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0.1 Circulation List

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

0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
0	2014-06-26	New Issue	Michael Apudo	Eng. Simon Kimitei

FOREWORD

This specification has been prepared by the Research and Development Department in collaboration with Distribution Division, both of The Kenya Power and Lighting Company Limited (KPLC) and it lays down requirements for overhead line instruments (high voltage test instruments) for use on distribution and sub-transmission power lines. It is intended for use by KPLC in purchasing the instruments.

1. SCOPE

1.1 This specification is for high voltage test instruments for use on distribution and sub-transmission power lines operated at 50 Hz.

1.2 The specification covers the following categories of high voltage test instruments:

a) Phase comparators (Phasing Out Sticks)
   (i) (0 – 72.5 kV)
   (ii) (0 – 36 kV)
b) Voltage Detector, (0-72.5 kV)

NOTE: *The sizes shall be as per the schedule of requirements in the tender.*

1.3 The specification also covers inspection and tests of the instruments as well as schedule of Guaranteed Technical Particulars to be fully filled, signed by the manufacturer and submitted for tender evaluation.

1.4 The specification stipulates the minimum requirements for high voltage test instruments acceptable for use in the company and it shall be the responsibility of the Suppliers & Manufacturer to ensure adequacy of the design, good workmanship and good engineering practice in the manufacture of the test instruments 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 61481: Live working: Portable phase comparators for use on voltages from 1 kV to 36 kV a.c.

IEC 61243: Live working –Voltage detectors – Part 1: Capacitive type to be used for voltages exceeding 1 kV a.c; Part 2: Resistive type to be used for voltages of 1 kV to 36 kV a.c

IEC 60832: Live working - Insulating sticks and attachable devices - Part 1: Insulating sticks Part 2: Part 2: Attachable devices

IEC 61235: Live working – insulating hollow tubes for electrical purposes

IEC 601010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

IEC 61326: Electrical equipment for measurement, control and laboratory use - EMC requirements.

IEC 61000: Electromagnetic compatibility (EMC)

IEC 60801-2: Electromagnetic compatibility for industrial-process measurement and control equipment - Electrostatic discharge requirements

IEC 60068: Environmental testing

IEC 60529: Degrees of protection provided by enclosures (IP Code)

OIML D 11: General Requirements for Measuring Instruments - Environmental Conditions

3. TERMS AND DEFINITIONS

For the purposes of this specification, the definitions given in the reference standards shall apply.

4. REQUIREMENTS

4.1. Service Conditions

4.1.1. Physical conditions

The high voltage test instruments shall be tropicalized, designed and constructed for continuous outdoor operation in tropical areas and harsh climatic conditions including areas exposed to:

a) Sea spray (along the coast),
b) Humidity of up to 95%
c) Average ambient temperature of +30°C, with a minimum of -1°C and a maximum of +40°C.
d) Altitude of up to 2000m above sea level

4.2. Safety and environmental requirements

4.2.1. Measuring instruments shall be designed and manufactured in accordance with IEC 601010-1 and OIML D 11 standard such that:
a) Their errors do not exceed the maximum permissible errors under rated operating conditions.
b) When they are exposed to disturbances, either:
(i) Significant faults shall not occur, or
(ii) Significant faults shall be detected and corrected by means of inbuilt checking facility.

4.2.2. Instruments powered by a battery (stand-alone, rechargeable auxiliary or back-up batteries) shall have the type (-s) and capacity (-ies) of the batteries allowed to be used in the applicable measuring instruments specified by the manufacturer.

4.2.3. Instruments powered by the mains power and provided with a back-up battery for data-storage only, shall also comply with the requirements for mains powered instruments.

4.2.4. Measuring instruments shall be constructed in such a way that possibilities for unintentional, accidental, or intentional misuse are minimal.

4.2.5. Software controlled instruments that are complex in their functionality shall require that the user is guided for the correct use and for achieving correct measurement results.

4.2.6. The manufacturer shall specify the limiting conditions; storage and transport conditions for each specified influence quantity - quantity which is not the subject of the measurement and whose change affects the relationship between the indication and the result of the measurement.

4.2.7. Measuring equipment shall have a valid calibration status prior to being confirmed, within a specified metrological requirement.

4.2.8. The measuring instruments shall also be designed manufactured and tested in conformity with the following safety and environmental design requirements and standards as per Table 1;

