DOCUMENT NO. KP1/13D/4/1/TSP/05/023

Kenya Power

33KV THREE CORE XLPE INSULATED ALUMINIUM CABLES – SPECIFICATION

A Document of the Kenya Power & Lighting Co. Ltd.
August 2021

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0.1 CIRCULATION LIST

COPY NO.	COPY HOLDER
1	Manager, Standards
2	Electronic copy (pdf) on Kenya Power server (http://172.16.1.40/dms/browse.php?fFolderId=23)

REVISION OF KPLC STANDARDS

To keep abreast of progress in the industry, KPLC Standards shall be regularly reviewed. Suggestions for improvements to approved Standards, addressed to the Manager, Standards Department, are welcome.

0.2 AMENDMENT RECORD

Rev No.	Date (yy-mm-dd)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
Issue1 Rev 1	2021-08-09	(i) Addition of more standard cable sizes in table 1. (ii) To update the ISO standards requirement	S. Nguli	Dr. Eng. Peter Kimemia

FOREWORD

This Specification has been prepared by the Standards Department of the Kenya Power and Lighting Company Plc (KPLC) and it lays down requirements for 33kV Three core XLPE insulated aluminum cables. It is intended for use by KPLC in purchasing the cables.

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

This specification stipulates the minimum requirements for 33kV three core aluminum cables acceptable for use in the company and it shall be the responsibility of the supplier and manufacturer to ensure that the offered design is of the highest quality and guarantees excellent service to KPLC.

The manufacturer shall exhibit good workmanship and good engineering practice in the manufacture of the 33kV three core aluminum cables for KPLC.

Users of KPLC specifications are responsible for its correct interpretation and application.

Specifications in this series are:

(i) KP1/3CB/TSP/05/021: Specification for 33kV 3/C Al XLPE Submarine Cable

(ii) KPLC1/3CB/TSP/05/024: Specification for 33kV S/C Al AWA PVC Cable

The following are members of the team that developed this specification:

Name	Department
Stephen Nguli	Standards

1. SCOPE

1.1. This Specification is for three core, stranded aluminium conductors, Cross Linked Polyethylene (XLPE) insulated, galvanized steel wire armoured(SWA), PVC outer sheathed power cables for operation at voltages of 19100 Volts to sheath, 33000 Volts between conductors and highest system voltage of 36000 Volts for use in KPLC distribution network operated at 50Hz.

1.2. The specification also covers inspection and test of the cables as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer and submitted together with other required details for tender evaluation.

1.3. The specification stipulates the minimum requirements for three core XLPE insulated aluminium 33kV cables acceptable for use in the company and it shall be the responsibility of the supplier to ensure adequacy of the design, good workmanship, good engineering practice and adherence to standards, specifications and applicable regulations in the manufacture of the cables for The Kenya Power & Lighting Company Plc.

1.4. The 33KV three core aluminium cables shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation up to the bidder's guarantee in a manner acceptable to the KPLC,

1.5. The specification is for the following sizes of 33kV cables;

3 x 50 mm² AL/XLPE/SWA/PVC
3 x 95 mm² AL/XLPE/SWA/PVC
3 x 185 mm² AL/XLPE/SWA/PVC
3 x 300 mm² AL/XLPE/SWA/PVC

Note: *The cable to be procured shall be specified in the tender*

2. NORMATIVE REFERENCES

The following standards contain provisions which through reference in this text constitute provisions of this specification. For dated editions, the cited edition shall apply; for undated editions, the latest edition of the referenced document shall apply.

For this specification, the definitions and abbreviations given in the reference standards shall apply.

IEC 60502-2:	Power Cables with extruded insulation and their accessories for rated voltages from 1kV (Um=1.2kV) up to 30kV (Um=36kV)- Part 2: Cables for rated voltages from 6kV (Um=7.2kV) up to 30kV (Um=36kV).
IEC 60228:	Conductors of insulated cables.

