



**HEAT SHRINKABLE CABLE TERMINATIONS AND JOINTING KITS Part 1: 11kV and 33 kV –  
SPECIFICATION**

A Document of the Kenya Power & Lighting Co. Ltd  
Doc. No. KP1/6C.1/13/TSP/05/026-1

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**HEAT SHRINKABLE CABLE  
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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)
0	2014-03-21	Issue No. 2	Eng. Simon Kimitei	George Owuor
0	2015-11-18	Cancel and replaces Issue No. 2 dated 2014-03-21	Michael Apudo	Dr. Eng. Peter Kimemia
Issue 3 Rev 1	2016-08-15	1. Clause 4.4.7 Replace compression connectors with mechanical connectors Remove bi-metal connectors.	Stephen Nguli Rotich Benard	Dr. Eng. Peter Kimemia

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## FOREWORD

This specification has been prepared by the Standards Department of The Kenya Power and Lighting Company Limited (KPLC) and it lays down requirements for Heat Shrinkable 11kV & 33kV Cable Terminations and Jointing Kits. It is intended for use by KPLC in purchasing the product.

The offered product shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous operation, in a manner acceptable to KPLC who will interpret the meaning of the drawings and specifications and shall have the power to reject any work or materials, which in their judgment, are not in full compliance with the specifications.

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

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## 1. SCOPE

- 1.1. This specification covers the general technical requirements of design, manufacture, testing and performance of heat shrinkable cable termination and jointing kits for use on paper insulated lead covered (PILC) and cross linked polyvinyl (XLPE) insulated steel/aluminum wire armoured cables for use on a.c.systems of voltages of up to 36,000 V 50Hz. It also covers termination and jointing kits for submarine cables (XLPE insulated, metal sheathed cables) and aerial bundled cables.
- 1.2. This specification covers the following termination and jointing kits:
- a) Indoor and outdoor terminations of heat shrink design; and
  - b) Straight Joints and transition joints of heat shrink design for use underground or in air.
- 1.3. The specification stipulates the minimum requirements for cable jointing kits & end termination kits for underground cable using heat shrinkable 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 and applicable standards and regulations as well as ensuring good workmanship in the manufacture of the cables for The Kenya Power & Lighting Company.
- 1.4. The specification does not purport to include all the necessary provisions of a contract.

## 2. REFERENCES

The following documents were referred to during the preparation of this specification; in case of conflict, the requirements of this specification take precedence.

- ISO 9001: Quality systems - Model for quality assurance in design/development, production, installation and servicing.
- IEC 60502-4: Test requirements on accessories for cables with rated voltages from 6 kV ( $U_m = 7.2$  kV) up to 30 kV ( $U_m = 36$  kV)
- IEC 61442: Electric cables – test methods for accessories for power cables with rated voltages from 6 kV ( $U_m=7.2$  kV) up to 30 kV ( $U_m=36$  kV)

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- IEC 60055-1: Paper-Insulated Metal-Sheathed Cables for Rated Voltages Up To 18/30 kV (With Copper or Aluminium Conductors and Excluding Gas-Pressure and Oil-Filled Cables) – Part 1: Tests on cables and their accessories
- IEC 61238-1: Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV) - Part 1: Test methods and requirements
- IEC 60093: Methods of test for insulating materials for electrical purposes; volume resistivity and surface resistivity of solid electrical insulating materials
- IEC 60250: Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths
- IEC 60270: High-voltage test techniques – Partial discharge measurements
- IEC 60060-1&2: High-voltage test techniques –Part 1: General definitions and test requirements – Part 2: Measuring Systems
- HD 629.1 S2: Test requirements on accessories for use on power cables of rated voltages from 3.6/6 (7.2) kV up to 20.8/36 (42) kV
- HD 631.3 S1: Electric cables - Accessories - Material characterisation  
Part 3: Fingerprinting for heat shrinkable components for medium voltage applications from 3.6/6(7.2) kV up to 20.8/36(42) kV
- ASTM 2303-97: Tracking and Erosion Resistance Test (step voltage test method)
- BS 6622: Electric cables. Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV. Requirements and test method
- ENA TS 09-13: Performance specification for high voltage heat shrinkable components for use with high voltage solid type cables up to and including 33,000 Volts.

**3. DEFINITIONS**

For the purpose of this specification the definitions given in the reference standards and the following shall apply:

**XLPE** : Cross-Linked Polyethylene

**SWA** : Steel Wire Armored

**AL (Al)**: Aluminium

**CU (Cu)**: Copper

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**S/C** : Single Core                      **O/D** : Outdoor  
**I/D** : Indoor                                **H/S** : Heat Shrink  
**P-X** : Paper to XLPE Transition      **3/C (3c)**: Three Cores  
**PILC** : Paper Insulated Lead Covered

#### 4. REQUIREMENTS

##### 4.1. Service conditions and System Parameters

###### 4.1.1. Service Conditions

The accessories shall be suitable for continuous operation indoors and outdoors in tropical areas:

- At altitudes of up to 2200m above sea level and humidity of up to 95%,
- Average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C, in direct sunlight,
- Heavy saline conditions along the coast and
- Isokeraunic levels of up to 180 thunderstorm days per year.

###### 4.1.2. System Parameters

Nominal Operation Voltage	33kV	11kV
System Highest Voltage	42KV	17.5KV
Frequency	50 Hz.	50 Hz.
Number of phases	3	3
Type of earthing	Non-effect-earthed system	Effectively earthed system
Symmetrical fault level	25 kA (900MVA)	13.1 kA (157MVA)

4.1.3. Assembled components forming part of a supply system shall perform without distress under the following conditions:

- Normal conditions: Continuous operation at a conductor temperature of 90°C for XLPE insulated cables. Continuous operation at a conductor temperature of 70°C for paper insulated cables.
- Fault conditions: Operation at a conductor and screen temperature of 250°C for XLPE. Operation at a peak transient conductor/metal sheath temperature of 160°C and 250°C respectively for PILC.