Table 1: Safety and Environmental Design Requirements

No	Particulars		Test Performance
1	Environmental conditions	Operating temperature	- 5°C--- +55°C
		Storage temperature	- 5 ... +60 °C
		Humidity range - Rel. humidity	20% -- 96%, non-condensing
		Altitude	Up to 2000m above sea level.
		Shock (operating)	15 g / 11 ms half sine as per IEC 60068-2-27
		Vibration (operating)	IEC 60068-2-6: Test Fc (Test level 2) Frequency range from 10 Hz to 150 Hz, continuous acceleration 2 g (20 m/s^2), 20 cycles per axis
		Dry heat test	IEC 60068-2-2: Type A test (Test level 2) Temperature - $55^0C \pm 2^0C$ Duration of exposure – 2 h
		Damp heat test	IEC 60068-2-30: Test Db Test level 2 Temperature - $55^0C \pm 2^0C$ Relative humidity – 93 % Duration of exposure – 4 h
		Salt mist test	IEC 60068-2-11 – Test level 4 Saline solution – 5 % NaCl, pH value- 6.5 – 7.2 %, Temperature – 35^0C Duration – 96 h
		Flammability test	IEC 60695-2-11 – Needle flame test
2	EMC tests	Emission standards for residential, commercial and light-industrial environments	IEC 61000-6-3 - Class A
		Electrostatic discharge requirements	IEC 61000-4-2 – Test level 3 Air discharge - 8kV, Contact discharge - 6kV
		Radiated, radio-frequency, electromagnetic field immunity tests	IEC 61000-4-3 – Test level 3 10 V/m (80 MHz bis 1 GHz)
		Fast Transients/Bursts	IEC 61000-4-4: Test level 2 Min Values ±1 kV (5/50 ns, 5kHz)
		Surges on signal, data and control lines	IEC 61000-4-5- Test level 3 Line to ground voltage – 2.0 kV Line to Line voltage – 1.0 kV
3	Safety	Rated Impulse Voltage for equipment -1.2/50µs	6000 V as per IEC 60664-1, table 1
		Overvoltage category	Class IV 600 V as per IEC 61010-1
		Pollution category	Degree 2 as per IEC 60664-1 clause 2.5.1
		Insulation material group	Group II - 400≤CTI<600 (PLC=1) as per IEC 60112 and IEC 60664-1 clause 2.7.1
		Minimum clearances for	5.5mm as per IEC 60664-1 section 3, clause 3.1

No	Particulars		Test Performance
		equipment to withstand steady state voltages, temporary over-voltages and to avoid partial discharge	and Table 1
		Partial discharge requirements	As per IEC 60664-1 Annex C
		Solid insulation design	Shall withstand short term and long term stresses as per IEC 60664-1 clause 3.3

* If the internal emission source(s) is operating at a frequency below 9 kHz then measurements need only to be performed up to 230 MHz

NOTE: *The tests results shall be as per the Performance Criteria A specified in IEC 61326-1 for the respective tests.*

4.3. Specific Requirements

4.3.1. High Voltage Phase Comparator (0 - 72.5 kV)

4.3.1.1. Design and construction

4.3.1.1.1. Phase comparators (phasing out stick) shall be a two-pole device - resistive phase comparator manufactured and tested according to IEC 61481, with electrical properties complying and exceeding requirements of IEC 61243-2 as a complete device suitable for determining the correct phase relationship between two energized conductors and shall as per of Fig. 1.

4.3.1.1.2. The three (3) phase rotation meter shall be a two-pole resistive device, designed and tested to IEC 61481, with electrical properties complying and exceeding requirements of IEC 61243-2 as a complete device suitable for determining the correct phase relationship between two energized conductors.

4.3.1.1.3. It shall conform to clause 4.2 and Table 1 of this specification and shall be used to determine the leading phase of any two phases of a three-phase conductor system as well as to check the phase sequence and phase orientation in three-phase electrical systems. It shall be a display type (analogue or digital) meter.

4.3.1.1.4. The phase comparators shall be constructed with epoxy encapsulated high voltage resistors to limit the current through the connecting cord to a maximum of about one milliamp and it shall have a range switch that requires add-on resistor sticks for higher voltage ranges up to 72.5 kV.

4.3.1.1.5. The connecting cord shall be insulated for voltages up to 10kV and shall be made with extra flexible alloy-tin coated copper-stranded conductors. It shall always be kept free and clear from the user, ground and any other conductors.

4.3.1.1.6. The phase comparators shall consist of two high quality glass fiber front-end poles manufactured and dielectrically tested to 100kV/3mm as per IEC 60832-1 standard requirements; with end fittings threaded for interchangeable probes made of composite polyurethane main body molding to give tough and very light weight construction and superior safety features.