BS 6622:	Specification for cables with extruded cross-linked polyethylene or ethylene propylene rubber insulation for rated voltages from 3.8/6.6kV to 19/33kV.
IEC 61034-1:	Measurement of smoke density of cables burning under defined conditions - Part 1 Test apparatus
IEC 60811-1-1:	Common Test Methods for Insulating and Sheathing Materials of Electric and Optical Cables
IEC 60540:	Test Methods for insulation and sheaths of electric cables and cords
IEC 602872-3:2017:	Calculation of the continuous current rating of cables
ISO 9001:2015:	Quality Management Systems — Requirements

Note: Unless otherwise stated, the latest editions (including amendments) apply.

3. Terms and Definitions

For the purpose of this specification the definitions given in IEC 60228 and IEC 60502-2 apply together with the following;

AL: Aluminum
PVC: Polyvinyl chloride
SWA: Steel Wire armour
XLPE: Cross-linked polyethylene

4. REQUIREMENTS

4.1. Service Conditions

The cables shall be suitable for the following service conditions and applications;

4.1.1 Cable Application

a) The cable shall be a distribution cable for use in outdoors installations and tropical conditions (temperature range of -1°C to +40°C, humidity of up to 95%, saline conditions and altitudes of up to 2200m above sea level).
b) The cable shall be suitable for laying in cable ducts and directly in the ground in switching stations, between stations and underground to overhead conversion.
c) The cable shall also be suitable for laying on slopes.
d) Permissible continuous loading operating temperature shall be 90°C.
e) Permissible emergency loading temperature shall be 130°C for at least 8 hours.
f) Permissible short circuit temperature shall be 250°C (for short-circuit duration of 5s as per IEC 60502).

4.1.2 The cables shall be connected to underground system operating at a nominal voltage of 33kV, 50Hz and maximum system voltage of 36kV and are solidly earthed at the transformer neutrals. The short circuit fault level shall be taken as 31.5kA 3s.

4.1.3 The cables shall have suitable anti-termite protection (details to be submitted by supplier to KPLC for approval before manufacture).

4.1.4 The cable shall have an oversheath with a fire performance that conforms to the requirements IEC standards.

4.1.5 The cable shall be designed for reliable service life of at least 30 years.

4.2. MATERIALS AND CONSTRUCTION

4.2.1. Design

4.2.1.1 The cable shall be designed and manufactured to BS 6622, IEC 60502-2 and the requirements of this specification.

4.2.1.2 All materials used shall be compatible and the cable shall have continuous operating temperature of 90°C and short circuit temperature of 250°C (5 seconds duration) as per IEC 60502-2.

4.2.2. Conductor

The cable shall be made from circular stranded compacted plain aluminum conductor that conforms to IEC 60228.

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 60502-2.

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.

4.2.4.4 Individual cores shall be identified by colored tape over the insulation and the colors shall be Red, Yellow and Blue.

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 each core. The screen shall consist of helically applied overlapped aluminum tape. An energy absorbing bedding layer should be applied.

4.2.6. Laying-up

4.2.6.1 The cores shall be laid-up with a right hand direction of lay. Fillers of non-hygroscopic material shall be used to form a substantially compact and circular cable.

4.2.6.2 The metallic screens of the three cores shall be in contact with each other.

4.2.7. Armour

4.2.7.1 An extruded separation layer of black polyvinyl chloride (PVC) shall be applied between the laid-up cores and the armor.

4.2.7.2 The armour shall consist of a three layer of round galvanized steel wires applied helically with a left-hand lay.

4.2.8. Oversheath

4.2.8.1 There shall be an extruded oversheath of black polyvinyl chloride (PVC) as per IEC 60502-2.

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

(i) 33000 VOLTS 3/ C AL 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.

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 for the XLPE cables shall be as per table 1

Table 1: Cable Sizes and Technical Characteristics.