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## 4.2. DESIGN AND CONSTRUCTION

### 4.2.1. General

Components specified shall be suitable for cables manufactured to the standards referred to in Clause 2.0 above, and to the sizes referred to in the Schedule of Prices. Components shall not be adversely affected in any manner by contact with other materials normally used in the construction of cable joints and terminations, and shall not increase the rate of corrosion of any metal with which they may come into contact. The cable descriptions based on KPLC specifications namely: KP1/3CB/TSP/05/027, KP1/3CB/TSP/05/024, KP1/3CB/TSP/05/023, KP1/3CB/TSP/05/007, KP1/3CB/TSP/05/008 and KP1/6C.1/13/TSP/05/006-1 amongst others and summarized as follows:

#### a) XLPE Cables

- (i) Three core cables with circular, stranded, copper or aluminum conductors with triple extruded conductor screen, insulation and insulation screen of which conductor and insulation screen are of semi-conducting materials and insulation is of dry vulcanized cross linked polyethylene, all the individual cores laid up with non-hygroscopic fillers, individual metallic screens of copper tape, armoured with a single layer of galvanized steel wires and overall PVC/PE sheathed suitable for 6350/11000 V & 19000/33000 V volts working voltage, manufactured generally in accordance with IEC 60502 and/or BS 6622 .
- (ii) Single core cables with circular, stranded, copper or aluminum conductors with triple extruded conductor screen, insulation and insulation screen of which conductor and insulation screen are of semi-conducting materials and insulation is of dry vulcanized cross linked polyethylene, metallic screen of copper tape or a concentric layer of wires or both, armoured with a single layer of aluminum wires and overall PVC/PE sheathed suitable for 6350/11000 & 19000/33000 volts working voltage, manufactured generally in accordance with IEC 60502 and/or BS 6622

#### b) PILC Cables

Three core cables with compact sectoral stranded copper or aluminum conductors with carbon black impregnated semi-conducting paper tapes conductor shield, insulation of paper, of 100% high quality sulphate – processed wood pulp paper tapes and insulation shielding of copper tapes intercalated with carbon black semi-conducting paper tapes over individual insulation. A binder of semi-conducting tapes (20 mil maximum), paper tapes (20 mil maximum) or copper tapes intercalated with paper tapes; armored with a single layer of galvanized steel wires, pure lead sheath and polyvinyl chloride (PVC) outer jacket in accordance with IEC 60055-1.

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#### 4.2.2. Design

Adequate consideration shall be given in the design of terminations, straight through joints and transition joints in respect of the following (Documentary evidence shall be furnished along with the tender).

- (a) Adequate stress relief at the screen cut back in case of screened cables (11kV XLPE S/C, & 33kV PILC) and in the crutch region in case of belted cables.
- (b) Reinstatement of primary insulation with a co-extruded bonded screen to the primary insulation (for joints).
- (c) Prevention of corrosion and sealing against ingress of moisture.
- (d) Provision of excellent electrical earth continuity across the straight through joints.
- (e) Non tracking, erosion and weather resistant performance for termination.
- (f) Proper earthing of screen/armour at the termination.
- (g) Lugs/Mechanical connectors with shear bolts to be suitable for proper connection of conductors as detailed in clause 4.2.1.
- (h) Compatibility of component materials.
- (i) Ensuring that proper clearances are maintained between cores and between each core and earthed parts.
- (j) Toxicity of compound.
- (k) Adequate shelf life (minimum 2 years) and expiry date shall be indicated on all sealants specified in clause 5.3(b)

#### 4.2.3. Ability to withstand load & Short circuit conditions

The ability to withstand electrical and mechanical stress that occur under normal, emergency and short circuit conditions, in the cable joints and the terminations shall not be less than that of the cable and as per Table 1.

#### 4.2.4. Electrical Stress Relief

- 4.2.4.1. Electrical Stress Control for the cable insulation screen in terminations and joints shall be achieved by means of heat shrinkable tubing having a defined impedance characteristic, volume resistivity and dielectric constant stable over time, in spite of variation in electrical stress, and changes in temperature, when measured in accordance with IEC 60093, IEC 60250 and Table 1.

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- 4.2.4.2. Electrical Stress relief shall be adequate enough so as to withstand voltages at twice the rated phase voltage to earth which shall be proved by partial discharge testing in accordance with IEC 60270 and Table 1.
- 4.2.4.3. Partial Discharge measured at twice the rated voltage shall be less than 20pC. The materials shall withstand the maximum permissible overload temperature of the cable concerned, thermal ageing and stress variations.
- 4.2.4.4. The bidder shall submit test data on the effects of temperature variation and thermal ageing on the impedance of the stress control tubing.
- 4.2.4.5. In addition to the heat shrinkable stress control tubing some form of stress relief material shall be provided which shall fill up voids and force air out of critical regions in the screen cutback area to prevent discharge.
- 4.2.4.6. In case of joints and terminations of belted cables (viz. PILC) the Crutch region shall be completely filled with a stress relieving high permittivity oil resistant material to ensure discharge free operation during service

#### 4.2.5. Reinstatement of Primary Insulation (Joints)

- 4.2.5.1. A systematic buildup of insulation shall be provided to reinstate the primary insulation. This shall be by means of a heat shrinkable tube made from a discharge resistant polymer.
- 4.2.5.2. To ensure a completely discharge free interface between the insulation & screen, the insulation and screen shall be reinstated using a single Triple Extruded Elastomeric screened insulating tubing. The recovered thickness of the insulation shall be at least 1.2 times the cable insulation thickness.
- 4.2.5.3. The recovery force of the tube shall be such that it eliminates the need for application of any grease over the cable insulation which is likely to attract dust or dirt and must be avoided. (the evidence of this should be established by way of a type test report)

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The metallic shield continuity over the joint core shall be reinstated by means of a fine mesh of tinned copper.

#### 4.2.6. Mechanical strength, armour continuity and sealing (Joints)

- 4.2.6.1. In case of straight through joints, steps shall be taken to restore the mechanical strength over the joints.
- 4.2.6.2. The material used shall be of stainless steel and the design shall be of light weight, impact resistant and capable of wrapping around over the complete length of the joint.
- 4.2.6.3. Heat shrinkable sleeves and filling materials to provide outer sealing against ingress of moisture and corrosion shall be provided and included in the kits for joints and terminations.