4.3.1.1.7. The major elements of the phase rotation meter shall be as shown in Fig. 1.

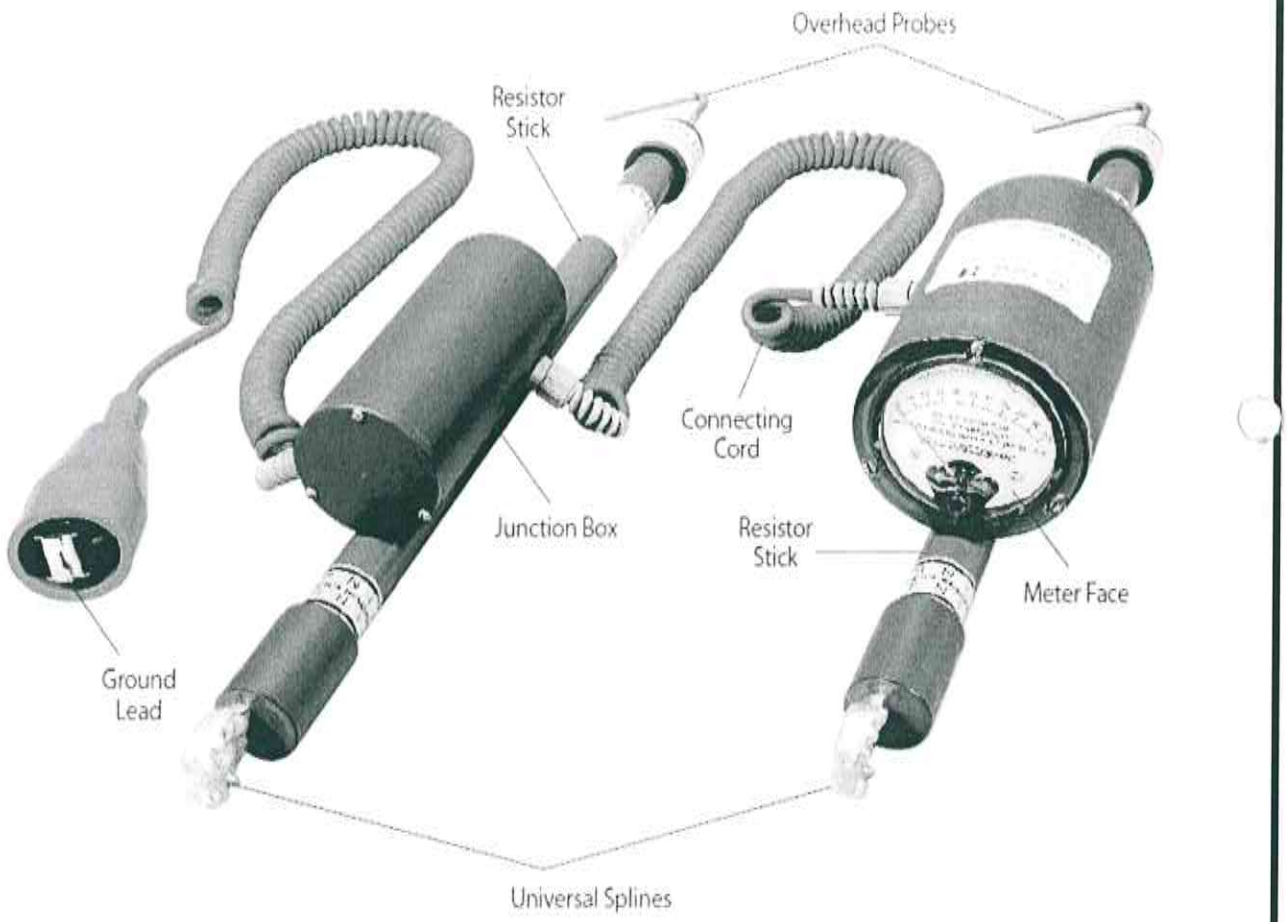

Fig. 1: General arrangement of Analogue HV Voltage Phase Rotation Tester.

4.3.1.2. **Features**

4.3.1.2.1. The phase comparators shall have probe fittings coupled with a high-impedance component encased in each pole and with an 8 m length of insulated cable stored on a reel and fixed onto one pole and connected to the voltmeter (digital/analogue) on the other pole.

4.3.1.2.2. The phase comparators shall be supplied in triple range: 0-5 kV, 5-15 kV standalone device and 15 - 72.5 kV with optional accessory add-on resistor sticks as follows:

a) To determine phase rotation on systems up to 5kV, the selector switch shall be set at LO range and without the add-on resistor sticks.
b) To determine phase rotation on systems up to 15kV, the selector switch shall be set for HI range and without the add-on resistor sticks.
c) To determine phase rotation on systems up to 72.5kV, the selector switch shall be set for HI ranges, with the optional add-on resistor sticks installed on one of the meter stick.

4.3.1.2.3. Phase rotation shall be determined by taking readings on the two phases; first in one direction, then the other. The meter shall indicate which phase is leading and which is lagging.

4.3.1.2.4. The meter shall also be used in overhead applications with a provision to include relevant probes, or underground by adding the appropriate underground probes for this application.

4.3.1.3. **Phasing Measurements**

4.3.1.3.1. Since the operation of the equipment occurs near two energized conductors, it shall be recommended that two person crews shall take the readings to allow each person to operate one stick and maintain high safety standards.

4.3.1.3.2. In order to take a reading, each probe shall contact an energized line with the connecting cord kept free and clear of energized phases and ground.

4.3.1.3.3. The phase rotation meter shall be designed to have three connections for proper operation. The connection to the ground lead shall be made first; to a known good ground before the probes are connected to live conductors.

4.3.1.3.4. After testing is complete, the main contacts probes shall be removed and isolated from all voltage sources prior to disconnecting the ground lead.

4.3.1.4. **Readings**

To determine which of the two phases is leading or lagging, two separate readings shall be required:

a) **READING 1:** Place one probe (resistor stick) on each of the two phases being tested and take a reading.
b) **READING 2:** Reverse the probes (resistor sticks) so that they contact the same two phases but in the opposite direction, and take a reading.

4.3.1.5. **Results**

4.3.1.5.1. The resistor stick with the meter on it shall show a higher indication when it is in contact with the leading phase. The meter shall also indicate relative phase rotation.

4.3.1.5.2. The resistor stick with the meter on the leading phase will indicate a reading of up to 100 at the maximum voltage for the range selected. The resistor stick with the meter on the lagging phase will indicate about 60% of the leading phase reading

4.3.1.5.3. For three phases there shall be three pairs of phases, so any two pairs shall be tested as outlined above. For example, with three Phases A, B and C, the sequence shall be:
a) Step 1: Test Phases A and B. A is determined to be leading B.
b) Step 2: Test Phases A and C. C is determined to be leading A.

4.3.1.5.4. Now, A leads B from Step 1. C leads A from Step 2. Therefore, the rotation is C-A-B. This can also be written as A-B-C. This shall be verified by testing the third pair of phases. Test phases B and C. Phase B are determined to be leading C.

