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0.1 Circulation List

COPY NO.	COPY HOLDER
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2	Procurement Manager
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0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
Issue 4 Rev 0	2013-04-30	Cancels and replaces 3rd Issue Rev 2 dated 2003-07-02	S. Kimitei	G. Owuor

FOREWORD

This specification has been prepared by the Research and Development Department of The Kenya Power and Lighting Company Limited (KPLC) and it lays down requirements for **Aluminium 4-core, PVC insulated, steel wire armoured cables**. It is intended for use by KPLC in purchasing the cables.

1. SCOPE

1.1 This specification is for four core, stranded and compacted circular aluminium conductors, PVC insulated, galvanized steel wire armoured, PVC outer sheathed power cables for operation at a.c. voltages of 600 Volts to sheath, 1000 Volts between conductors and highest system voltage of 1200 Volts for use in KPLC distribution network.

1.2 This specification covers the following cable sizes:

4 x 25 mm² AL/PVC/SWA/PVC
4 x 70 mm² AL/PVC/SWA/PVC
4 x 120 mm² AL/PVC/SWA/PVC
4 x 185 mm² AL/PVC/SWA/PVC
4 x 300 mm² AL/PVC/SWA/PVC

1.3 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.

The specification stipulates the minimum requirements for Aluminum 4-core PVC insulated, steel wire armoured cables acceptable for use in the company and it shall be the responsibility of the supplier to ensure adequacy of the design, good engineering practice, adherence to the specification, applicable standards and applicable regulations as well as ensuring good workmanship in the manufacture of the cables for The Kenya Power & Lighting Company.

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.

BS 6346:	600/1000V and 1900/3300V armoured electric cables having PVC insulation;
IEC 60502-1:	Power cables with extruded insulation and their accessories for rated voltages from 1kV (Um=1.2kV) up to 30kV (Um=36kV) - Part 1: Cables for rated voltages from 1kV (Um=1.2kV) up to 3kV (Um=3.6kV);
IEC 60228:	Conductors for insulated cables;
IEC 60811-1-1:	Common test methods for insulating and sheathing materials of electric cables:– Part 1: Methods for general application; Section 1: Measurements of thickness and overall dimensions – Tests for determining the mechanical properties;
KS 04-187:	Specification for conductors of insulated cables.

3. TERMS AND DEFINITIONS

For the purpose of this specification the definitions given in BS 6346, IEC 60228, IEC 60502-1 and KS 04-187 apply, together with the following:

Al:	Aluminium
PVC:	Polyvinyl Chloride
SWA:	Steel Wire Armour

4. REQUIREMENTS

4.1 SERVICE AND SYSTEM CONDITIONS

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 upto 90% and saline conditions along the coast).

b) The cable shall be suitable for laying in cable ducts and in the ground in power stations and customer installations.
c) The cable shall also be suitable for laying on slopes.
d) Permissible continuous loading operating temperature shall be 70°C.

4.1.2 Operating Voltage

The rated operating voltage (U_o/U), required by this specification is 600/1000 V at 50Hz a.c.

4.2. CABLE CONSTRUCTION

4.2.1. Design

4.2.1.1 The cable shall be designed and manufactured in accordance with requirements of IEC 60228 and IEC 60502-1 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 70°C and short circuit temperature of 160°C (5 seconds max duration) as per IEC 60502-1.

4.2.2. Conductors

The cable shall be made from stranded circular compact plain aluminium conductors, class 2 in accordance with IEC 60228 and KS 04-187, and as specified in the table 1 in clause 4.3 of this specification.

4.2.3. Insulation

4.2.3.1 Material

The insulation shall be extruded dielectric of type PVC/A in accordance with the requirements of IEC 60502-1.

The insulation shall be applied by extrusion to form a compact and homogeneous layer.

4.2.3.2 Insulation Thickness

The average thickness of insulation when determined in accordance with IEC 60811-1-1, shall not be less than the nominal values given in table 1 of clause 4.3 as appropriate, and the smallest of the measured values shall not fall below the nominal value by more than (10%+0.1mm).

4.2.3.3 Identification of Cores

Cores shall be identified by colouring throughout the insulation material. Colours of the cores shall be in the following sequence:– Red, Yellow, Blue and Black.

Black colour shall be used only for Neutral.

4.2.4. Laying up

Cores shall be laid up with a right hand direction of lay. Non-hygroscopic fillers shall be applied integrally with the bedding of armoured cable to form a compact and circular cable.

A plastic binder tape shall be applied over the laid up cores of the cable.