#### 4.3. TYPES OF JOINTS AND TERMINATION

- 4.3.1. The Termination Kits and Jointing Kits for the following shall be complete with all necessary components required for a complete Joint or a complete Termination as indicated in the Annex B - General Information (Kit Content).
  - (a) Indoor cable terminations suitable for XLPE and PILCSWA U.G. Cable
  - (b) Outdoor cable terminations suitable for XLPE and PILCSWA U.G. Cables.
  - (c) Straight through joints suitable for XLPE and PILCSWA Cables.
  - (d) In-line Transition Joints suitable for joining PILCSWA to XLPE Insulated U.G. Cables.
- 4.3.2. The components in contact with impregnating oil in the paper insulated cables shall be of oil resisting material.
- 4.3.3. In the case of Straight Through Joints and Transition Joints they shall include mechanical connectors with shear head bolts of removable type, suitable for the cables and conforming to the requirements of IEC 61238-1 (Class A).

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4.3.4. The completed Straight Through Joints and In-line Transition Joints shall be designed to be used directly buried in ground and in water logged conditions. These joints enclosures shall have sufficient space which permit crossed core jointing.

4.3.5. Terminations shall have a minimum core length (trifurcation of cable to lug) as follows.

- a) Indoor 12kV terminations : 450 mm
- b) Indoor 36kV terminations : 650 mm
- c) Outdoor 12kV terminations : 800 mm
- d) Outdoor 36kV terminations : 1200 mm

#### 4.4. BASIC COMPONENTS

##### 4.4.1. General

4.4.1.1. All components and materials used in the cable jointing kits and terminations shall conform to the relevant IEC 60502-4, HD 629.1 S2, ASTM 2303-97, ENA TS 09-13 and associated standards as per clause 2.0.

4.4.1.2. The components shall be compatible with solid dielectric cable insulation and with each other and shall be non-toxic. (Documentary evidence certifying non-toxicity shall be furnished during tender).

##### 4.4.2. Heat Shrinkable Tubing & Moulded Parts

4.4.2.1. The term "Heat Shrinkable" refers to extruded or moulded polymeric material which are cross linked to develop elastic memory and supplied in an expanded or otherwise deformed size and shape.

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4.4.2.2. Subsequent heating in an unconstrained state to a temperature above the shrink temperature results in the material recovering or shrinking to its original shape.

4.4.2.3. All heat shrinkable polymeric tubing exposed to direct sunlight shall be ultra violet stable, non-tracking and suitable for operation in the presence of severe external contamination and environmental pollution.

4.4.2.4. Materials offered shall have good electrical and environmental performance and comply with requirements of IEC 60502-4, all the associated standards and Table 1.

#### 4.4.3. Tubing Components

##### 4.4.3.1. Internal Insulation Tubing

Heat Shrinkable flexible polymeric tubing, having suitable thickness, dielectric strength elongation, tensile strength, high permittivity etc., for use in internal construction of cable joints and terminations at installations where it is not be exposed to day light.

##### 4.4.3.2. Stress Control Tubing

Heat Shrinkable flexible polymeric tubing possessing properties to provide electric stress control over the insulated cores in cable joints and terminations installations where it will not be exposed to day light.

##### 4.4.3.3. Anti-track Tubing (Indoor/Outdoor Termination)

4.4.3.3.1. A heat Shrinkable flexible polymeric tubing, easily distinguishable by colour from non-anti-track material, preferably coloured red, possessing anti-track and erosion resistance properties for use as an external covering of insulated cores in cable joints and termination at indoor and outdoor installations.

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4.4.3.3.2. The anti-track tubing for terminations at its ends shall have adequate anti-track adhesive coating applied internally so as to provide sufficient bonding in order to prevent the ingress of moisture.

4.4.3.3.3. The Anti-track Tubing shall conform to the requirements of List 2 of ENA TS 09-13.

4.4.3.3.4. The anti-track tubing shall also pass the Xenon Arc Lamp Weather Ohm Meter Test as given below:

- a) The material shall have a percentage elongation to break in excess of 100%, after 15,000 hours of 24 hours cycling.
- b) Each 24 hour cycling consisting of
  - (i) 9 periods of 102 minutes of UV light followed by 18 minutes of light plus water spray i.e. 18 hours.
  - (ii) 6 hours in the dark only.

**NOTE:** *The test reports shall be submitted with the bid for evaluation.*

#### 4.4.3.4. External Protective Tubing

Heat shrinkable flexible polymeric tubing, preferably coloured black, for protecting exposed metallic sheaths and sheath/earth connections on cable joints and terminations at indoor and outdoor installations.

#### 4.4.4. Moulded Components

##### 4.4.4.1. Glove (Indoor/Outdoor Terminations)

4.4.4.1.1. A heat shrinkable flexible polymeric permanently coloured black, possessing electrical conducting properties, for sealing a prepared crutch in cable joints and terminations at indoor and outdoor installations.

4.4.4.1.2. The Glove shall be pre-coated with a sealant adhesive so as to seal effectively onto the cable sheath.

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4.4.4.1.3. The glove (breakout) shall conform to the requirements of List 2 of ENA TS 09-13.

**4.4.4.2. Anti-track Weather Sheds (Indoor/Outdoor Terminations)**

4.4.4.2.1. A heat shrinkable flexible polymeric moulding easily distinguishable from non-anti-track material preferably red in colour, possessing anti-track and erosion resistant properties, for application over prepared cable cores.

4.4.4.2.2. The shrinkable part of the sheds shall be internally coated with an anti-track adhesive so as to provide sufficient bonding in order to prevent the ingress of moisture.

4.4.4.2.3. The total creepage distance shall not be less than 372 mm and 1116 mm for 12 kV and 36 kV respectively

4.4.4.2.4. The Anti-Track Weather sheds shall conform to the requirements of List 2 of ENA TS 09-13.

**4.4.4.3. Anti-track Lug Sealing End Boots - (Indoor Terminations)**

A heat shrinkable flexible polymeric shaped moulding possessing anti-track and erosion resistant properties, for sealing onto the cable lugs of the terminations.