4.3.1.6. **Accessories**

The following accessories to be supplied with the equipment, to be declared by the purchaser (KPLC) during tender shall include:

a) Proof Tester rated 5kV DC at the test leads to confirm proper operation of the phase rotation meter. The proof tester shall operate from one 9V alkaline battery and produces approximately 5kVDC at the connecting leads.
b) Add on resistor sticks for use on voltages above 15kV up to 72.5kV voltages.
c) Probes;
   - Brass hook probe
   - Brass pigtail probe

4.3.2. High Voltage Phase Comparator (0 - 36 kV)

4.3.2.1. Design and construction

4.3.2.1.1. The high voltage phase comparator (phasing-out stick) shall be a two-pole device - resistive phase comparator manufactured and tested according to IEC 61481, with electrical properties complying and exceeding requirements of IEC 61243-2 as a complete device suitable for determining the correct phase relationship between two energized conductors and shall as per of Fig. 4.

4.3.2.1.2. This two-pole phase comparators shall fully comply with the requirements of clause 4.2 on safety, environment and design of various parts.

4.3.2.1.3. The comparator shall be capable of detecting voltage ranges from 0 kV to 36 kV at 50Hz with a direct voltage read out on a digital KV meter.

4.3.2.1.4. The phase comparators shall be used to determine the correct phase relationship between two energized conductors of the same nominal voltage and frequency.

NOTE: *The high voltage phase comparator shall not be used as a voltage tester.*

4.3.2.1.5. The phase comparators shall be designed for use indoors and outdoors installations in all weather conditions (e.g. rain, snow, fog and dew) and shall be marked "For use in indoor and outdoor installations and for use in wet weather conditions".

4.3.2.1.6. It shall possess an inbuilt high voltage (HV) protective resistor against shorts and grounds.

NOTE: *When two sources are in phase, potential difference is minimum and when two voltages are out of phase, the potential difference is maximum.*

4.3.2.2. Principle of Operation

4.3.2.2.1. The phase comparators as a resistive device shall consist of two inter-connected poles (the master pole with the panel meter and the slave pole) and shall comprise of resistors, neon and a panel meter. The phase comparator shall draw current from the circuit or source under test.

4.3.2.2.2. The master pole shall carry the panel meter with the colour coded scale and the integral neon light indicator. The colour coded scale shall indicate "in-phase/out-of-phase" band on the scale. (Green = in-phase; Red=out-of-phase).

4.3.2.2.3. The neon light shall lit up when the voltage between the poles is greater than ±1.2kV (threshold) and at ±1.5kV (fully lit).

4.3.2.2.4. If two energized conductors are out-of-phase and a contact electrode is touched onto each pole, current will flow between the conductors through the resistors (resistors shall be inside the fiberglass front end in each pole) in the poles and the interconnecting lead/cord. This shall cause the neon to lit and the panel meter's indicator to move into the out-of-phase area (Red).

4.3.2.2.5. If two energized conductors are in-phase and a contact electrode is touched onto each pole, current will not flow between the conductors through the resistors in the poles and the interconnecting lead/cord. This shall not cause the neon to lit and the panel meter's indicator to move. The indicator will stay into the in-phase area (Green).

4.3.2.2.6. At the junction between the handle section and the front end section, there shall be a RED BAND which is the limit mark. By definition, this mark, or the Red Band, shall indicate the physical limit to which the poles of the Phase Comparators are inserted between live components or touch them.

4.3.2.2.7. The phase comparator instruments covered under this specification shall conform to the requirements of Table 2 and 3 whereas the shape shall conform to Fig. 2.

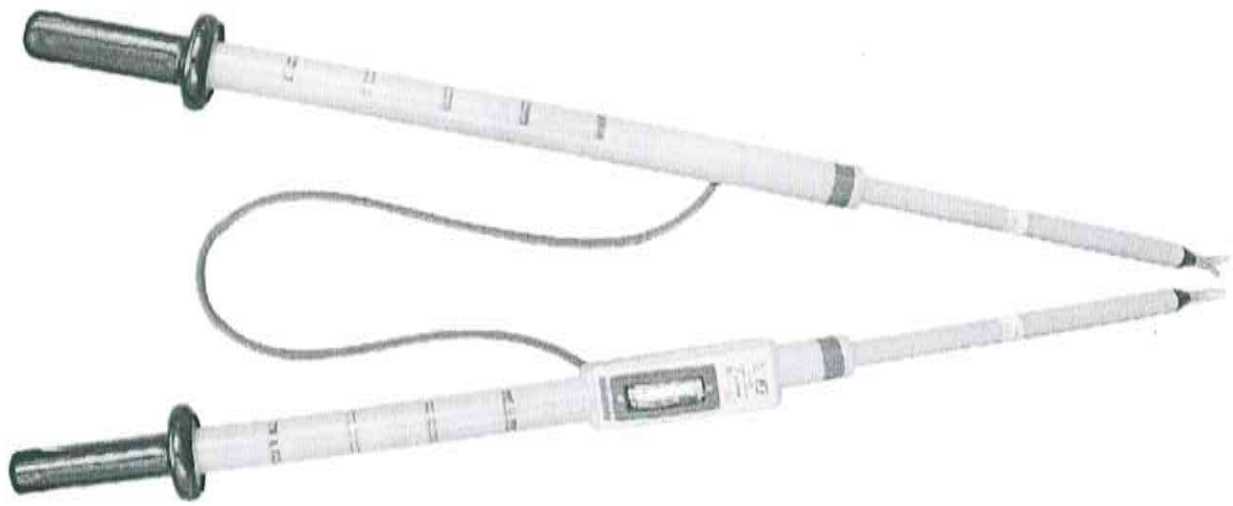

Fig. 2: General arrangement drawing for double-pole phase comparator.