There shall be no adhesion between the bedding of armoured cable or the sheath and insulation. Where the bedding or sheath is applied integrally with fillers, it shall be possible to strip it from the cable without damaging the insulation.

4.2.5. Bedding

4.2.5.1 Material

Bedding of four core cables shall comprise of extruded layers of polymeric material compatible with the underlying insulation and suitable for use at the operating temperatures of the cable.

The bedding shall not adhere to the underlying cores.

4.2.5.2 Bedding Thickness

The average thickness of the bedding, when determined in accordance with IEC 60811-1-1 shall not be less than the nominal value given in table 1 of clause 4.3 as

appropriate and the smallest of the measured values shall not fall below the nominal value by more than (20%+0.2mm).

4.2.6. Armour

4.2.6.1 General

Armour for the four core cable shall comprise a single layer of circular galvanized steel wires. The armour wires shall be applied helically with a left hand lay and shall fully comply with the requirements of BS 6346 and IEC 60502-1.

4.2.6.2 Wire diameter

The nominal diameter of the wires shall be as specified in clause 4.3 table 1.

4.2.6.3 Electrical Resistance

When measured and corrected to 20^0 C, the electrical resistance of the armour of the completed cable shall not exceed the appropriate value given in clause 4.3 table 1.

4.2.7. Outer Sheath

4.2.7.1 General

The outer sheath of the cable shall comprise an extruded layer of BLACK PVC in accordance with the requirements of BS 6346. The PVC shall be of type ST1 with maximum conductor temperatures in normal operations of 80^0C as per the requirements of IEC 60502-1.

4.2.7.2 Thickness

The average thickness of the outer sheath, when determined in accordance with IEC 60811-1-1, shall be not less than the nominal value given in table 1 of clause 4.3 as appropriate and the smallest of the measured values shall not fall below the nominal value by more than (20%+0.2mm).

4.2.7.3 Marking

The external surface of the cable shall be legibly embossed with the following information on two lines running parallel to the length of the cable, approximately equally spaced around the circumference of the cable.

Electric Cable 600/1000 V Manufacturers Name Description of Cable **PROPERTY OF KPLC**

For example, for 4-core, 25mm^2, PVC insulated cable manufactured by manufacturer XYZ, the legend would read as follows: Electric Cable 600/1000V XYZ 4x25mm^2 AL PVC/SWA/PVC **PROPERTY OF KPLC**
Note: The bedding material is not included in the PVC/SWA/PVC naming convention.

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. In addition, each cable shall be sequentially marked by indelible printing, indenting or other suitable means, at 1m intervals, to indicate the approximate length of cable remaining on the drum. The numbers shall start with 001, 1m from the inner end of cable and continue every metre to the outer end.

4.3. STANDARD SIZES AND CHARACTERISTICS

Table 1: Mechanical and Electrical characteristics of standard sizes of PVC cables

Conductor nominal sectional area	mm^2	25	70	120	185	300
Number of cores		4	4	4	4	4
Voltage Designation Uo/U (Um)		600/1000 (1200) V				
Conductor shape		Stranded shaped compacted				
Nominal insulation thickness	mm	1.2	1.4	1.6	2.0	2.4
Bedding thickness	mm	1.0	1.2	1.4	1.6	1.6
Average outer sheath thickness	mm	1.8	2.1	2.4	2.6	3.0
Armour wire diameter	mm	1.6	2.0	2.5	2.5	2.5
Armour wire resistance at 20^{0}C	Ω/km	2.1	1.2	0.71	0.59	0.47
Minimum number of wires in the conductor	no	6	12	15	30	30
Minimum diameter of the conductors	mm	5.6	9.3	12.3	15.3	19.7
Maximum diameter of the conductors	mm	6.5	10.2	13.5	16.8	21.6
Outer diameter of cable	mm	27.8	39.2	49.3	59	72
Maximum conductor resistance at 20^{0}C	Ω/km	1.2	0.443	0.253	0.164	0.100
Minimum insulation resistance of cable for 1000m at 20^{0}C	MΩ	10	10	10	10	10
Approximate weight of cable	Kg/Km	1440	2830	4650	6440	9240
Approximate length of cable on drum	m	3000	2000	1000	750	500

Note:

The Current Carrying Capacity of the cable underground, in ducts and in air shall be stated by the manufacturer in the Guaranteed Technical Particulars as per Annex A

Table 2: Mechanical characteristics of Insulating and Sheathing compounds (before and after ageing)

