tested in accordance with the requirements of this specification, IEC 60228 and IEC 60840. It shall be the responsibility of the manufacturer to perform or to have performed all the relevant tests.
- 5.2 Copies of previous type test reports and type test certificates by the relevant International or National Testing/Standards Authority of the country of manufacture (or ISO/IEC 17025 accredited independent laboratory) shall be submitted with the offer for evaluation. A copy of accreditation certificate for the laboratory shall also be submitted (all in English Language).
- 5.3 Test reports to IEC 60840 for the cables and accessories to be supplied shall be submitted to KPLC for approval before shipment of the goods. KPLC Engineers (2) will witness the following tests at the factory before shipment:
- a) Conductor examination
  - b) Measurement of electrical resistance of conductor
  - c) Measurement of thickness of insulation and oversheath
  - d) Measurement of thickness of metallic sheath
  - e) Measurement of diameters
  - f) Hot set test for XLPE
  - g) Measurement of capacitance
  - h) Partial discharge test
  - i) Voltage test
  - j) Bending test followed by partial discharge test
  - k) Tan delta measurement
  - l) Heating cycle voltage test followed by partial discharge measurement
  - m) Impulse withstand test followed by a power frequency voltage test
  - n) Tests on accessories.

The above tests shall be carried out in accordance with IEC 60840 and this specification.

As per IEC 60840, if the sample from any length selected for the tests fails in any of the tests above, further samples shall be taken from two further lengths of the same batch and subjected to the same tests as those in which the original sample failed. If both additional samples pass the tests, the other cables in the batch from which they

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were taken shall be regarded as having complied with the requirements of this specification. If either fail, this batch of cables shall be regarded as having failed to comply and shall be rejected.

During acceptance testing, the manufacturer shall demonstrate that the accessories are mechanically and electrically fit for the cable offered.

- 5.4 During delivery of the cables and their accessories, KPLC will inspect them and may perform or have performed any of the relevant tests in order to verify compliance with the specification. The manufacturer shall replace/rectify without charge to KPLC, cables/accessories which upon examination, test or use fail to meet any or all of the requirements in the specification.

## 6. MARKING, LABELLING AND PACKING

- 6.1 The finished cable shall be wound on wooden drum such as to prevent damage during transportation and handling. The drums shall be made from treated timber resistant to termite attack.
- 6.2 The actual length of cable shall not be less than the length indicated on the drum.
- 6.3 Both ends of every drum length of cable shall have been sealed to prevent the ingress of water during transportation, storage, handling and installation. Both ends shall be secured to the drum to prevent mechanical damage.
- 6.4 The following information shall be marked legibly and in a permanent manner on the flange of the drum:
- The manufacturer's name;
  - The type and rating of cable;
  - The conductor cross-sectional area in mm<sup>2</sup>;
  - The length of the cable, in metres;
  - The year of manufacture;
  - The gross mass and net mass, in kilogram;
  - The instructions for handling and use (in English Language);
  - The words "**PROPERTY OF KENYA POWER & LIGHTING CO.**"

**Note: The cable itself shall have been marked in accordance with clause 4.2.8.2**

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**ANNEX A: Guaranteed Technical Particulars** (to be filled and signed by the Manufacturer for all clauses and submitted together with copies of manufacturer's catalogues, brochures, drawings, technical data, sales records and type test reports for tender evaluation)

Tender No.....

Description		Bidder's offer
Manufacturer		
Country of manufacture		
Service Conditions & application		
Applicable Standard(s)		
Type and design		
Conductor		
Conductor screen		
Insulation		
Insulation screen		
Water barriers		
Metallic sheath		
Oversheath	Material	
	Marking	
<b>RATINGS/CHARACTERISTICS</b>		
Conductor nominal cross-sectional area		
Voltage designation U <sub>0</sub> /U(U <sub>m</sub> )		
Conductor shape		
Thickness of insulation		
Thickness of metallic sheath		
Thickness of oversheath		
Maximum conductor resistance at 20°C		
Current carrying capacity	underground	
	In air	
Power frequency withstand voltage		
Impulse withstand voltage and power frequency withstand voltage for cable		
Impulse withstand voltage and power frequency withstand voltage for terminations		
Cable accessories (type & design)		
Quality Assurance Program		
Copy of ISO 9001:2008 submitted		

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	List of Type Test Reports submitted (indicate Test Report Numbers)	
	List of Tests to be witnessed by KPLC Engineers at the factory before shipment	
	Marking on cable & drum (parameters to be indicated and method of marking)	
	Packing	
	Installation and technical manuals to be provided during delivery	
	List of catalogues, brochures, drawings, technical data and customer sales records submitted to support the offer.	
	Statement of compliance and or deviations from Tender Specifications	
	Inspection/test by KPLC during delivery before acceptance to stores/site	

.....  
**Manufacturer's Name, Signature, Stamp and Date**

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