4.3.2.3. **Accessories**

The phase comparator shall be supplied complete with the following accessories;

a) Two (2) Y-shaped contacts and one (1) hook contact,
b) Two (2) rose contacts
c) Carrying case and cleaning kit
d) Instruction manual and IEC Certificate of conformance.

Table 2: Technical particulars of Voltage Comparators:

Two-pole phase comparators design parameters		
System voltage, kV	11	33
Full scale voltage, kV	12	36
Maximum voltage, kV	15	40
Display type	Neon and digital panel meter	
Total resistance, MΩ	6.78	19.68
Tolerance	±5 %	
Response time, s	< 1	
Neon threshold, kV	±1.2	
Neon fully lit, kV	±1.5	
Handle material	Composite material with polyurethane	
Front end material	Fiberglass wound tubing	
Deflection of meter	The contact electrodes shall not be deflected by more than 150 mm when loaded at the electrode by 10 N	
Connection lead cord strength	Each pole connected shall withstand 10,000 swing with 10 N load applied and a vertical pull with 200 N applied.	

Table 3: Insulation rod mechanical and electrical parameters

Item		**Value**
Handle material		Composite material with Polyurethane
Front end material		Fiberglass wound tubing
Length of insulating element, mm	11 kV	> 400
	33 kV	> 800
Length of handle, mm		> 800
Frequency withstand voltage test		100kV/3mm
Leakage current, μA		30
Minimum rod diameter, mm		24
Impact resistance, MPa/cm		>147
Buckling resistance, MPa		>343
Surface resistivity (after water-immersed), Ω		$>10 \times 10^{11}$
Volume resistivity, Ω/cm		$.10 \times 10^{31}$

4.3.3. Voltage Detector (Voltage Testers), 0 - 66kv

4.3.3.1. Design and construction

4.3.3.1.1. The voltage detector shall be of the capacitive type, to be used in contact with the conductor / equipment to be tested and shall conform to the requirements of IEC 61243-1.

4.3.3.1.2. The voltage detector shall be a complete device which shall include at least the following elements: handle, hand guard, insulating element, limit mark, indicator, and contact electrode with or without contact electrode extension as per IEC 61243-1 Figure 1a).

4.3.3.1.3. The voltage detector shall have the testing element built-in i.e. not utilising a testing element separately installed between the detector and the item to be tested

4.3.3.2. Operating Voltage Range and Electrical Characteristics

4.3.3.2.1. The voltage detector shall not be fitted with a voltage selection switch shall be suitable for use with system nominal voltages ranges as follows:

a) Minimum nominal voltage, Un min. = 0 kV.
b) Maximum nominal voltage, Un max. = 36 kV.
c) Maximum nominal voltage, Un max. = 72.5 kV.

4.3.3.2.2. The voltage detector and its components shall be rated for making contact with live conductors at a potential of Un maximum continuously and with unlimited time duration. The maximum duration of live contact shall be specified and shall not be less than 5 min refer IEC 61243-1 Section 4.2.9.

4.3.3.2.3. The voltage detector shall be able to withstand without damage and thus not affect its operational functionality, transient voltages that may appear on KPLC AC distribution system up to 50% greater than Un maximum.

4.3.3.2.4. The accuracy of the voltage detector shall be 2% or better over the range Un minimum to Un maximum and shall operate between 97% and 103% of the nominal operating frequency of 50Hz.

4.3.3.2.5. The type of detector to be supplied shall comply with the threshold voltage of Section 4.2.1.2 of IEC 61243-1. The voltage detector shall shut down after 3 minutes of inactivity i.e. enter a sleep mode.

4.3.3.2.6. The voltage detector shall comply with all the safety, environmental and design requirements of clause 4.2 and Table 1 of this specification

4.3.3.3. **Indication**

The voltage detector shall provide:

a) Clear perceptibility under normal light, at night, in all weather conditions, and in high ambient noise conditions from a distance of at least 3 m from the user.
b) Clear perceptibility when held with the electrode pointing to the sun, i.e. glare shall not prevent a person from reading the indicator.
c) Clear indication of the state "voltage present" and/or "voltage not present" as per IEC 61243-1 section 4.1.2 and 4.2.1.
d) The tester shall have both visual and audible indications (Group I) as per IEC 61243-1 section 4.2.2.
e) The tester shall have digital voltage readout between 0 and Un maximum V AC
f) An audible alarm shall be initiated when the detected voltage is Un min or greater.
g) Low Battery warning indication when incorporating a built-in power source
h) A Sleep Mode function when incorporating a built-in power source.

4.3.3.4. **Self-testing Facility**

4.3.3.4.1. Self-testing facilities shall be provided to ensure that the voltage detector functions properly before and immediately after each voltage detection as per IEC 61243-1 section 4.2.7.

4.3.3.4.2. It is preferred that an "in-built" self-testing function is utilised and shall verify that:

a) The contact electrode and contact electrode extension if applicable are tested for continuity,
b) "Live" indications provided by the detector are activated and proved to be working.

4.3.3.5. **Attachment to Insulating Stick**

The voltage detector shall be designed to mount onto an insulating stick fitted with a universal adaptor in accordance with IEC 60832-2 Appendix A.