**4.4.5. Sealants**

4.4.5.1. Wherever required, sealant shall be used in conjunction with heat-shrinkable components to effect seals in joints and terminations, and shall be able to accommodate the creep or relaxations that may occur with recovered heat shrink materials.

4.4.5.2. The sealant shall have adhesive properties to maintain hermetic or oil seals between components at all time when used on polymeric or paper insulated cables respectively.

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4.4.5.3. The 12kV and 36kV Sealants shall be anti-tracking and shall conform to the requirements of List 3 of ENA TS 09-13.

#### 4.4.6. Mechanical and corrosion protection inner/outer sleeve

4.4.6.1. The mechanical strength over the straight through joint shall be provided by a wraparound joint casing in order to prevent damage at the joint.

4.4.6.2. It shall be of light weight by design and made out of galvanized steel in order to be impact resistive and to provide earth fault current capacity.

4.4.6.3. The metallic parts shall be protected against corrosion by heat shrinkable sleeve internally and fully with adhesive so as to prevent the ingress of moisture.

#### 4.4.7. Cable Lugs and Mechanical connectors

All Cable Sockets (Lugs) and Mechanical connectors shall be suitable for use with the cable types referred to in the Schedule of Prices.

- (a) The lugs shall be of high conductivity (99.96%) tinned copper with shear head bolts. These shall be supplied in pairs as per BS EN 61238-1
- (b) The mechanical connectors (tested in accordance with BS EN 61238-1 (Class A-Short circuit Test)) shall be of tinned high conductivity copper with shear head bolts (minimum tin thickness of 15µm).
- (c) The bolts shall be of solid multi-shear with extruded profile. When completely tightened, the shears shall flush with connector body as per BS EN 61238-1

#### 4.4.8. Conductivity of Lead Sheath and earthing

4.4.8.1. This shall be achieved by the use of a Roll Spring Wrapping over the lead sheath and Tinned Copper braid of adequate length and shall withstand the short circuit current at the symmetrical fault level stipulated under system parameters clause 4.1.2

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4.4.8.2. The tinned copper braid used for earthing the Lead Sheath or Copper Tape Shield of a Cable Termination shall be solder blocked against ingress of moisture and shall be pre-terminated at one end with a lug.

4.4.8.3. The continuity of lead sheath across the PILC joints shall be made by means of a single tinned copper braid of suitable length and cross section.

#### 4.5. PERFORMANCE REQUIREMENTS FOR TERMINATIONS AND JOINTS

The performance parameters of the cable terminations and joints be tested as per the sequence of Table 1. The test methods shall be as per the relevant standards in clause 2.0.

**Table 1: Performance Requirements for Terminations and Joints as per IEC 61442, IEC 60502-4 and ENA TS 09-13**

Sr. No.	Test Sequence	Test Voltage (Phase to ground)		Required Result
	Voltage designation	U <sub>0</sub> /U/U <sub>m</sub>		
1	Nominal Voltage - phase to phase	6.35/11/12 kV	19.1/33/36kV	
2	Impact Test - 4kg. wedge dropped 6 times from 2m (armored cable joints only)	-	-	No functional damage
3	AC or D.C Voltage withstand for 5min at 4.5U <sub>0</sub>	28 kV	85 kV	No breakdown / No flashover
4	Partial Discharge (XLPE Cable only) for 10s – 2U <sub>0</sub> slowly reducing to 1.73U <sub>0</sub> at ambient temperature of 20 <sup>0</sup> C±15 <sup>0</sup> C	12.5kV	38kV	≤10pC
5	Impulse Voltage Withstand 10 positive and 10 negative 1.2/50µs between conductor and grounded screen.	95 kV	200 kV	No breakdown / No flashover
6	Thermal cycles in air –three cycles at θ <sub>i</sub> and 2.5U <sub>0</sub>	16 kV	48 kV	No breakdown No flashover
7	Partial Discharge (XLPE cables only) at θ <sub>i</sub> and at ambient temperature of 20 <sup>0</sup> C±15 <sup>0</sup> C for 2U <sub>0</sub>	12.5 kV	38kV	≤10pC

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Sr. No.	Test Sequence	Test Voltage (Phase to ground)	Required Result
8	Thermal cycles Terminations – 30cycles at $\theta_t$ and 2.5U <sub>0</sub> In air In water Joints – 60 cycles at $\theta_t$ and 2.5U <sub>0</sub> In air	12.5 kV 38kV	No visible signs of damage
9	Partial Discharge (XLPE cables only) at $\theta_t$ and at ambient temperature of $20^{\circ}\text{C} \pm 15^{\circ}\text{C}$ for 2U <sub>0</sub>	12.5 kV 38kV	$\leq 10\text{pC}$
10	Thermal short circuit (screen) – Two (2) short circuits at I <sub>sc</sub> of the cable screen -	-	No visible deterioration
11	Thermal short circuit (screen) – Two (2) short circuits to raise conductor to $\theta_{sc}$ of the cable – $250^{\circ}\text{C}$	-	No visible deterioration
12	Dynamic Short Circuit - One (1) short circuit at I <sub>d</sub>	63 kA 63 kA	No visible deterioration
13	Impulse Voltage Withstand 10 positive and 10 negative 1.2/50 $\mu\text{s}$ between conductor and grounded screen.	95 kV 200 kV	No breakdown / No flashover
14	AC Voltage withstand for 15min at 2.5U <sub>0</sub>	16 kV 48 kV	No breakdown / No flashover
15	Humidity tests (only for outdoor terminations – 300h) at 1.25U <sub>0</sub>	7.5 kV 22.5 kV	No breakdown / No flashover
16	Salt fog test (only for outdoor terminations) Concentration: 224kg/m <sup>3</sup> - 1,000h at 1.25U <sub>0</sub>	7.5 kV 22.5 kV	No flashover