Conductor nominal sectional area	mm^2	50	95	185	300
Voltage Designation	kV	19/33 (36)			
Conductor shape		Compact round stranded			
Conductor diameter	mm	8.4	11.3	15.8	20.5
Thickness of insulation	mm	8.0	8.0	8.0	8.0
Thickness of separation layer	mm	1.5	1.5	1.7	1.9
Nominal armour wire diameter	mm	3.15	3.15	3.15	3.15
Thickness of oversheath, nominal	mm	3.5	3.5	4.3	4.3
Approximate overall diameter	mm	74.8	82.5	93.3	104.4
Test Voltage (after installation), d.c.	kV/5 min	63	63	63	63
Impulse withstand voltage of the cable	kV, pk	200	200	200	200
Power frequency withstand voltage for cable	kV ,rms	95	95	95	95
Maximum conductor resistance At 20 °C	Ω/km	0.640	0.320	0.164	0.100
Maximum conductor resistance At 90 °C	Ω/km	0.822	0.4107	0.2114	0.1302
Approx. Weight	Kg/km	8168	9687	12115	14940
Recommended Drum Length	m	500	500	400	300

***Note**: The Current Carrying Capacity of the cable in the ground and in air shall be stated by the manufacturer in the Guaranteed Technical Particulars as per Annex A.*

APPENDICES

APPENDIX A: TESTS AND INSPECTION (NORMATIVE)

A.1. The 33kV three core XLPE insulated aluminum cables and their accessories shall be manufactured and tested shall be inspected and tested in accordance with the requirements of this specification, IEC 60228, IEC 60840 and other applicable IEC standards listed in clause 2 and the requirements of this specification. It shall be the responsibility of the manufacturer to perform or to have performed all the relevant tests.

A.2. **Type Tests:** 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 (to IEC 60840) 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.

A.3 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 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.

A.4. The test certificates shall be from an accredited reputable independent testing laboratory, acceptable to the purchaser. Proof of accreditation by a national/international authority shall be forwarded with the offer. Test reports shall be complete including all the pages as

issued by the testing authority. *Submission of only parts of test reports shall not be acceptable.*

A.5. Copies of previous type test reports by the relevant International or National Testing/Standards Authority of the country of manufacture (or ISO/IEC 17025 or ILAC accredited independent laboratory) shall be submitted with the tender for evaluation (all in English Language). A copy of accreditation certificate for the laboratory shall also be submitted.

APPENDIX B: QUALITY MANAGEMENT SYSTEM

B.1 The bidder shall submit a quality assurance plan (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 9001:2015.

B.2 The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2015 certificate shall be submitted with the tender for evaluation.

B.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 for similar rating of cables sold in the last five years as well as reference letters from at least four of the customers shall be submitted with the tender for evaluation.

APPENDIX C: FACTORY ACCEPTANCE TESTS

C.1 Kenya Power shall conduct compulsory inspection of the cables at the manufacturer's factory, and thereafter post-delivery to selected sites, installation, testing, and commissioning.

C.2 Upon completion of manufacturing, the 33kV cables shall be subject to acceptance tests at the manufacturer's works before dispatch. shall be witnessed by two or more Engineers appointed by The Kenya Power and Lighting Company Plc (KPLC).

C.3 The manufacturer/supplier shall give one months' notice to Kenya Power on intended dates to conduct the Factory Acceptance Tests (FATs). The Supplier shall further provide letters of invitation to the Kenya Power Engineers nominated to attend the FATs

APPENDIX D: INSPECTION AT DELIVERY POINT

D.1. On receipt of the cables, KPLC shall inspect the 33kV cables for acceptance at stores and may perform or have tests performed to verify compliance of the cables with this specification.

D.2. The supplier shall replace/rectify without charge to KPLC, any equipment which upon examination, test or use, fail to meet any or all of the requirements in this specification.

APPENDIX E: WARRANTY

E.1. The supplier/manufacturer warrants the purchaser that all goods supplied under this contract shall have no defect arising from design, materials or workmanship.

E.2. A warranty of 60 months from the date of delivery of the 33cables to Kenya Power store shall be offered by the manufacturer.

APPENDIX F: MARKING, LABELING & PACKAGING

F.1. The finished cable shall be wound on metallic drum such as to prevent damage during transportation and handling. The drums shall be protected against corrosion.

F.2 The actual length of cable shall not be less than the length indicated on the drum.