4.3.3.6. **Insulating Stick**

Insulating sticks for use with the voltage detector shall comply with the requirements below;

a) Insulating Element and Handle

(i) The insulating element and handle shall meet or exceed the requirements of all applicable sections of IEC 61243-1 and in particular sections 4.3, 4.4 and 4.5.

(ii) The handle section may be of the same material as the insulating element and integrated with it, or may be separate. Hollow or foam-filled handles shall be sealed at the end, with a rubber crutch tip or similar, to keep water out.

(iii) The insulating element shall be of a length, which ensures that a minimum distance of 1500 mm is achieved between the hand guard and the indicator.

(iv) The handle shall not be less than 800 mm long.

Note: For this measurement, the voltage detector shall be so oriented that the measured voltage can be easily read by the person holding the voltage detector.

b) Hand Guard and Limit Mark

(i) A hand guard shall be provided and it shall constitute a raised physical lip or barrier of at least 20 mm in height.

(ii) There shall be a limit mark, identifiable by a red ring about 20mm wide, which is permanent and clearly recognizable by the user. The limit mark indicates the safe insertion depth of the voltage detector which assists to prevent adverse effects of interference fields.

c) Operating Head

The operating head shall be a universal adaptor in accordance with IEC 60832-2 Appendix A. The universal adaptor shall be permanently fixed to the insulating stick by suitable means.

4.3.3.7. **Probe**

4.3.3.7.1. **General**

The detectors shall be supplied complete with the required probe that enables its use on the following:

(i) Overhead lines.
The probe shall be a pointed knurled type, suitable for conductors up to 33mm in diameter and be removable to allow replacement due to wear.

(ii) Exposed busbars of outdoor substations.
A special probe shall be provided to be used to make contact with exposed bus bars of sizes up to 100mm for outdoor substations.

4.3.3.7.2. **Mechanical Strength**

The length and mass of all probes, in conjunction with the method of fixing the contact electrode to the detector case and internal circuits, shall be designed to ensure the integrity of the detector system under normal field use for a minimum of ten years.

4.3.3.8. **Silicone Cloths**

If the operating instructions of the voltage detector require the use of a silicone oil impregnated cloth, then these shall be supplied. A silicone impregnated cloth shall be used to keep the surface of the insulating sticks clean and hydrophobic. The cloths shall be reusable. The supplier shall provide information regarding:

a) The number of times the cloths may be re-used.
b) Methods for cleaning and re-impregnating the cloths.

4.3.3.9. **Wet Weather Use**

The detectors shall be designed to be used in outdoor wet weather conditions. The voltage detector shall be certified for use in wet weather (outdoor) conditions in accordance with sections 6.1.1 and 7.1.2 of IEC 61243-1. Full instructions shall be provided regarding any special procedures and conditions that may be required during wet weather use.

4.3.3.10. **Specific Features**

The voltage detector design shall resemble Fig. 3 with characteristics as per Table 4 & 5. It shall have the following features:

a) The design shall include signalisation being effected by LEDs for visual indication (2 LEDs / 1x green, 1x red), and/or by a piezo sound element for audible indication.
b) It shall have a multiple-part design, with a handle section LH, an insulating element Li, and a head part with insertion depth Ai.
   - The handle section LH shall be the area in which the high voltage detector is to be held during voltage test.
   - The insulating element Li shall be located between the hand guard and the limit which shall be marked with a red ring.

c) It shall offer the user the required protective distance in accordance with clause 4.1.2 and sufficient insulation towards the installation part to be tested for absence of voltage.

d) The insertion depth Ai shall form part of the high voltage detector between limit mark (red ring) and contact electrode. This shall ensure reduction of the influence of interference fields on the indicator to the required safety levels provided in Table 2.

e) The instrument shall be powered by 9-volt lithium battery; with a simple battery exchange without the use of additional tool.

f) The instrument shall come complete with the following accessories:

(i) Carrying bag, - A Ø 150 mm x1220 mm long polyester tubular bag with two (2) black strap belts, one (1) shoulder strap; a lid with zipper and transparent pockets inside for instruction for use

(ii) Brass threaded fork contacts for overhead lines and special contacts for substations.

(iii) Handle extensions

(iv) Cases and wall holders

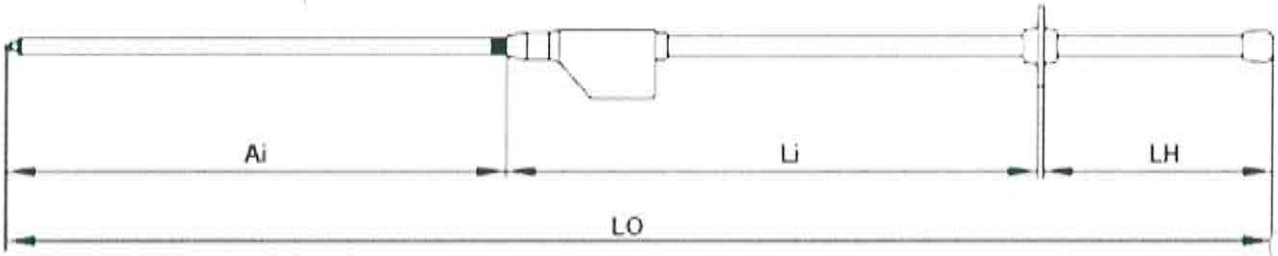

Fig. 3: High Voltage Detectors

Table 4: Technical particulars of Voltage Detector.

