



Kenya Power

TITLE:
**SPECIFICATION FOR CABLE
TERMINATION AND JOINTING
KITS**
Part 2: 66kV Single Core XLPE
Insulated Copper Cable

Doc. No.	KP1/3CB/TSP/05/026-2
Issue No.	1
Revision No.	0
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(to be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, installation instructions, sales records, four customer reference letters, details of manufacturing capacity, the manufacturer's experience, copies of complete type test reports and accreditation certificate to ISO/IEC 17025 for the testing laboratory for tender evaluation, all in English Language)

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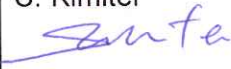
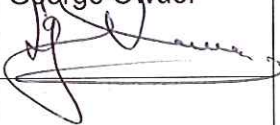
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0.1 Circulation List

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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 1 Rev 0	2014-03-03	New Issue	S. Kimitei 	George Owuor 

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FOREWORD

This specification has been prepared by the Research and Development Department in collaboration with Common Services Department both of The Kenya Power and Lighting Company Limited (abbreviated as KPLC) and it lays down requirements for cable accessories (pre-molded joints and termination kits) for 66kV single core XLPE insulated copper cable (with corrugated aluminium metallic sheath). It is intended for use by KPLC in purchasing the items.

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

1. SCOPE

This specification is for cable joints and termination kits for single core XLPE insulated copper cables (with corrugated aluminium metallic sheath) 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 cable 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 cable accessories acceptable for use in the company and it shall be the responsibility of the Supplier to ensure adequacy of the design, good workmanship, adherence to standards and the specification as well as ensuring good engineering practice in the manufacture of the cable accessories 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 60815: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.

IEEE 48: Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV

IEC 61238-1: Compression and mechanical connectors for power cables for rated voltages up to 30 kV ($U_m = 36$ kV) –Part 1: Test methods and requirements

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 Application

- The cable accessories shall be suitable for use in outdoors installations and tropical conditions with a temperature range of -1°C to $+40^{\circ}\text{C}$ and humidity of up to 90%.
- The cable shall be laid in cable ducts and directly in the ground in switching stations, between stations and along sub-transmission lines.
- Permissible continuous loading operating temperature shall be 90°C .
- Permissible emergency loading temperature shall be 130°C for at least 8 hours.
- Permissible short circuit temperature shall be 250°C (for short-circuit duration of 5s as per IEC 60840).

4.1.2 The cable and cable accessories 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 accessories (termination and jointing kits) shall be designed and manufactured to IEC 60840, IEEE 48 and the requirements of this specification.

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- 4.2.1.2 All materials used shall be compatible and suitable for the continuous operating temperature of the cable of 90°C and short circuit temperature of 250°C (5 seconds duration).
- 4.2.1.3 The cable accessories shall be suitable for 66kV single core XLPE insulated copper cable that has corrugated aluminum metallic sheath.
- 4.2.1.4 Silicone rubber with an excellent adhesive property between insulation and conductive material shall be used for the manufacture of the joints and termination kits.
- 4.2.1.5 The test requirements for complete cable joint and termination kits shall be as per Table 1.

Table 1: Technical requirements for test of 66kV cable joints and terminations as per IEEE 48.

No.	Item	Technical data for 66 kV accessories
1	Nominal voltage, U	66 kV
2	Max. service voltage, Um	72.5 kV
3	Power frequency voltage withstand test	120kV/30 min, No breakdown, No flashover.
4	Room temperature partial discharge test	Test voltage 72kV, Partial discharge < 5pC
5	Thermal cycle test	96 kV heating for 8 hours, cooling for 16 hours, Conductor's temperature is 95~100 °C (20 cycles)
6	Under the high temperature partial discharge test	72 kV, 95~100 °C, Partial discharge < 5 pC
7	Lightning impulse voltage test	450 kV positive and negative polarities each 10 times, No breakdown, No flashover.
8	After test of impulse voltage withstand voltage test	120 kV/15min, No breakdown, No flashover
9	Outdoor joint/termination short-term power frequency voltage test	Rain status, 120 kV, 1min, No flashover, No breakdown.
10	Short circuit current for 3 seconds.	25 kA
11	Outdoor joint/termination radio interference test	61kV generated 1MHz interference voltage shall not be greater than 450 μV
12	Pressure leak test	No gas shall escape at 0.2 MPa for 1 hour

