



TITLE:
**SPECIFICATION FOR PVC
INSULATED SINGLE PHASE
CONCENTRIC ALUMINIUM CABLES
WITH 2-CORE COPPER
COMMUNICATION CABLE**

Doc. No.	KP1/3CB/TSP/05/033
Issue No.	1
Revision No.	0
Date of Issue	2015-01-07
Page 1 of 16	

TABLE OF CONTENTS

FOREWORD

1. SCOPE
2. REFERENCES
3. TERMS AND DEFINITIONS
4. REQUIREMENTS
5. TESTS AND INSPECTION
6. MARKING AND PACKING
7. DOCUMENTATION

ANNEX A: *Guaranteed Technical Particulars (to be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records, customer reference letters, details of manufacturing capacity, the manufacturer's experience and copies of complete type test certificates and accreditation certificate to ISO/IEC 17025 for the testing laboratory for tender evaluation, all in English Language).*

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Authorized by: Head of Department, Standards

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Issue No.	1
Revision No.	0
Date of Issue	2015-01-07
Page 2 of 16	

0.1 Circulation List

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Issue No. 1

Revision No. 0

Date of Issue 2015-01-07

Page 3 of 16

FOREWORD

This specification has been prepared by the Standards Department in collaboration with Energy Management Department both of The Kenya Power and Lighting Company Limited (abbreviated as KPLC) and it lays down requirements for low voltage (LV) PVC insulated single phase concentric aluminium cables with communication cables. It is intended for use by KPLC in purchasing the cables.

1. SCOPE

- 1.1. This specification is for LV PVC insulated single phase concentric aluminium cables with embedded communication cables to be used by KPLC for split prepayment metering. The cable shall carry both power and data in a single cable and shall have circular stranded aluminium conductors insulated red for operation upto and including 1,000V between phases and 600V phase to earth, concentric layers comprising of a blue PVC covered aluminium wires (combined neutral-earth conductor) and PVC insulated two (2)-cores copper cables for data communication complete with a black PVC outer sheath.
- 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 for tender evaluation.
- 1.3. The specifications stipulates the minimum requirements for LV PVC insulated single phase concentric aluminium cables with communication cable acceptable for use in the company (KPLC) 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 and Lighting Company Ltd.

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.

IEC60811-1-1: Common test methods for insulating and sheathing materials of electric cables and optical cables – Part 1-1: Methods for general application –

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Doc. No.	KP1/3CB/TSP/05/033
Issue No.	1
Revision No.	0
Date of Issue	2015-01-07
Page 4 of 16	

Measurement of thickness and overall dimensions – Tests for determining the mechanical properties

- IEC 60304: Standard colours for insulation for low-frequency for cables wires
- BS 7870-3.20: LV and MV polymeric insulated cables for use by distribution and generation utilities; --Part 3: Specification for distribution cables rated voltage 0.6/1 kV; --Section 3.20: PVC insulated split concentric cables with copper or aluminium conductors.
- BS 4808-1: Specification for L.F. cables and wires with PVC insulation and PVC sheath for telecommunication — Part 1: General requirements and tests.
- BS 6360: Specification of conductors in insulated cables and cords
- BS 6746: Specification for PVC insulation and sheath of electric cables
- KS 04-1022: Kenya standard specification for 600/1000V PVC-insulated single-phase concentric cables with copper or aluminium conductors for electricity supply.

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`

- a) The cable shall be a service cable for continuous operation outdoors and tropical conditions (temperature range of -1⁰ C to +40⁰ C, humidity of upto 90% and saline conditions along the coast).
- b) The cable should be suitable for laying in cable ducts and in air.
- c) Permissible continuous loading operating temperature shall be 70⁰ C and short circuit temperature of 160°C.

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Doc. No.	KP1/3CB/TSP/05/033
Issue No.	1
Revision No.	0
Date of Issue	2015-01-07
Page 5 of 16	

4.2. MATERIALS AND CONSTRUCTION

4.2.1. General

The cable shall be designed and manufactured to BS 7870-3.20: 2001 and Kenya Standard KS 04-1022 and the requirements of this specification.

4.2.2. Phase conductor

4.2.2.1. The phase conductor shall be circular stranded plain annealed aluminium conductors (class 2) as specified in KS 04-1022 and shall comply with all provisions of KS 04-187. The phase conductor shall have a left-hand direction of lay. The typical construction shall be as per Fig. 1.