Designation of compound	Unit	PVC/A	ST1
Maximum conductor temperature in normal operation	^{0}C	70	80
Without ageing (IEC 60811-1-2, sub clause 9.1)			
Tensile strength, minimum	N/mm^2	12.5	12.5
Elongation-at-break, minimum	%	150	150
After ageing in air oven IEC 60811-1-2, sub clause 8.1 After ageing without conductor			
Treatment			
➢ Temperature	^{0}C	100	100
➢ Tolerance	^{0}C	±2	±2
➢ Duration	h	168	168
Tensile strength			
➢ Value after ageing, minimum	N/mm^2	12.5	12.5
➢ Variation, maximum	%	±25	±25
Elongation-at-break			
➢ Value after ageing, minimum	%	150	150
➢ Variation, maximum	%	±25	±25

5. TESTS AND INSPECTION

5.1 The cable shall be inspected and tested in accordance with the requirements of this specification, BS 6346, IEC 60811-1-1 and IEC 60502-1. It shall be the responsibility of the supplier to perform or to have performed the tests specified and whatever other tests he normally performs at works.

5.2 Copies of previous Type Tests Reports 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 to ISO/IEC 17025 for the same third party testing laboratory used shall also be submitted with the tender (all in English Language)

5.2.1 Copies of type test reports to be submitted with the tender (by bidder) for evaluation shall include the following:

5.2.1.1 Electrical Type Tests

a) Insulation resistance measurement at ambient temperature tests.
b) Insulation resistance measurement at maximum conductor temperature test.
c) Voltage test for 4h.
d) Impulse test for completed cable.

5.2.1.2 Non Electrical Type Tests

5.2.1.2.1 Mechanical strength tests for PVC/A insulation and ST1 over sheath.

a) Tensile strength and elongation-at-break tests: without ageing; after ageing in an air, oven and after ageing of pieces of complete cable.

5.2.1.2.2 Thermoplastic properties of insulation and over sheath.

a) Hot pressure tests (indentation) test.
b) Behavior at low temperatures tests.

5.2.1.2.3 Heat shock tests
5.2.1.2.4 Water absorption tests

5.2.2 Routine and sample test reports for the cables to be supplied shall be submitted to KPLC for approval before shipment/delivery of the goods. KPLC Engineers will witness tests at the factory before shipment.

5.2.3 Tests to be witnessed by KPLC Engineers at the factory before shipment shall be in accordance with BS 6346, IEC 60228, IEC 60502-1, this specification and shall include the following:

5.2.3.1 Routine Tests

a) Spark test on cores.
b) Spark test on over sheath of armoured cables.
c) Voltage test on completed cables.
d) Insulation resistance tests.

e) Conductor resistance tests.
f) Armour resistance tests.

5.2.3.2 Sample Tests

a) Measurement of insulation thickness
b) Measurement of extruded bedding and over sheath thickness
c) Conductor examination – physical tests and check of dimensions

6. SEALING, PACKING AND MARKING

6.1 Sealing

Before dispatch, the ends of the cable shall be sealed with closing fitting PVC end caps to prevent the ingress of water during transportation and storage.

The sealing shall enclose the oversheath completely.

6.2 Packing

Cables shall be wound on to non-returnable wooden drums, close battened to prevent damage during transportation or storage. The wood shall be treated to resist biological attacks. The drums shall have wooden lagging all round, with no gaps.

Each drum shall contain only one continuous length of cable which shall be of the length indicated in table 1, clause 4.3 above in length. The actual length of cable shall not be less than the length indicated on the drum

Both ends of the cable shall be secured to the drum to prevent mechanical damage

6.3 Marking

6.3.1 Each drum shall be legibly and indelibly marked with the following information on the flange:

a) The manufacturer's trade name;
b) The year of manufacture.
c) The rated voltage of the cable, 600/1000 (1200) V
d) The type of cable. For example AL 4 core PVC/SWA/PVC;
e) The conductor cross-sectional areas in mm²;

f) The length of the cable, in metres;
g) The identifying serial number;
h) The words "NOT TO BE LAID FLAT" or a suitable pictogram;
i) An arrow and words, "ROLL THIS WAY", on each flange of the drum to indicate in which direction the drum shall be rolled in order to prevent the cable from unwinding.
j) A capital letter "T" approximately 50mm high surrounded by a circle with an approximate outside diameter of 65mm, if the wood has been treated to resist biological attack.
k) The gross mass of the drum and net mass cable, in kilogram;
l) The words "PROPERTY OF THE KENYA POWER & LIGHTING CO."