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4.2.2. Cable Jointing Kits

- 4.2.2.1 The cable jointing kits shall be straight through, pre-moulded/pre-fabricated type.
- 4.2.2.2 They shall be suitable for connecting the cables specified in clause 4.3, Table 2 and the design requirements for each joint shall be:
- A high current connection between conductors,
 - A joint insulation which meets the same performance standards as the cable as specified in IEC 60840 and IEEE 48 standards.
 - A high current connection to permit the flow of short circuit current between the two cable sheaths or screen wires,
 - A screen connection electrically insulated from earth potential to match the insulating integrity of the cable over-sheath,
 - A protection of the joint and cable insulation against the ingress of water,
 - A protection against corrosion of the joint metal work, flame retardant protection, anti-termite protection, etc.
- 4.2.2.3 Each cable jointing kit shall contain the following:
- Separate stress control tubing for smoothing the electrical field over the cable screen ends.
 - Stress control tubing for smoothing the electrical field over the connector. This should be moulded together with the insulation and screen tubing used for insulation and insulation screen on the outer layer.
 - Metallic shielding (copper mesh) for continuing the correct shield across the joint area and making electrical contact with insulation screen.
 - Outer shielding heat shrink/cold shrink outer sleeve forming a barrier against moisture and corrosion.
 - Mechanical joint connector with stepless shear bolts that stretches axially and breaks off immediately the shear torque is achieved. Its contact technology shall be type-tested electrically and mechanically to IEC 61238-1.
 - Earth braids and connectors.
 - Push on devices to be used in installation of pre-moulded tubes if necessary
 - Heat shrinkable cable caps for sealing off moisture on cut cables. The cable caps shall shrink when heated and tightly fit the cable.
- 4.2.2.4 The joints shall be designed and manufactured to ensure that all components and materials shall be suitable for use in the service conditions specified.

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- 4.2.2.5 The complete components and materials shall be free from defects, which would likely cause them to be unsatisfactory in service.
- 4.2.2.6 The components and materials shall be manufactured to ensure high moisture sealing capacity, resistance to fungal and insect attack.

4.2.3. Outdoor cable terminations

The terminations required in this specification shall have the following characteristics:

- Shall be of heat/cold shrinkable silicon rubber based and suitable for use in terminating XLPE cables with stranded compacted round copper conductors.
 - Shall have a stress control tubing component with proper electrical stress control at the operating voltage over the insulated cable cores at the termination.
 - Shall have anti-tracking tubing with resistance to tracking and erosion of the material.
 - Shall be designed and manufactured to ensure that all components and materials are suitable for use in the specified service conditions.
 - 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.
 - Outdoor terminations shall be of specific creepage distance of 31 mm/kV, pollution level IV conforming and tested to IEC 60815 and shall be provided with sheds for creepage extension.
- 4.2.4. Specialized tools that are required during the terminating and jointing processes shall be stated at tendering stage and the costs shall be quoted separately for both the joints and the terminations for purposes of tender evaluation.
- 4.2.5. The supplier shall provide the installation procedures and instructions for the pre-moulded straight through joints and heat/cold shrinkable termination kits to be used as accessories of the cable specified in clause 4.3.

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4.3. SIZES AND CHARACTERISTICS OF THE CABLES

The cable terminations and jointing kits specified shall be suitable for cables of sizes and technical characteristics as per Table 2, with approximated cable dimensions as per Table 3 and Table 4.

Table 2: Sizes and technical characteristics of the 66kV cables as per IEC 60840

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

Table 3: Characteristics of Copper Conductor / XLPE Insulation / Aluminium Sheath / PVC (PE) Outer Sheath

Nominal Area (mm ²)	Conductor diameter (mm)	Diameter over XLPE insulation (mm)	Diameter over insulation screen (mm)	Diameter over Aluminium sheath (mm)	Diameter over PE outer sheath (mm)
185	15.5	43	46	60	64
300	21.5	49	53	65	70
400	23.5	52	56	66	76

Table 4: Construction of Copper Conductor / XLPE Insulation / Aluminium Sheath / PVC (PE) Outer Sheath

Conductor		Approx. Thickness of Conductor Shield (mm)	Thickness of Insulation (mm)	Approx. Thickness of Insulation Shield (mm)	Thickness of Aluminium Sheath (mm)	Thickness of Jacket (mm)	Approx. Weight (kg/m)
Nominal Area (mm ²)	Shape						
185	C.C*	1.0	12.0	1.5	2.3	3.5	5.2
300	C.C*	1.0	12.0	1.5	2.5	4.5	7.0
400	C.C*	1.0	12.0	1.5	2.7	6	8.1

* - Circular Compacted.