4.2.2.2. The insulation of the central phase conductor shall be red PVC compound – type TI 1 as specified in KS 04-1022, KS 04-188 and BS 6746 and Table 1 of this specification. It shall be applied by an extrusion process and shall be spark tested in accordance with KS 04-1022 clause 4.1.

4.2.2.3. The thickness of insulation, determined in accordance with KS 04-1022, shall be not less than the value given in table 2 of this specification and the smallest of the measured values shall not fall below the value given in the said table by more than (10%+0.1mm).

4.2.3. Concentric layer

4.2.3.1. Neutral-earth conductor

The earth-neutral conductors shall be manufactured from plain annealed aluminium wires in accordance with KS 04-1022 and as required by clause 6.1 of BS 7870-3.20:2001. Conformity shall be checked by visual inspection. The d.c resistance shall conform to the values given in Table 2.

Note:

1. To distinguish the neutral-earth conductor, each wire shall be covered by extrusion with a black polymeric compound (covering shall not be regarded as insulation). The tensile strength of the covering shall not be less than 4 N/mm^2 and elongation at break of not less than 50% when tested in accordance with IEC 60811-1-1:1 clause 9.
2. The diameter shall be approximately the same as that of the individual wires as the communication cable.

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Doc. No.	KP1/3CB/TSP/05/033
Issue No.	1
Revision No.	0
Date of Issue	2015-01-07

Page 6 of 16

4.2.3.2. Communication cable

4.2.3.2.1. Construction

- 4.2.3.2.1.1. The communication cable shall be a two (2)-core single equipment cables helically wrapped over the core cable adjacent to the earth-neutral conductors. The wires shall be stranded (class 2 of BS 6360:1991), which may be screened, for purposes of internal wiring of electronic and other equipment according to BS 4808-1:1972.
- 4.2.3.2.1.2. All conductor wires shall be circular in cross section and shall consist of standard annealed copper, smoothly drawn, uniform in quality, free from defects and uniformly coated with pure tin satisfying the mechanical requirements of BS 6360 and all conductors shall meet the test for soldering given in BS 2011, Test 2T - Method 1.
- 4.2.3.2.1.3. The length of lay of the strands shall not exceed 20 times the calculated diameter over the assembled conductor. The direction of lay of the strands shall be right-hand.
- 4.2.3.2.1.4. A joint in a solid conductor or in one of the individual wires of a stranded conductor shall be made in a skillful manner, shall be essentially smooth, and shall not have any sharp projections. The joints shall be done using machine brazing or welding of the conductor as a whole.
- 4.2.3.2.1.5. The colours of the two cables shall correspond with standard colours shown in IEC 60304:1982 with the following characteristics:
 - a) Spiral or ring markings shall be easily identifiable within every 15 mm length and shall be made by applying one or more ink stripes on a base colour or by direct extrusion.
 - b) Sequence of colour for each pair shall be in unique combinations and it shall not be possible to confuse them with the colors of the power cable pairs.

4.2.3.2.2. Insulation

The insulation material shall be PVC compound - type TI 1 as specified in KS 04-1022, KS 04-188 and BS 6746 and of thickness, overall diameter and colour as specified in Table 2. These properties shall remain sufficiently consistent during normal use.

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 COMMUNICATION CABLE**

Doc. No.	KP1/3CB/TSP/05/033
Issue No.	1
Revision No.	0
Date of Issue	2015-01-07
Page 7 of 16	

4.2.3.3. Non-hygroscopic string separators

Non-hygroscopic string separators shall be approximately the same as the diameter on the individual insulated communication cables. Conformity shall be checked through visual examination as per BS 7870-3.20: 2001 clause 14.3.

4.2.3.4. Application of the concentric layer

4.2.3.4.1. The concentric layer shall be applied with a right hand direction of lay. The wires forming the neutral-earth continuity conductor and the communication cable shall be applied helically in individual group over the insulation with a non-hygroscopic string separation.

4.2.3.4.2. Either one or two string hygroscopic string separation shall be located on either side of the group of neutral-earth continuity conductor to separate them from the group of insulated communication cables.

4.2.3.4.3. The length of the lay and the number of strings shall be such that the coverage of approximately 90% is achieved. Conformity shall be checked through visual examination as per BS 7870-3.20: 2001 clause 14.3.