**NOTE:**  $\theta_t$  is the maximum cable conductor temperature in normal operation +5 K to 10 K.

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## ANNEX A: DRAWINGS

### A Drawings

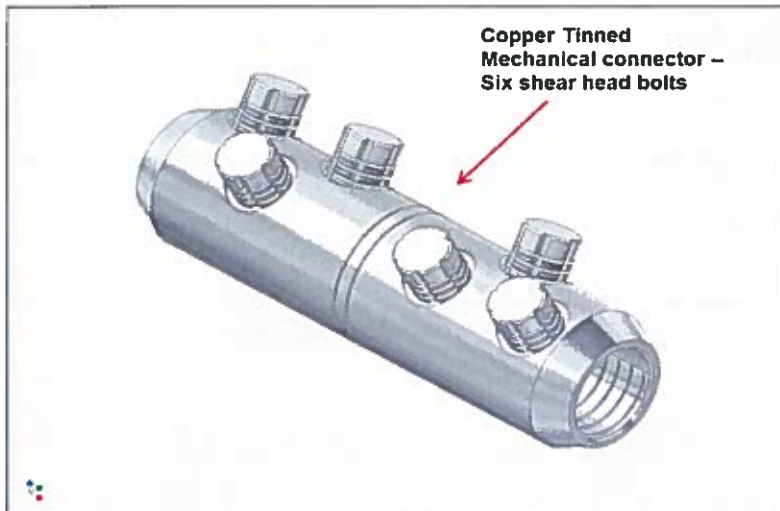


Fig 1(i) Mechanical Connectors, BS EN 61



Fig 1(ii): Mechanical Lugs

The dimensions of the mechanical lugs shall be as detailed below

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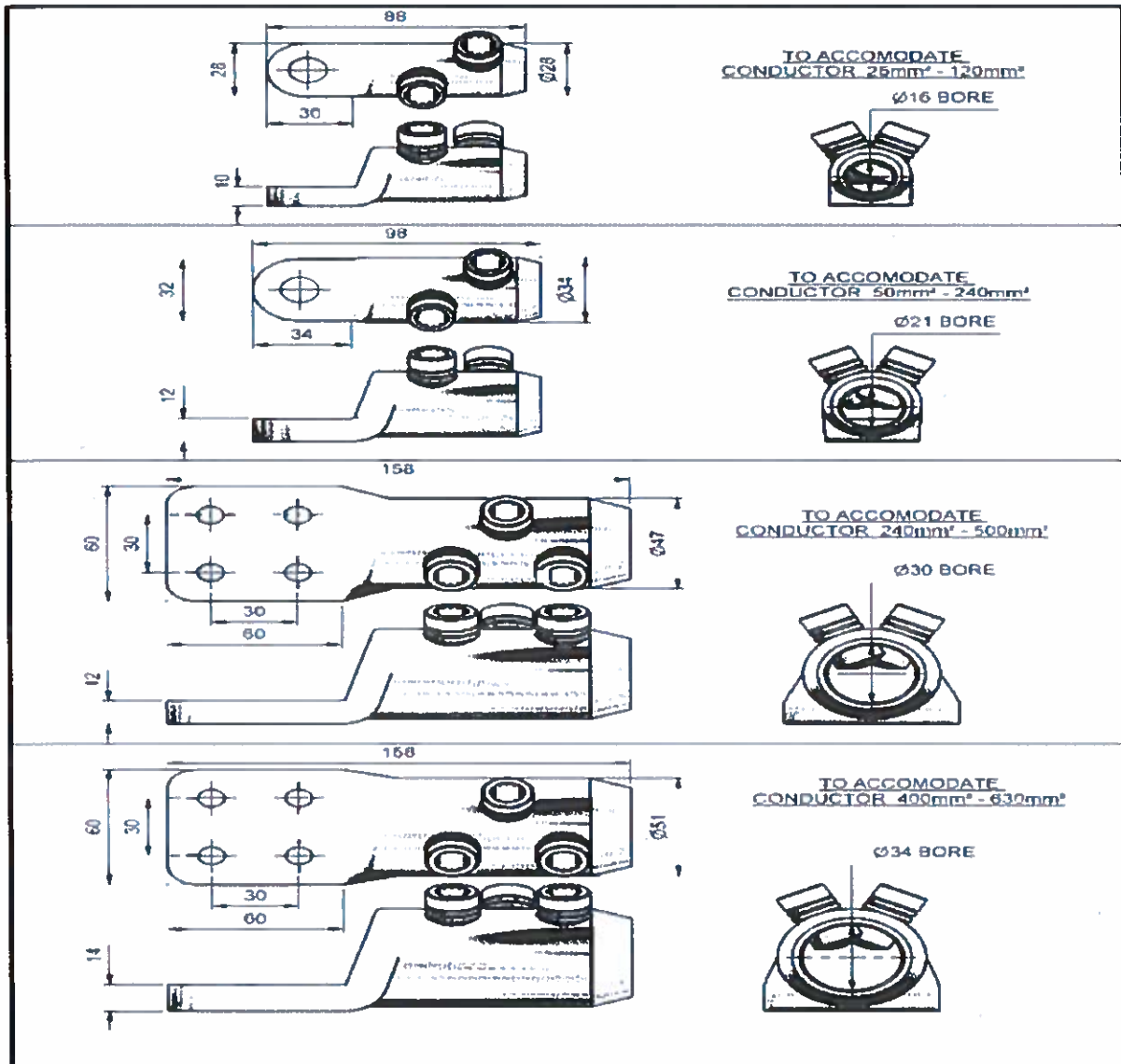


Fig2: Dimensions of Mechanical connectors

## B ANNEX B

### B.1 QUALITY MANAGEMENT SYSTEM

B.1.1 The bidder shall submit a quality assurance plan (QAP) that will be used to ensure that the cable joints and terminations design, material, workmanship, tests, service capability, maintenance and documentation, will fulfill the requirements stated in the contract documents,

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standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008.

B.1.2 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.

B.1.3 The bidder shall indicate the delivery time of the cable joints and terminations, 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 cable joints and terminations 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.

## B.2 TESTS AND INSPECTION

B.2.1 The cable joints and terminations shall be inspected and tested in accordance with IEC 6052-4, IEC 61442, IEC 60055-1, IEC 61238-1, IEC 60093, IEC 60250, IEC 60270, IEC 60112, HD 631.3 S1, ASTM 2302-97 and the requirements of this specification. It shall be the responsibility of the supplier to perform or to have performed all the tests specified.

B.2.2 Copies of previous Test Reports confirming full conformity to clause 4.0 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).