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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 accessories 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.
- 4.4.2. The Manufacturer's Declaration of Conformity to reference standards and a copy of their quality management system certificate to ISO 9001: 2008 shall be submitted with the tender for evaluation.
- 4.4.3. The bidder shall indicate the delivery time of the cable termination and jointing kits, manufacturer's monthly & annual production capacity and experience in the production of the type and size of cable accessories 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 size of cable accessories sold in the last five years including 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 termination and jointing kits shall be inspected and tested in accordance with the requirements of this specification and IEC 60840, IEC 60815 and IEEE 48 standards. It shall be the responsibility of the manufacturer to perform or to have performed all the relevant tests.
- 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).

Copies of Type Test Reports to IEC 60840, IEC 60815 and IEEE 48 to be submitted with the tender for evaluation shall include the following:

- a) Thermal cycle voltage test;
- b) Partial discharge tests
 - At ambient temperature, and
 - At high temperature.

The tests shall be carried out after the final cycle of item a) above or, alternatively, after the lightning impulse voltage test in item d) below;

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- c) Lightning impulse voltage test followed by a power frequency voltage test;
- d) Partial discharge tests, if not previously carried out in item c) above;
- e) Tests of outer protection for buried joints;
- f) Pressure leakage tests.
- g) Radio interference tests.
- h) Adhesive tests on the silicone rubber.

Test voltages shall be in accordance with this specification, IEC 60840 and IEEE 48.

5.3 Range of type approval as per IEC 60840, IEC 60815 and IEEE 48

When type tests have been successfully performed on one or more accessories with one or more cable(s) of specific cross-section(s), and of the same rated voltage and construction, the type approval shall be considered as valid for accessories within the scope of this specification with other rated voltages, constructions and with other cables, provided that all the following conditions are met:

- (i) The voltage group is not higher than that of the tested accessory (ies);

NOTE: In this context, accessories of the same rated voltage group are those of rated voltages having a common value of U_m , highest voltage for equipment, and the same test voltage levels. For example, tests on an accessory of rated voltage $U = 66 \text{ kV}$ would also cover accessories of rated voltages $U = 60 \text{ kV}$ and $U = 69 \text{ kV}$.

- (ii) The cable with another conductor cross-section, rated voltage and construction is within the range of type approval as per IEC 60840 and IEEE 48. When the calculated nominal electrical stress at the cable insulation screen does not exceed 2.5 kV/mm , the type approval shall be considered as valid for accessories on all cables in this range.

- (iii) The accessories have the same or a similar construction as that of the tested accessory (ies).

NOTE: Accessories of similar construction are those of the same type and manufacturing process of insulation and semi-conducting screens.

- (iv) The calculated nominal electrical stresses within the main insulation parts of the accessory and at the cable and accessory interfaces do not exceed those of the tested accessory (ies).

A type test certificate signed by the representative of a competent witnessing body, or a type test certificate issued by an independent test laboratory accredited to ISO/IEC 17025 shall be acceptable as evidence of type testing.

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5.4 Routine and sample test reports to this specification, IEC 60840, IEC 60815 and IEEE 48 for the cable accessories manufactured for KPLC shall be submitted by the supplier to KPLC for approval before shipment of the goods.

KPLC Engineers (2) will witness routine tests and the following sample tests as per this specification, IEC 60840, IEC 60815 and IEEE 48 at the factory before shipment:

a) Tests on components:

The characteristics of each component shall be verified in accordance with the specifications of the accessories manufacturer through tests. The manufacturer of a given accessory shall provide a list of the tests to be performed on each component, indicating the frequency of each test. The components shall be inspected against their drawings. There shall be no deviations outside the declared tolerances.

b) Tests on complete accessory:

The following electrical tests shall be carried out as per this specification, IEC 60840, IEC 60815 and IEEE 48 and by the manufacturer on a fully assembled accessory:

- (i) Partial discharge tests
 - At ambient temperature
 - At high temperatures;
- (ii) Voltage tests - Power frequency tests
- (iii) Pressure leak test
- (iv) Examination of the accessories after completion of the above tests.