4.2.3.5. Binders

One or more overlapped synthetic binder tape (s) shall be applied immediately over the concentric layer as per BS 7870-3.20: 2001 clause 7.

4.2.4. Over-sheath or Outer Jacket

4.2.4.1. The oversheath shall be an extruded layer of black PVC compound – type TM 1 as specified in KS 04-1022 and BS 6746. The oversheath shall be spark tested in accordance with KS 04-1022.

4.2.4.2. The minimum thickness of the oversheath shall not fall below the values on Table 2 of this specification by an amount more than (15% + 0.1mm).

4.2.4.3. The outer sheath insulation PVC compound shall be treated with anti-UV chemicals prior to shaping by injection moulding to prevent UV attack by sunlight.

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4.2.4.4. A non-metallic rip-cord shall be laid under the sheath. It shall provide an effective means of slitting the sheath longitudinally to facilitate removal. The rip cord shall incorporate the manufacturer's identification colours.

Table 1: Test requirements for insulation and overs-heath PVC compounds - BS 6746

Test	Test details	Requirements	
		TI 1	TM 1
Tensile properties	Min. tensile strength, N/mm ²	12.5	10.0
	Min. elongation, %	125	125
Low temperature bend test	Temperature at which specimen shall not crack, °C	-15±2	-15±2
Low temperature elongation test	Test temperature, °C	-15±2	-15±2
	Min. elongation, %	20	20
Low temperature impact test	Temperature at which specimen shall not crack, °C	-15±2	-15±2
Accelerated ageing for 7 days at 80±20C followed by tensile strength and elongation at break test and loss of mass test	Tensile strength after ageing	Min. value, N/mm ²	12.5
		Max. variation, %	20
	Elongation at break after ageing	Min. value, %	125
		Max. variation, %	20
Max. loss of mass after ageing, mg/cm ²	2.0	2.0	
Pressure test at high temperatures	Test temperature, °C	80±2	70±2
	Max. indentation, %	50	50
Resistance to cracking	Temperature at which specimen shall not crack, °C	150±2	150±2
Insulation resistance test	Min. K value at 700C, MΩ.Km	0.037	-

4.3. STANDARD SIZES AND CHARACTERISTICS

The characteristics of the cables shall comply with Table 2 and as per the requirement of clause 4 of BS 7870-3.20:2001.

Table 2: Characteristics (as per KS 04-1022, BS 6360 and BS 7870-3.20)

Property		Cable sizes			
Phase Conductor	Nominal area, mm ²	10	16	25	35
	Form of conductors	Circular/compacted circular stranded			
	No. & approx. dia. of wires, No./mm	7/1.35	7/1.70	7/2.14	7/2.52
	Min-Max. dia. of completed conductors, mm	*	4.6-5.2	5.6-6.5	6.6-7.6
	Nominal diameter of conductors, mm	4.05	5.10	6.42	7.56
	Minimum thickness of insulation mm	1.55	1.55	1.60	1.65
Concentric neutral	Approx. no. of wires	7	11	14	16

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Doc. No. KP1/3CB/TSP/05/033

Issue No. 1

Revision No. 0

Date of Issue 2015-01-07

Page 9 of 16

Property		Cable sizes			
conductors	Approx. diameter of wires, mm	1.50	1.50	1.50	1.50
Minimum lay lengths, mm		146.5	155	165	178
Thickness of over sheath, mm		1.4	1.4	1.5	1.6
Minimum thickness of over sheath at any point		1.09	1.09	1.17	1.20
Maximum conductor dc resistance per 1000m of cable at 20°C	Phase, Ω	3.08	1.15	1.20	0.868
	Neutral-earth, Ω	4.61	3.08	1.91	1.20
Maximum weight of the complete conductor excluding insulation		*	43.9	69.5	96.4
Power frequency withstand voltage, for 5mins, kVrms		3.5			
Insulation resistance at 500Vdc in 1min at 20°C., MΩ/Km		8	8	6	5

* Manufacturer to state the design value based on the sizes of conductors specified

Table 3: Characteristics of communication cable as per BS 4808-1 and BS 6360

Property	Cable sizes
Cross-sectional area, mm ²	1.0
Form of conductors	Circular stranded
Nominal diameter of stranded conductor	1.32
Maximum diameter of stranded conductor	1.4
No. & approximately diameter of wires, No./mm	7/0.44
Thickness of insulation	0.33
Maximum dc resistance at 20°C, Ω/Km	18.1
Insulation resistance measurement at 500Vdc in 1 min at 20 ± 5 °C., MΩ/Km	>50
Maximum temperature rating of each tin coated conductor, °C	150
Power frequency withstand voltage, for 5mins, kVrms	1.0

4.4. EMBOSSING ON CABLE

The cable shall be embossed with the following information throughout the length of the over-sheath.