B.2.3 Type Test Reports for the cable joints and terminations to be supplied under the contract shall be submitted to The Kenya Power & Lighting Company for approval before shipment/delivery.

B.2.4 Type Test Reports for the cable joints and terminations shall include the following:

### A. Material Tests:

The following tests shall be performed to verify the quality of material requirements. The tests shall be carried out in the manner specified in ENA TS 09-13, Parts 3 and 4 and shall satisfy the requirements stated therein:

- a) **Tests for Tubing and Moulded Components**
  - (i) Corrosion Resistance
  - (ii) Density
  - (iii) Dimensions

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- (iv) Electric strength
- (v) Flame Retardance
- (vi) Fungus resistance
- (vii) Heat Shock
- (viii) Low Temperature Flexibility
- (ix) Relative permittivity
- (x) Secant Modulus
- (xi) Solvent Resistance
- (xii) Tensile strength and ultimate elongation
- (xiii) Thermal Ageing
- (xiv) Tracking Resisting
- (xv) Visual Examination
- (xvi) Volume Resisting
- (xvii) Water Absorption
- (xviii) Water Vapour Permeability
- (xix) Weather Resistance

**b) Tests for Sealants**

- (i) Corrosion Resistance
- (ii) Electric strength
- (iii) Flow at elevated temperature
- (iv) Internal pressure sealing ability
- (v) Low temperature flexibility
- (vi) Peel strength
- (vii) Solvent Resistance

*Note: Expiry date of each sealant and adhesive to be marked*

**B. Electrical Performance Tests**

The following tests shall be carried out to check the electrical performance of the components in the sequence specified in Table 1:

- a) A.C. Voltage withstand -for indoor termination as per IEC 60060-1 & 2 and IEC 61442 clause 4 or 5
- b) Partial discharge -for screened cables as per IEC 60270, IEC 60885-2 and IEC 61442, clause 7
- c) Impulse voltage withstand as per IEC 61442 clause 6 and IEC 60230
- d) Thermal cycles as per IEC 61442, clause 9
- e) Thermal short circuit as per IEC 61442 clause 11

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- f) D.C. Voltage withstand as per IEC 60060-1
- g) Humidity -for termination as per IEC 61442 clause 13
- h) Dynamic short circuit as per IEC 61442 clause 12
- i) Salt fog -Outdoor termination as per IEC 60507 and IEC 61442 clause 13

B.2.5 The cable joints and terminations 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).

B.2.6 Routine and sample test reports for the cable joints and terminations 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 include all the tests in clause as routine tests by the respective test standards and the following:

- a) Density to be tested as per ISO/R 1183 Method A
- b) Tensile Strength to be tested as per ISO 37
- c) Ultimate Elongation to be tested as per ISO 37
- d) Low Temperature Flexibility to be tested as per ASTM D 2671 Procedure C
- e) Thermal Endurance to be tested as per IEC 60216
- f) Electric Strength to be tested as per IEC 60243
- g) Di-electric Constant to be tested as per IEC 60250
- h) Volume Resistivity to be tested as per IEC 60093

B.2.7 Upon delivery of the cable joints and terminations, 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, cable joints and terminations which upon examination, test or use fail to meet any of the requirements in the specification.

### B.3 MARKING AND PACKING

#### B.3.1 Marking

The following shall be marked on all heat shrinkable tubing and moulded parts;

- a) Name of original manufacturer
- b) Part number of item
- c) Manufacturing batch number (for traceability).
- d) Standard of manufacture and Year of Manufacture for identification purpose.
- e) The letters, "Property of KPLC" shall be marked on the package of the kit

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### B.3.2 Packing

B.3.2.1 For the purposes of identification, gloves shall be marked clearly and permanently in a prominent position with the supplier's name and reference number.

B.3.2.2 Electrically conducting components shall be marked "Conducting clearly and permanently".

B.3.2.3 Components shall normally be supplied in a package as a complete joint or termination which shall be clearly marked with the supplier's name, reference number, batch references, voltage, application and cable size. In addition, KPLC part numbers as indicated in the bill of quantity shall be marked on the package.

B.3.2.4 Packaging shall be designed to protect against ingress of moisture and mechanical damage. Components supplied with adhesive coatings shall have means to prevent the coated surfaces from adhering to each other. The complete heat shrinkable components, required to complete in all respects one termination shall be supplied in a kit form; one joint to be supplied in kit form surfaces from adhering to each other.

### B.3.3 Storage

B.3.3.1 Component shall be capable of being stored without deterioration within the temperature range  $1^{\circ}\text{C}$  to  $+40^{\circ}\text{C}$  for a minimum period of 2 years.

B.3.3.2 Components of materials if subject to a shelf life limitation shall have the final date of use prominently and permanently shown on all packaging. However, shelf life of any of these components shall not be less than 2 years in local ambient conditions (tropical humidity from date of manufacture

### B.4 DOCUMENTATION

B.4.1 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:

- Guaranteed Technical Particulars fully filled and signed by the manufacturer;
- Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
- Sales records and customer reference letters;
- Details of manufacturing capacity and the manufacturer's experience;

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- e) Detailed documentary evidence in support of conformity of various materials and components to specified standards. The information shall include the following.
- (i) Step by step instruction procedures supported with illustrated drawings.
  - (ii) List of materials indicating quantities in each kit (as indicated in Annex B). Names of the manufacturers whose components are included in the kits shall be indicated.
  - (iii) Time required for carrying out a complete joint or termination.
  - (iv) Performance Test Certificates as per the test sequence referred below. Names of the manufacturers whose components were in the joints/terminations which were tested must be submitted.
  - (v) Type approval and quality assurance test certificates for sealants shall accompany the Tender.
  - (vi) Natural weathering data on the materials offered.
  - (vii) Accelerated weathering test certificates on the materials offered.
- f) Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025; This test performance for the materials shall include the parameters in Table 1 and any deviation shall analytically be justified:
- (i) Relative humidity
  - (ii) Temperature variation
  - (iii) Contaminant concentration
  - (iv) Programme of 24 hour cycle describing UV exposure; light and water spray and darkness
  - (v) Per year equivalence of weather ohm meter hours

The test certificates shall include the graphical illustrations of variations of elongation and electrical strength with ageing.