The above tests shall be performed on one accessory of each type per contract. If the sample fails either of the above two tests, two further samples of the same accessory type shall be taken from the contract and subjected to the same tests. If both additional samples pass the tests, the other accessories of the same type from the contract shall be regarded as having complied with the requirements of this specification. If either fails, this type of accessory of the contract shall be regarded as having failed to comply.

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

5.5 During delivery of the cable 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 supplier shall replace/rectify without charge to KPLC, cable

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accessories which upon examination, test or use fail to meet any of the requirements in the specification.

6. MARKING, LABELLING AND PACKAGING

- 6.1. All accessories shall be clearly and indelibly marked by the manufacturer to indicate the following:
- a) The manufacturer's identification mark and reference/catalogue number (visible on the completed accessory).
 - b) The accessory range (visible on the accessory packaging)
 - c) The manufacturer's identification mark and a part number (visible on all components forming part of an accessory). This part number shall be referenced in the bill of materials. Components that are physically impossible to mark shall be individually packed and the packaging shall be marked.
 - d) The expiry date (visible on the packaging of all components or consumables that are subjected to a shelf life limitation). These components or consumables shall be individually packed.
- 6.2. Each accessory shall be packed in a strong cardboard container to protect it from mechanical damage. Individual parts shall be packed in strong sealed plastic bags to protect them from ingress of dirt and moisture. The cardboard container shall have:
- a) Installation instructions indicating the tools required for each stage all in English Language.
 - b) All necessary components and consumables required to complete the installation as per the instructions, i.e. accessory components, cleaning kit and earthing kit as well as connectors. It shall not be left to the jointer to decide the quantity to use in each application.
 - c) A bill of materials referenced according to the component part numbers.
- Packing shall be such as to permit easy identification of the components without their removal from the packaging.
- 6.3. The supplier shall indicate measures taken to ensure prudent management of material with limited shelf life. These measures may include staggered delivery of such material.

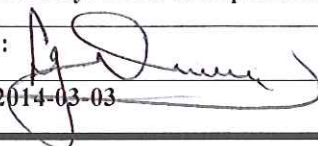
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6.4. The manufacturer shall provide a detailed safe procedure for decommissioning and disposal of the termination and jointing kits. This may include retrieval of decommissioned kits by the manufacturer from KPLC for safe disposal.

Note: The characters used in marking shall be at least 3mm high.

7. DOCUMENTATION

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

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 filled and signed by the manufacturer,
- b) Design manufacturer's drawings showing outline of joints, terminations and accessories together with all pertinent dimensions. Any variation in these dimensions due to manufacturing tolerances shall be indicated.
- c) Catalog for all the components used. Catalog numbers for the offered items shall be high-lighted.
- d) Construction and method of assembly of joints and terminations shall be clearly set out in illustrated installation instructions supplied at the time of tendering and included in every product kit during delivery. All documentation shall be in English Language.
- e) Duly completed attached technical data schedule for each offered item.
- f) Complete list of items contained in each joint and termination kit along with the price for each item of kit contents.
- g) Quality Assurance Plan (QAP) that will be used to ensure that the joints and terminations design, material, workmanship, tests, service capability, maintenance and documentation will fulfill the requirements stated in the contract documents, standards, specifications and regulations.
- h) Test Program to be used after manufacture
- i) Marking details and method to be used in marking of the joints and terminations to ensure that the marking is permanent, legible and durable,
- j) Supplier's undertaking to ensure adequacy of the design, good workmanship, good engineering practice and adherence to applicable standards in the manufacture of the joints and terminations kits for KPLC,
- k) Packaging details (including packaging materials, total number of joints/terminations per packaging).

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 joints/terminations to KPLC stores.