- a) 600/1000 VOLTS PVC CABLE WITH 2-C COMMS CABLE - PROPERTY OF KPLC
- b) Year of manufacture
- c) Size of cable
- d) Name of manufacture
- e) Number of cores, type and nominal area of phase and communication conductors

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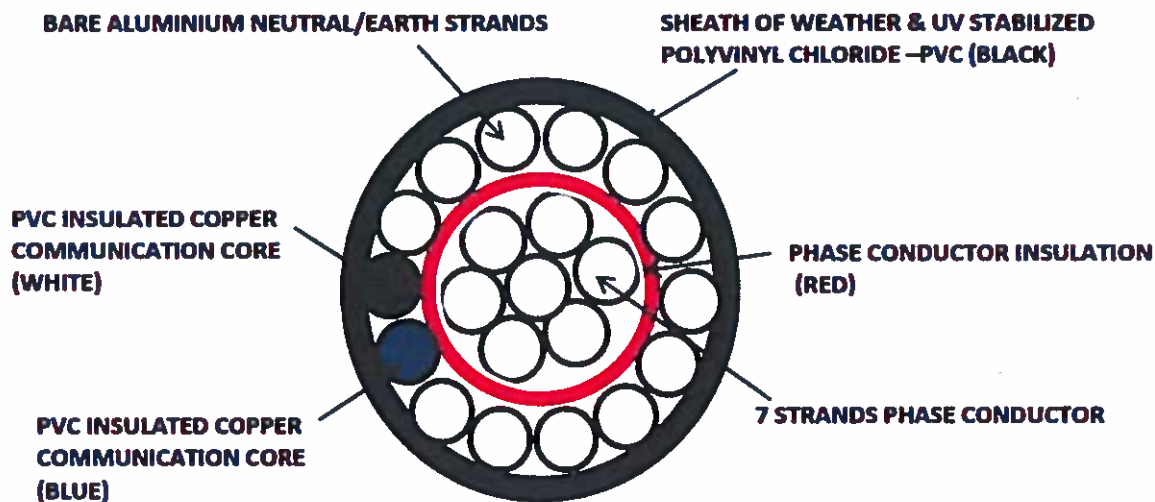
Date: 2015-01-07

(Example: "16 SQ MM 600/1000 VOLTS PVC AL CABLE WITH 2-C COMMS CABLE - PROPERTY OF KPLC' XXX)

'XXX' being the manufacturer's name

Letters and figures shall be raised and consist of upright block characters which shall be legible. Minimum size of characters shall be 3mm. The gap between the end of one inscription and the beginning of the next shall be not greater than 25mm and the gap between each complete set of markings shall be not greater than 500mm.

An indelible marking shall be given at every one meter interval to assist field personnel in cutting required length.



Note: This illustration is diagrammatic only and is not intended to illustrate the design.

Fig. 1: Typical construction- Concentric service cables with communication cores

4.5. QUALITY MANAGEMENT SYSTEM

4.5.1 The bidder shall submit a quality assurance plan (QAP) that will be used to ensure that the conductor design, material, workmanship, tests, service capability, maintenance and documentation, will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008.

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Doc. No.

KP1/3CB/TSP/05/033

Issue No.

1

Revision
No.

0

Date of
Issue

2015-01-07

Page 11 of 16

4.5.2 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.

4.5.3 The bidder shall indicate the delivery time of the conductors, manufacturer's monthly & annual production capacity and experience in the production of the type and size of conductor being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers for similar rating of conductors 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.

5. TESTS AND INSPECTION

5.1. The cable shall be inspected and tested in accordance with requirements of this specification and KS 04-1022, BS 7870-3.20, BS 4808-1, BS 6360, BS 6746 and the requirements of this specification. It shall be the responsibility of the supplier to perform or to have performed all the tests specified.

5.2. Copies of previous Test Reports confirming full conformance to clause 4 requirements for the cable issued by a **third party testing laboratory that is accredited to ISO/IEC 17025** shall be submitted with the tender for the purpose of technical evaluation. The accreditation certificate for the third party testing laboratory shall also be submitted with the tender (all in English Language).