One-pole capacitive high voltage detector		
System voltage	33 kV	66, kV
Highest system voltage	36, kV	72.5, kV
Threshold set with range	3.3 kV to 4.95 kV	1.65 kV to 14.6 kV
Voltage range	0 – 36 kV	0 – 72.6 kV
Measurement accuracy	Manufacturer to state	
Indication group	Group I	
Frequency range	0 – 200 Hz	
Surge voltage strength	>150 kV	>300 kV
Response Time	< 1 s	
Auto- OFF, min	± 3 min	

One-pole capacitive high voltage detector	
Bridging protection	Yes
Spark protection	Yes
Power source	9 V block IEC 6 LR61 alkali-manganese indication of battery condition
Battery low	>7 V
Battery current	< 30 mA
Green - Armed	Yes
Red – V detected	Yes
Test/Arming button	Yes
Self-test	Continuous and automatic testing
Construction	For indoor and outdoor installations
Protection against enclosure	IP 65, device suitable for use in moist environments

Table 5: Insulation rod mechanical and electrical parameter

Item		Value
Handle material		Composite material with polyurethane
Front end material		Fiberglass wound tubing
Length of insulating element – Ai	33 kV	> 900
	66 kV	> 1600
Length of handle – Li + LH, mm		> 800
Frequency withstand voltage test		100kV/3mm
Leakage current, µA		30
Minimum rod diameter, mm		24
Impact resistance, MPa/cm		>147
Buckling resistance, MPa		>343
Surface resistivity (after water-immersed), Ω		$>10 \times 10^{11}$
Volume resistivity, Ω/cm		$.10 \times 10^{31}$

4.4. Quality Management System

4.4.1. The supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the high voltage test instruments design, physical properties, tests and documentation, will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2008.

4.4.2. The Manufacturer's Declaration of Conformity to applicable standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 certificate shall be submitted with the tender for evaluation.

4.4.3. The bidder shall indicate the delivery time of the items, manufacturer's monthly & annual production capacity and experience in the production of the type and size of items being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers for similar type of the high voltage test instruments sold in the last five years as well as reference letters from at least four of the customers shall be submitted with the tender for evaluation.

5.0. TESTS AND INSPECTION

5.1. The high voltage test instruments shall be inspected and tested in accordance with the requirements of IEC 61243, IEC 60832, IEC 61010-1, IEC 61481, IEC 60664- 1 & 3, IEC 61326, IEC 60112, IEC 60068, IEC 61000, IEC 60965 and IEC 60529 standards. 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 document (all in English Language)

5.3. Copies of type test reports to be submitted with the tender (by bidder) for evaluation shall be as stated below:

a) Type tests for equipment performance

- Electromagnetic compatibility (EMC)
- Impulse overvoltage tests on the equipment -Clearances
- Dielectric voltage withstand tests on the equipment - Controlled overvoltage
- Functional tests on the instruments that shall include:
  - Clear indication
  - Clear perceptibility of visual indication
  - Clear perceptibility of audible indication
  - Frequency dependence
  - Response time
  - Power source dependability
  - Check of testing element
  - Non-response to d.c voltage
  - Time rating

b) Type tests for printed circuit board coating performance

- Environmental, humidity and thermal conditioning tests
- Dielectric voltage withstand tests
  - ❖ Protection against bridging for indoor/outdoor type
  - ❖ Protection against bridging for outdoor type
  - ❖ Spark resistance
- Comparative tracking index (CTI)
- Resistance to soldering heat test
- Flammability test
- Coating adhesion test
- Insulation resistance between conducting parts

5.4. Routine and sample test reports for the high voltage test instruments 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.

5.5. On receipt of the goods KPLC will perform any of the tests specified in order to verify compliance with this specification. The supplier shall replace without charge to KPLC the test unit which upon examination, test or use; fail to meet any of the requirements in the specification.

5.6. Tests to be witnessed at the factory before shipment shall be in accordance with IEC 61010-1, IEC 60664- 1 & 3, IEC 61326, IEC 60112 and IEC 60529 standards and this specification and shall include the following:

a) Visual and dimensional inspection
b) Grip force and deflection (only applicable for instrument as a complete device)
c) Vibration resistance
d) Torsion and tension of the adaptor.
e) Drop resistance
f) Shock resistance
g) Climatic dependence
h) Degree of protection
i) Durability of markings
j) Functional tests on the instruments as per clause 5.3a

6.0. MARKING AND PACKING

6.1. PACKING

6.1.1. The high voltage test instruments shall be carried in a sturdy tubular polyester bag case with two (2) black strap belts, one (1) shoulder strap; a lid with zipper and transparent pockets inside for instruction for use.

6.1.2. The accessories shall be packed in suitable matching bag with a shoulder carrying strap and a hand grip.

NOTE:

a) All equipment shall be suitably packed for protection against damage during loading, unloading, transport and storage.

b) Parts subject to damage due to vibration shall be removed and separately packed if necessary.