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**ANNEX A: SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR
 OFFERED CABLE ACCESSORIES**

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

TENDER NO..... BIDDER'S NAME & ADDRESS

Sr. No.	Description	Bidder's offer
	Name and address of the Manufacturer	State
	Country of manufacture	State
	Manufacturer's Letter of Authorization	State
	Model/Type Reference No. of the offered cable accessories	State
	Manufacturer's warranty and guarantee for the offered cable accessories	State
1	Scope	State
2	Applicable Standards	State
3	Terms and Definitions	State
4	Requirements	
4.1	Service and System Conditions	
4.1.1	Application a) to e)	State
4.1.2		State
4.2	Materials and Construction	
4.2.1	Design	
4.2.1.1		State
4.2.1.2		State
4.2.1.3		State
4.2.1.4		
4.2.1.5	Test requirements for 66kV cable joints and terminations	
1	Nominal voltage kV, U	66
2	Max. service voltage kV, Um	72.5
3	Power frequency voltage withstand test	120kV/30min, No breakdown, No flashover.
4	Room temperature partial discharge test	Test voltage 72kV, Partial discharge < 5pC
5	Thermal cycle test	96 KV heating for 8 hours, cooling for 16 hours, Conductor's temperature is 95~100 °C (20 cycles)

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6	Under the high temperature partial discharge test	72 KV, 95~100 °C, Partial discharge < 5pC	State
7	Lightning impulse voltage test	450 kV positive and negative polarities each 10 times, No breakdown, No flashover.	State
8	After test of impulse voltage withstand voltage test	120 kV/15min, No breakdown, No flashover	State
9	Outdoor joint/termination short-term power frequency voltage test	Rain status, 120kV, 1min, No flashover, No breakdown.	State
10	Outdoor joint/termination radio interference test	61kV generated 1MHz interference voltage shall not greater than 450μV	State
11	Short circuit current for 3 seconds	25kA	State
12	Pressure leak test	No gas shall escape at 0.2 MPa for 1 hour	State
4.2.2	Cable Jointing Kits		
4.2.2.1			State
4.2.2.2			State
a)-f)			
4.2.2.3	Contents and Material used		
a) -h)			State
4.2.2.4			State
4.2.2.5			State
4.2.2.6			State
4.2.3	Outdoor cable terminations		
a) - g)			
4.2.4			State
4.2.5			State
4.3	Sizes & Characteristics of the Cables		
	Nominal area, mm ²	185 300 400	State
	Voltage designation U ₀ /U(U _m), kV	38.1/66(72.5)	State
	Shape of conductor	c.c. c.c. c.c.	State
	Maximum resistance of conductor at 20°C	0.09 0.06 0.04 91 01 7	State
	Conductor diameter, mm	15.5 21.5 23.5	State
	Diameter of XLPE insulation, mm	43 49 52	State
	Diameter over insulation screen, mm	46 53 56	State

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	Diameter of Aluminum sheath, mm	60	65	66	State
	Diameter over PE outer sheath, mm	64	70	76	State
	Approx. thickness of cond. Sheath, mm	1.0	1.0	1.0	State
	Thickness of insulation, mm	12.0	12.0	12.0	State
	Approx. thickness of insulation shield, mm	1.5	1.5	1.5	State
	Thickness of aluminum sheath, mm	2.3	2.5	2.7	State
	Thickness of jacket, mm	5.2	7.0	8.1	State
4.4	Quality Management System				
4.4.1					State
4.4.2					State
4.4.3					State
5.0	Tests and Inspection				
5.1					State
5.2					State
5.3					State
5.4					State
5.5					State
6	Marking, Labeling and Packaging				
6.1					State
6.2					State
6.3					State
6.4					State
7.0	Documentation				
7.1 – 7.3					
8.0	Manufacturer's Guarantee and Warranty				State
9.0	List catalogues, brochures, technical data and drawings submitted to support the offer.				State
10.0	List customer sales records & four customer reference letters submitted to support the offer.				State
11.0	List Test Reports submitted with tender				State
12.0	List test reports to be submitted to KPLC for approval before shipment				State
13.0	Statement of compliance to specification (indicate deviations if any & supporting documents)				State

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

Issued by: Head of Section, Tech Stds& Specs

Authorized by: Head of Department, R&D

Signed:

Signed:

Date: 2014-03-03

Date: 2014-03-03