5.3. Test Reports for the cable to be supplied under the contract shall be submitted to The Kenya Power & Lighting Company for approval before shipment/delivery and shall include all the tests in clause 4.2, 4.3 and 4.4 on the following:

- a) Insulation tests
- b) Neutral covering material
- c) Over-sheath
- d) Compatibility

5.4. The cable shall be subject to acceptance tests at the manufactures' works before dispatch. Acceptance tests (routine & sample tests) will be witnessed by two Engineers appointed by The Kenya Power and Lighting Company Limited (KPLC). Routine and sample test reports for the cable to be supplied shall be submitted to KPLC for approval before shipment of the goods. Tests to be witnessed by KPLC Engineers at the factory before shipment shall be in accordance with ISO 2023, ISO 37, ISO 5081, ISO 48, ISO 188, ISO 2781, IS 5557 and this specification and shall include:

- a) Phase conductor resistance
- b) Communication conductor resistance

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Doc. No.	KP1/3CB/TSP/05/033
Issue No.	1
Revision No.	0
Date of Issue	2015-01-07
Page 12 of 16	

- c) Voltage test on complete cable
- d) Spark test
- e) Phase communication, neutral and earth conductor material and construction
- f) Insulation - application, thickness, colour and durability of colour
- g) Concentric layers – material and construction.

5.5. Upon delivery of the cable, KPLC will inspect them and may perform or have performed any of the relevant tests in order to verify compliance with the specification. The supplier shall replace/rectify without extra or additional charge to KPLC, cables which upon examination, test or use fail to meet any of the requirements in the specification.

6. MARKING AND PACKING

6.1 The finished cable shall be wound in one continuous length on wooden drum such as to prevent damage during transportation and handling. The drums shall be made from treated timber resistant to termite attack and shall be lagged all round to prevent damage to the cable. There shall be no gaps in the wooden lagging around the drum.

6.2 Each drum shall contain only one continuous length of cable of 2500m in length. The actual length of cable shall not be less than the length indicated on the drum.

6.3 Both ends of the cable shall have been sealed to prevent ingress of water during transportation, storage, handling and installation. The sealing shall enclose the oversheath completely and shall be by close fitting plastic caps. Both ends of the cable shall be secured to the drum to prevent mechanical damage.

6.4 The following information shall be marked legibly and in 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 mm²
- d) The length of cable in metres
- e) The year of manufacture
- f) The gross mass and net mass in Kilograms
- g) The instructions for handling and use (in English language)
- h) The words "**PROPERTY OF THE KENYA POWER & LIGHTING CO.**"

Note: The cable shall have been marked in accordance with clause 4.4.

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Doc. No.

KP1/3CB/TSP/05/033

Issue No.

1

**Revision
No.**

0

**Date of
Issue**

2015-01-07

Page 13 of 16

7. DOCUMENTATION




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

- a) Guaranteed Technical Particulars fully filled and signed by the manufacturer;
- b) Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
- c) Sales records and customer reference letters;
- d) Details of manufacturing capacity and the manufacturer's experience;
- e) Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
- f) Copy of accreditation certificate to ISO/IEC 17025 for the testing laboratory.
- g) Manufacturer's warranty and guarantee
- h) Manufacturer's letter of authorization, copy of the manufacturer's ISO 9001:2008/ KEBS Diamond mark certificate and other technical documents required in the tender.

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

- a) Guaranteed Technical Particulars,
- b) Design Drawings and construction details of the cable,
- c) Quality assurance plan (QAP) that will be used to ensure that the cable design, material, workmanship, tests, service capability, maintenance and documentation will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008
- d) Detailed test program to be used during factory testing,
- e) Marking details and method to be used in marking the cable,
- f) 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 cables for The Kenya Power & Lighting Company
- g) Packaging details (including packaging materials, lagging and length on drum).

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

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Doc. No.	KP1/3CB/TSP/05/033
Issue No.	1
Revision No.	0
Date of Issue	2015-01-07
Page 14 of 16	

ANNEX A: Guaranteed Technical Particulars (to be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records, four customer reference letters, the manufacturer's experience and copies of complete type test reports for tender evaluation, all in English Language)

Tender No.