F.3 Both ends of every drum length of cable shall have been sealed (with end caps) to prevent the ingress of water during transportation, storage, handling and installation. Both ends shall be secured to the drum to prevent mechanical damage.

F.4 The following information shall be marked legibly and in a permanent manner on the flange of the drum:

a) The manufacturer's name;
b) The type and rating of cable;
c) The conductor cross-sectional area in mm^2;
d) The length of the cable, in metres;
e) The year of manufacture;
f) The gross mass and net mass, in kilogram;
g) The instructions for handling and use (in English Language);
h) The words "**PROPERTY OF KENYA POWER & LIGHTING CO.**"

APPENDIX G: DOCUMENTATION (NORMATIVE)

G.1. The bidder shall submit its tender complete with technical documents required by Appendix M (Guaranteed Technical Particulars) for tender evaluation. The technical documents to be submitted (all in English language) for tender evaluation shall include the following:

(i) Guaranteed Technical Particulars signed by the manufacturer;

(ii) Copies of the Manufacturer's catalogues, brochures, and technical data sheets (including ratings) for 33KV cables.

(iii) Detailed drawings and step by step procedure for safe installation and correct commissioning process of the 33kVcables. This shall include the recommended maximum earthing resistance values for safe operation of the cables

(iv) Sales records for the last five years and at least four customer reference letters;

(v) Details of manufacturing capacity and the manufacturer's experience;

(vi) Copies of required type test reports by a third-party testing laboratory accredited to ISO/IEC 17025;

(vii) Copy of accreditation certificate to ISO/IEC 17025 for the third-party testing laboratory;

(viii) Manufacturers letter of authorization, ISO 9001:2015 certificate and other technical documents required in the tender.

G.2. The successful bidder (supplier) shall submit the following documents/details to The Kenya Power & Lighting Company for approval before manufacture:

(i) Fully filled clause by clause Guaranteed Technical Particulars (GTP) signed by the manufacturer;

(ii) Design drawings and technical details;

(iii) Quality assurance plan (QAP) that shall be used to ensure that the design, material; workmanship, tests, service capability, maintenance and documentation shall 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 9001:2015;

(iv) Detailed test program to be used during factory testing;

(v) Marking details;

(vi) Packaging details (including packaging materials and marking and identification of batches). The manufacturer shall state the maximum acceptable storage duration for the complete 33kV cables, taking cognisance of the service conditions defined in clause 4.1.

(vii) Manufacturer's undertaking to ensure adequacy of the design, good engineering practice, adherence to the specification and applicable standards and regulations as well as ensuring good workmanship in the manufacture of the 33kV cables for the Kenya Power & Lighting Company.

G.3. The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the 33kV cables to KPLC stores.

G.4 Routine and sample test reports to be submitted to Kenya Power for approval before shipment/delivery of the goods.

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APPENDIX H: GUARANTEED TECHNICAL PARTICULARS (GTPS)

(to be filled, stamped and signed by the Supplier/manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records for previous five years, four customer reference letters, details of suppliers' capacity and experience; and copies of complete test certificates and test reports for tender evaluation or approval, all in English Language)

Tender No. .....

Bidder's Name.....

Clause	Description	KPLC Requirement	Supplier's offer
	Manufacturer's name	state	
	Manufacturer's letter of Authorization.	Provide a copy	
	Scope of supply		
	Type or designation	state	
2	Reference standards	state	
4.1.1	Service conditions	List and specify	
4.1.2	The cable short circuit fault level	State	
4.1.3	Cable anti-termite protection	Specify	
4.1.4	Cable Fire retardant performance (attach Wire glow Type Test Report)	specify	
4.1.5	Cable design life	State	
4.2.1.1	Standard(s) of manufacture	State	
4.2.1.2	Cable rated continuous operating temperature	State	
	short circuit temperature and time	State	
	Applicable standard(s)	Specify	
4.2.2	Conductor material and standard	Specify	
4.2.3.1	Conductor screen material	Specify	
4.2.3.2	Application of extruded conductor screen	specify	
4.2.4.1	Insulation Material and standard of manufacture	specify	
4.2.4.2	Application of extruded insulation screen	Specify	
4.2.4.3	Colour of insulation	specify	
4.2.4.4	Core Identification	state	