- (i) Total creepage distance and protected creepage distance provided in the termination.
  - (ii) Minimum tail lengths for indoor and outdoor terminations
- g) Type Test Certificate of the following test shall also be submitted with the tender:
- (i) Power Frequency Withstand Voltage test - As per IEC 60060
  - (ii) Impulse Withstand Voltage test - As per IEC 60060
  - (iii) Partial discharge test - As per IEC 60270
  - (iv) Tracking and Erosion resistance test - As per ASTM D2303
  - (v) Load cycle test - As per IEC 60230

**NOTE:** For straight through joints, load cycle tests with the cable joint submerged in water, shall also be included.

- Thermal short circuit test - As per IEC 60230
- Humidity withstand test - As per IEC 60466

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(vi) Impact Test

A wedge shaped weight of 4 (four) kg shall be dropped from a minimum height of one meter and shall be followed by 48 (forty eight) hours of immersion in water at a pressure of 0.05 Mpa.

- h) Quality Control/Assurance Standards: Bidders shall submit evidence of approval of their manufacturing operation against ISO 9001 standard.
- i) Copy of accreditation certificate to ISO/IEC 17025 for the testing laboratory.
- j) Manufacturer's warranty and guarantee
- k) 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.
- l) **Manufacturers who have not previously supplied the joints and terminations to KPLC shall submit a list of electrical utilities which are using the quoted joints and terminations.**

B.4.2 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 joints and terminations,
- 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 joints and terminations,
- 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 cable joints and terminations for The Kenya Power & Lighting Company
- g) Packaging details (including packaging materials).

B.4.3 The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the cable joints and terminations to KPLC stores.

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**ANNEX C:**

**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	
Type designation of cable jointing kit/ termination kit			Specify	
Operating voltage Uo/U			Specify	
1.	Scope		Specify	
1.1-1.2				
2.	Applicable Standards		Specify	
3.	Terms & Definitions		Specify	
4.	<b>REQUIREMENTS</b>		Specify	
4.1.1	Service Conditions		Specify	
4.1.2	System parameters	Nominal operation voltage	Specify	
		System highest voltage	Specify	
		Frequency	Specify	
		Number of phases	Specify	
		Type of earthing	Specify	
		Symmetrical fault level	Specify	
4.1.3	Normal conditions	Continuous operation at temperature	90°C XLPE	Specify
			70°C PILC	Specify
	Fault conditions	Operation at a conductor and screen temperature of 250°C for XLPE		Specify
		Operation at peak transient temperature for PILC	Conductor 160°C	Specify
metal sheath	250°C		Specify	
4.2	<b>DESIGN AND CONSTRUCTION</b>		<b>Provide</b>	
4.2.1	Our scope XLPE cables three core and single core		Specify	
	PILC cables		Specify	
4.2.2	<b>Design with consideration of below</b>		<b>Provide</b>	

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Clause number	KPLC requirement	Bidder's offer
	Adequate stress relief at screen cut back/crutch region for screened cables/belted cables respectively	Specify
	Reinstatement of primary insulation with a co-extruded bonded screen to the primary insulation	Specify
	Prevention of corrosion and sealing against ingress of moisture	Specify
	Provision of excellent electrical earth continuity across the straight through joints	Specify
	Non tracking, erosion and weather resistant performance for termination	Specify
	Proper earthing of screen/armour at the termination	Specify
	Lugs/mechanical connectors with shear bolts to be suitable for proper connection of conductors detailed in clause 4.2.1	Specify
	Compatibility of component materials	Specify
	Ensuring that proper clearances are maintained between cores and between each core and earthed parts	Specify
	Toxicity of compound	Specify
	Adequate shelf life	Specify
4.2.3	Ability to withstand load and short circuit conditions	Specify
4.2.4	Electrical stress relief	Provide
4.2.4.1	Achieved by heat shrinkable tubing	Impedance characteristic
		Volume resistivity
		Dielectric constant, and its stability under stress
4.2.4.2	Can withstand twice rated voltage	Specify
4.2.4.3	Partial discharge at twice rated voltage less than 20pC	Specify
	Materials shall withstand maximum permissible overload temperature, thermal ageing and stress variations	Provide test data
4.2.4.5	Besides heat shrinkable stress control, specify other stress relief material provided	Specify
4.2.4.6	For PILC high permittivity oil resistant stress relief material provided	Specify
4.2.5	<b>Reinstatement of primary insulations (joints)</b>	Specify
	Type of insulation provided	Specify
	Recovered thickness shall be at least 1.2 times cable insulation thickness	Specify
	The recovery force of the tube shall eliminate need of application of any grease over the cable insulation likely to attract dust	Specify
	Metallic shield material of manufacture	Specify
4.2.6	<b>Mechanical strength, armour continuity and sealing (joints)</b>	Provide

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Clause number	KPLC requirement	Bidder's offer
	Mechanical strength restored	Specify
	Material for restoration of mechanical strength	Specify
	Heat shrinkable sleeves and filling material provided	Specify
<b>4.3</b>	<b>TYPES OF JOINTS AND TERMINATIONS</b>	Specify
4.3.1	Indoor cable terminations for XLPE and PILCSWA U.G cable	Specify
	Outdoor cable terminations for XLPE and PILCSWA U.G cables	Specify
	Straight through joint for XLPE and PILCSWA cables	Specify
	In-line transition joints for joining PILCSWA to XLPE U.G cables	Specify
4.3.2	For PILC oil resisting material provided	Specify
4.3.3	For straight through and transition joints, mechanical connectors with shear head bolts.	Specify
4.3.4	Straight through joints and transition joints suitable for burying in ground and water logged areas	Specify
	Have sufficient space to permit crossed core jointing	Specify
4.3.5	Indoor 12kv terminations core length	Specify
	Indoor 36kv terminations core length	Specify
	Outdoor 12kv terminations core length	Specify
	Outdoor 36kv terminations core length	Specify
<b>4.4</b>	<b>BASIC COMPONENTS</b>	<b>Provide</b>
4.4.1	Follows standards	Provide proof
	Non- toxic	Provide proof
	Compatible to dielectric cable insulation and to each other	Provide proof
4.4.2	All heat shrinkable material shall can recover original state on heating in unconstrained state at temperature above shrink temperatures	Specify /proof
	Ultra Violet stable and non- tracking	Specify
	Good for severe external contamination and environmental pollution	Specify
	Materials offered with good electrical and environmental performance	Provide proof
4.4.3	<b>Tubing components</b>	
Internal insulation tubing	Heat shrinkable flexible polymeric tubing	Specify
	Thickness	Specify
	Dielectric strength	Specify
	Elongation	Specify
	Tensile strength	Specify
Stress control tubing	High permittivity	Specify
	Heat shrinkable flexible polymeric tubing	Specify
	Provides electric stress control over the insulated	Specify