Clause number	KPLC requirement		Bidder's offer
Manufacturer's Name and address			specify
Country of Manufacture			specify
Bidder's Name and address			specify
1.	Scope		specify
1.1-1.3			
2.	Applicable Standards		specify
3.	Terms & Definitions		specify
4.	REQUIREMENTS		specify
4.1	Service Conditions		specify
4.2	Materials & Construction		specify
4.2.1	General requirements	BS 7870-3.20: 2001 and Kenya Standard KS 04-1022	specify
4.2.2	Phase conductor (Material & construction)		
4.2.2.1	Typical construction	Material Direction of lay	specify
4.2.2.2	Insulation	As per KS 04-1022, KS 04-188 and BS 6746	specify
4.2.2.3	Thickness of insulation	As per KS 04-1022	specify
4.2.3	Concentric layer		specify
4.2.3.1	Neutral- earth conductor (Material & construction)		
	Material	Plain annealed aluminum	Specify
	Cover material	Polymeric compound	
	Properties of cover material	Tensile strength	4 N/mm ²
		Elongation, %	50
4.2.3.2	Communication cable		
4.2.3.2.1	Construction		specify
4.2.3.2.1.1			specify
4.2.3.2.1.2	Material	As per BS 6360 and BS 2011, Test 2T, Method 1	specify
4.2.3.2.1.3		Length of lay	specify

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Issue No.	1
Revision No.	0
Date of Issue	2015-01-07
Page 15 of 16	

Clause number	KPLC requirement		Bidder's offer
		Direction of lay of the strand	
4.2.3.2.1.4	Joints	Shall be essentially smooth, and shall not have any sharp projections	specify
4.2.3.2.1.5	Colours	Correspond with standard colours shown in IEC 60304:1982	specify
4.2.3.2.2	Insulation		
	Material	PVC compound - type TI 1 as specified in KS 04-1022, KS 04-188 and BS 6746	specify
	Dimensions	As per table 2	
4.2.3.3	Non hygroscopic string separation		specify
4.2.3.4	Application of concentric layer		
	Lay direction	Right hand lay	specify
	Composition	Neutral & earth conductor and communication cable	specify
	Application	Applied together with string separation	specify
	Coverage	90 %	specify
4.2.3.5	Binders	Synthetic binders tape	specify
4.2.4	Over-sheath or Outer Jacket		
4.2.4.1	Material	As per KS 04-1022 and BS 6746	Prove compliance
	Oversheath testing	In accordance with KS 04-1022	
4.2.4.2	Minimum thickness	Shall not fall below the values on Table 2 by > (15% + 0.1mm).	Prove compliance
4.2.4.3	Non-metallic rip-cord	Shall be laid under the sheath Shall incorporate the manufacturer's identification colour.	specify
4.3	Standard sizes and characteristics	As per table 2, Table 3 and as per the requirement of clause 4 of BS 7870-3.20:2001.	Prove compliance
4.4	Embossing on cable Oversheath (parameters to be indicated and method of marking)		specify
4.5	Quality Management System		Provide
	Quality Assurance Plan		Provide
	Copy of ISO 9001:2008 Certificate		Provide
	Manufacturer's experience		Provide
	Manufacturing Capacity (units per month)		Provide
	List of previous customers		Provide
	Customer reference letters		Provide
5.1	Test standards and responsibility of carrying out tests		Provide

Issued by: Head of Section, Standards Development

Authorized by: Head of Department, Standards

Signed:

Signed:

Date: 2015-01-07

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TITLE:
**SPECIFICATION FOR PVC
INSULATED SINGLE PHASE
CONCENTRIC ALUMINIUM CABLES
WITH 2-CORE COPPER
COMMUNICATION CABLE**

Doc. No.	KP1/3CB/TSP/05/033
Issue No.	1
Revision No.	0
Date of Issue	2015-01-07
Page 16 of 16	

Clause number	KPLC requirement	Bidder's offer
5.2	Copies of Type Test Reports submitted with tender	Provide
5.3	Acceptance tests to be witnessed by KPLC at factory before shipment	Provide
5.4	Test reports to be submitted by supplier to KPLC for approval before shipment	Provide
5.5	Replacement of rejected cables	Provide
6.1	Markings	Provide
6.2	Packing	Provide
7.1	Documents submitted with tender	Provide
7.2	Documents to be submitted by supplier to KPLC for approval before manufacture	Provide
8.0	Statement of compliance to specification	Provide

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

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Signed: 	Signed: 
Date: 2015-01-07	Date: 2015-01-07