4.2.5.1	Insulation screen material & application of metallic layer		state	
4.2.5.2	Composition of insulation layer		state	
4.2.5.3	Metallic screen application on each core		specify	
4.2.6	**Laying up**			
4.2.6.1	Laying up of the cores & filler material used		Specify	
4.2.6.2	Metallic screens contact for the three cores		specify	
4.2.7.1	Armour Material		specify	
4.2.7.2	No. of layers to be applied and direction		specify	
4.2.8.1-4.2.8.2	Oversheath	Material and standard(s)	State	
		Anti-termite protection	specify	
		Fire Resistance	specify	
		Marking, state parameter to marked and method of marking	specify	
		Size of characters and intervals of marking	specify	
4.3	**RATINGS/CHARACTERISTICS**			
	Conductor nominal cross-sectional area		state	
	Voltage designation $U_o/U(U_m)$		state	
	Conductor shape		state	
	Thickness of insulation		state	
	Thickness of screening materials		state	
	Thickness of metallic sheath		state	
	Thickness of oversheath		state	
	Maximum conductor resistance at 20°C		state	
	Maximum conductor ac resistance at 90°C		state	
	Current carrying capacity	In ground (state conditions)	state	
		In air (state conditions)	state	
	Impulse withstand voltage and power frequency withstand voltage for cable		state	
	Minimum bending radius of cable		state	
	Weight per km (kg/km)		state	
	Length of cable per drum(m)		State	
	Test Voltages (list all as per IEC 60840)		state	

	Impulse withstand voltage and power frequency withstand voltage for cable	state	
	APPENDICES		
A	**TESTS AND INSPECTION (NORMATIVE)**	State	
A.1	Test standard(s)	state	
A.2	Type test certificates submitted with tender for evaluation and tests covered	State/List	
A.3	Mode of sampling during testing and acceptance criteria.	State	
A.4	Copies of previous type test and routine test reports by the relevant independent /international testing laboratory submitted.	List	
A.5	Valid Accreditation Certificate of the Testing Laboratory as per ISO/IEC 17025:2017 Routine test to be witnessed at the factory by KPLC engineers	Attach/ List	
B	**Factory Acceptance Tests**		
B1	Submit QAP for the cable manufacturing	Attach	
B2	Copy of valid ISO 9001: 2015 certificate	Attach	
B3	Manufactures lead in time, monthly & annual production capacity Experience in the production of the type and size of cable being offered.	specify	
	A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers for similar rating of cables sold in the last five years as well as reference letters from at least four of the customers	List	
C	**Factory Acceptance Tests**		
C1	Inspection of cables at manufacturers premises	State compliance	
C2	Acceptance tests of cables at the Factory(FAT)	State compliance	
C3	Manufacturer to provide letters of invitation to KPLC nominated engineers	State compliance	

D	**Inspection at Delivery Point**		
D.1.	Inspection of cables at KPLC stores	State compliance	
D.2.	Supplier shall replace/rectify without charge to KPLC any cable found not compliant to any specification	State compliance	
E	**Warranty**		
E.1.	Warranty that goods are new and without defects	provide	
E.2.	Warranty period	State	
F.	**Packaging & Labeling**		
F.1.	Mode of cable Packaging and protection against corrosion	Specify	
F.2.	Length of cable on drum (m)	State	
F.3.	Cable sealing at both ends	State	
F.4.	Markings on the drum and flange	List	
G	**DOCUMENTATION**		
G.1.	Technical documentation submitted with tender	List	
G2	Documents to be submitted Kenya Power for approval before manufacture/supply	State	
G3	Submit recommendations for use, detailed user's installation guide, etc. during delivery	State	
G4	Routine and sample test reports to be submitted to Kenya Power for approval before shipment/delivery of the goods	State	

***Note*

Words like 'agreed', Yes; 'confirmed', 'As per KPLC specifications', etc. shall not be accepted and shall be considered non-responsive.

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Manufacturer's Name, Signature, Stamp and Date