6.3.2 The following information shall be printed on a suitable label. This label shall be firmly attached to one of the flanges of the drum:

a) The year of manufacture;
b) The rated voltage of the cable 600/1000 V;
c) The type of cable. For example 4-core PVC/SWA/PVC;
d) The conductor size in mm^2;
e) The length of the drum in metres;
f) The gross mass of the cable and drum in Kg.
g) An identifying serial number;
h) The purchasers name. For example, "**PROPERTY OF KENYA POWER & LIGHTING CO.**"
i) The order number;
j) Any other contract particulars.

***Note**: The cable shall have been marked in accordance with clause 4.2.7.3*

7. DOCUMENTATION

7.1 The bidder shall submit its tender complete with technical documents required by Annex A (Guaranteed Technical Particulars) for tender evaluation.

a) Guaranteed Technical Particulars;
b) Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
c) Sales records for the last five years and at least four 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; the Type Test Reports shall not be more than five years old.

f) Copy of accreditation certificate for the testing laboratory.

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.
d) Test Program to be used after manufacture,
e) Marking details and method to be used in marking the cables,
f) Manufacturer's undertaking to ensure adequacy of the design, good workmanship, good engineering practice and adherence to applicable standards in the manufacture of the cables for KPLC,
g) Packaging details (including packaging materials, lagging and length on drum).

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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, details of manufacturing capacity, the manufacturer's experience and copies of complete type test certificates and type test reports for tender evaluation, all in English Language)*

Table 3: Guaranteed Technical Particulars.

1	2		3	4
Item	Description	Units	Schedule 1 (KPLC)	Schedule 2 (Tenderer)
1	Manufacturer		Specify	
2	Country of manufacture		Specify	
3	Name and address of Bidder		Specify	
4	Service conditions			
	a) Cable application		Specify	
	b) Operating voltage	V	Specify	
5	Cable construction			
	a) Design			
	• Standards applicable		Specify	
	• Materials characteristics		Specify	
	b) Conductors types	mm^2	25, 70, 120, 185, 300	
	c) Insulation			
	• Materials		PVC/A	
	• Insulation thickness	mm	Specify	
	• Identification of cores	no	Specify	
	d) Laying up		Specify	
	e) Bedding			
	• Bedding material		Specify	
	• Bedding thickness	m	Specify	
	f) Armour			
	• Armour material		Galvanized steel	
	• Armour wire diameter	mm	Specify	
	• Armour wire electrical resistance at 20°C	Ω/km	Specify	
	g) Outer sheath			

	• Outer sheath material		PVC type ST1	
	• Thickness	mm	Specify	
	• Marking		Specify	
6	Standards and Characteristics			
	a) Conductor nominal x-sectional area	mm^2	Specify	
	b) Number of cores	no	Specify	
	c) Voltage designation $U_o/U(U_m)$	V	Specify	
	d) Conductor shape		Specify	
	e) Nominal insulation thickness	mm	Specify	
	f) Inner sheath thickness	mm	Specify	
	g) Average sheath thickness	m	Specify	
	h) Armour wire thickness	mm	Specify	
	i) Number of wires in the conductor	no	Specify	
	j) Average diameter of the conductors	mm	Specify	
	k) Outer diameter of conductors	mm	Specify	
	l) Maximum conductor resistance at 20^0C	Ω	Specify	
	m) Minimum insulation resistance of cable for 1000m at 20^0C	MΩ	Specify	
	n) Approximate weight of cable	Kg	Specify	
	o) Approximate length of cable on drum	m	Specify	
	p) Current carrying capacity			
	• air	A	Specify	
	• duct	A	Specify	
	• underground	A	Specify	
	q) Power frequency withstand voltage	V	Specify	
7	Copies of type test reports to be submitted with tender for evaluation		As per clauses 5.2.1.1 and 5.2.1.2	
8	List of Tests to be witnessed by KPLC Engineers at the factory before shipment		As per clauses 5.2.3.1 and 5.2.3.2	
9	Embossing of the cable over sheath (parameters to be indicated and method of marking)		Specify	
10	Marking of cable drum (parameters to be indicated and method of marking)		Specify	
11	Packing (treated wooden drum and lagging)		Specify	

12	**Length of cable on the drum (shall be in one continuous length)**		Specify	
13	**Installation and technical manuals to be provided during delivery**		Specify	
14	**List of catalogues, brochures, drawings, technical data and customer sales records submitted to support the offer.**		Specify	
15	**Statement of compliance to tender specifications**		Specify	
16	**Deviations from tender specifications**		Specify	
17	**Inspection/Tests by KPLC during delivery before acceptance to stores/site.**		Specify	

NB: - *This schedule does not in any way substitute for detailed information required elsewhere in the specification.*

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Manufacturer's Name, Signature, Stamp and Date