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**TITLE:**  
**HEAT SHRINKABLE CABLE**  
**TERMINATIONS AND JOINTING**  
**KITS**  
**Part 1: 11kV and 33 kV Kits**  
**SPECIFICATION**

Doc. No.	KP1/6C.1/13/TSP/05/026-1
Issue No.	3
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Clause number	KPLC requirement		Bidder's offer
		cores in joints and terminations	
Anti-track tubing		Heat shrinkable flexible polymeric tubing	Specify
		Easily distinguishable by color from anti track material (RED)	Specify
		Has anti-track and erosion resistance properties	Specify
		Anti-track tubing with adequate anti-track adhesive coating internally	Specify
		Shall pass the xenon arc lamp weather ohm meter test	Provide test report
External protective tubing		Heat shrinkable flexible polymeric tubing	Specify
		Colour	Specify
		Protects exposed metallic sheaths	Specify
4.4.4	Moulded components		Provide
4.4.4.1	Glove(indoor/outdoor terminations)	Heat shrinkable flexible polymeric color black	
		State its electrical conducting properties	Specify
		Pre coated with sealant adhesive	Specify
4.4.4.2	Anti-track weather sheds	Heat shrinkable flexible polymeric moulding	Specify
		Easily distinguishable by color from anti track material (RED)	Specify
		Has anti-track and erosion resistance properties	Specify
		Shrinkable parts of sheds internally coated with anti-track adhesive	Specify
		Creepage distance and voltage	Specify
4.4.4.3	Anti-track lug sealing end boots	Heat shrinkable flexible polymeric shaped moulding	Specify
		Has anti-track and erosion resistance properties	Specify
4.4.5	<b>Sealants</b>		Specify
	Adequate provided to work with heat-shrinkable components		Specify
	Can accommodate creep or relaxations of heat shrink materials		Specify
	Shall have adhesive properties		Specify
	Shall be anti-tracking		Provide test report
4.4.6	<b>Mechanical and corrosion protection sleeve</b>		
	Wrap around joint casing provided		Specify
	Light weight		Specify
	Material of manufacture of joint casing		Specify
	Impact resistive		Specify
	Can provide earth fault current capacity		Specify

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Clause number	KPLC requirement	Bidder's offer
	Heat shrinkable sleeve to prevent corrosion of metallic parts provided	Specify
4.4.7	<b>Cable lugs and mechanical connectors</b>	Provide
	For 11kV and 33kV Cable Terminations, the lugs shall be of high conductivity tinned copper.	Specify
	For 11kV and 33kV Cable Joints, the mechanical connectors shall be of high conductivity tinned copper with shear head bolts (minimum tin thickness of 20µm).	Specify
4.4.8	<b>Conductivity of lead sheath and earthing</b>	Provide
	Achieved by roll spring wrapping over the lead sheath and tinned copper braid	Specify
	Shall withstand short circuit current at symmetrical fault level	Specify
	Tinned copper braid or copper tape shield shall be solder blocked against moisture ingress. Pre terminated at one end with a lug	Specify
	Continuity of PILC joints by means of a single tinned copper braid	Specify its length and cross section
4.5	<b>PERFORMANCE REQUIREMENTS FOR TERMINATIONS AND JOINTS; TABLE 1</b>	Comply
	Nominal voltage- phase to phase	
	Impact test- 4kg. wedge dropped 6 times from 2m (armoured cable joints only)	
	AC or DC voltage withstand for 5 min at 4.5U <sub>0</sub>	
	Partial discharge (XLPE cables only)	
	Impulse Voltage with stand 10 positive and 10 negative 1,2/50uS between conductor and grounded screen	
	Thermal cycles	Terminations
		Joints
	Partial discharge (XLPE cables only)	
	Thermal cycles	Terminations
		Joints
	Partial discharge (XLPE cables only)	
	Thermal short circuit (screen)	
	Thermal short circuit (screen) - 250 <sup>0</sup>	
	Dynamic short circuit	
	Impulse Voltage with stand 10 positive and 10 negative 1,2/50uS between conductor and grounded screen	
	Ac voltage withstand for 15min at 2.5U <sub>0</sub>	
	Humidity tests (only for outdoor terminations) – 300h at 1.25U <sub>0</sub>	

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Clause number	KPLC requirement	Bidder's offer
	800 uS/cm: 100hr spray rate 0.4L/m <sup>3</sup> /hr	
	Salt fog test (only for outdoor terminations) Concentration: 224kg/m <sup>3</sup> - 1,000h at 1.25U <sub>0</sub>	
B.1	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
B2.1	Test standards and responsibility of carrying out tests	Provide
B2.2	Copies of Type Test Reports submitted with tender	Provide
B2.3	Type Test Reports to be submitted for approval before shipment/delivery	Provide
B2.4	Type Test Reports required	Provide
B2.5	Acceptance tests to be witnessed by KPLC at factory before shipment	Provide
B2.6	Test reports to be submitted by supplier to KPLC for approval before shipment	Provide
B2.7	Replacement of rejected cables	Provide
B3.1	Markings	Provide
B3.2	Packing	Provide
B3.3	Storage	Comply
B4.1	Documents submitted with tender	Provide
B4.2	Documents to be submitted by supplier to KPLC for approval before manufacture	Provide
B4.3	Submit recommendations for use, care, storage and routine inspection/testing procedures	Comply
	Statement of compliance to specification	Provide

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

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