6.2. MARKING

The high voltage test instruments and its accessories shall be marked in a permanent manner with the following information (in English Language):

a) Product name and name of manufacturer
b) Type of instrument (description of type, number and overall size of sections)
c) Model: for indoor or outdoor use.
d) Nominal voltage range of operation
e) Assembly information for the high voltage instrument i.e. "Only to be used by insulating sticks".
f) Explanation visual and audible indication
g) Date for next periodic testing
h) Year of construction and serial number
i) Nominal frequency
j) Type number of high voltage instrument.
k) Standard to which the instrument complies
l) Marking of accessories and devices suitable for live working
m) Indication of high voltage instrument:
   Group I: Indication with at least two distinct active signals, which give an indication of the condition "voltage present" and "no voltage present".
n) Climatic conditions (usage and storage)
o) Design: High voltage instruments with contact electrode extension are marked "Category S". This instrument may be used in substations and on overhead lines.
p) Indication of battery type or self-powering.

q) Maximum permissible measurement limits
r) The words "**Property of Kenya Power & Lighting Co**" shall be engraved permanently on each instrument while the other parameters shall be marked on a permanent label.
s) The overvoltage protection category and duty rating e.g. category IV-field.

7.0. DOCUMENTATION,

7.1. Documentation

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

a) Fully filled clause by clause description of the item on offer as per Annex A (Guaranteed Technical Particulars) and signed by the manufacturer;
b) Copies of the Manufacturer's catalogues, brochures, detailed design 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 relevant type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
f) Copy of accreditation certificate to ISO/IEC 17025 for the third party testing laboratory;
g) Manufacturers letter of authorization, ISO 9001:2008 certificate and other technical documents required in the tender.
h) A full list of deliverables required under the contract regarding the number of sets of equipment required, including:
   - Insulating sticks;
   - Probe;
   - Silicone cloths;
   - Carry cases; and
   - Spares.

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

a) Guaranteed Technical Particulars signed by the manufacturer;
b) Design drawings with details of the high voltage test instruments to be manufactured for KPLC.
c) Quality assurance plan (QAP) that will be used to ensure that the 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) All documentation necessary for safety of the equipment as specified in IEC 61010-1 clause 5.4 shall be provided with the equipment.

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 test set for The Kenya Power & Lighting Company;

g) The manufacturer shall be required to also provide detailed information regarding the instruments:

(i) Maintenance Requirements

The supplier shall advise on the following requirements in relation to:

- Before-use inspection.
- Periodic maintenance and test including but not limited to the frequency and details of maintenance and test requirements of all components of the instruments and components such as the insulating stick, battery, etc. It is preferred that the battery be user replaceable without the need for special tools or re-calibration.

(ii) Essential Spares

The supplier shall advise the minimum quantity of essential spares to be kept by the purchaser (KPLC) to ensure repair of the instruments can be carried out properly.

(iii) Instructions for Use

The supplier shall provide comprehensive instructions, drawings and information for use of the instruments and their adaptors. As a minimum, the instructions shall address the following:

- Correct operation.
- Care and maintenance by the operator.
- Service, testing and repair.

Where the manufacturer's standard brochures and instructions do not meet this requirement, the supplier shall provide the necessary information as a supplement to that of the brochure.

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 high voltage test instruments to KPLC stores.

ANNEX A: *Guaranteed Technical Particulars (to be filled and signed by the supplier and submitted together with copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records and copies of test certificates for tender evaluation)*

Tender No ..... Bidder's Name & Address .....

	Description	Bidder's Offer
1	Name of the manufacturer and country of origin	
	Type Reference Number or Model Number	
2	Applicable Standards	
3	Terms and Definitions	
4	Requirements	
4.1	Service conditions	
4.1.1	Physical conditions	
4.1.2	Approach & Insulation Distance Information	
4.2	Safety and environmental requirements	
	4.2.1 – 4.2.8	

Safety and environmental design requirements

	Particulars	KPLC Requirements	
	Operating temperature	-25°C--- +55°C	
	Storage temperature	-5 ... +60 °C (23 ... +140 °F)	
	Humidity range - Rel. humidity	20% -- 96%, non-condensing	
	Shock (operating)	15 g / 11 ms half sine as per IEC 60068-2-27	
	Vibration (operating)	IEC 60068-2-6: Test Fc (Test level 2) Frequency range from 10 Hz to 150 Hz, continuous acceleration 2 g (20 m/s^2), 20 cycles per axis	
	Dry heat test	IEC 60068-2-2: Type A test (Test level 2) Temperature - $55^0C \pm 2^0C$ Duration of exposure – 2 h	
	Damp heat test	IEC 60068-2-30: Test Db Test level 2 Temperature - $55^0C \pm 2^0C$ Relative humidity – 93 % Duration of exposure – 4 h	
	Salt mist test	IEC 60068-2-11 – Test level 4 Saline solution – 5 % NaCl, pH value- 6.5 – 7.2 %, Temperature – 35^0C Duration – 96 h	
	Flammability test	IEC 60695-2-11 – Needle flame test	

	Emission standards for residential, commercial and light-industrial environments	IEC 61000-6-3 - Class A	
	Electrostatic discharge requirements	IEC 61000-4-2 – Test level 3 Air discharge - 8kV, Contact discharge - 6kV	
	Radiated, radio-frequency, electromagnetic field immunity tests	IEC 61000-4-3 – Test level 3 10 V/m (80 MHz bis 1 GHz)	
	Fast Transients/Bursts	IEC 61000-4-4: Test level 2 Min Values ±1 kV (5/50 ns, 5kHz)	
	Surges on signal, data and control lines	IEC 61000-4-5- Test level 3 Line to ground voltage – 2.0 kV Line to Line voltage – 1.0 kV	
	Rated Impulse Voltage for equipment -1.2/50µs	6000 V as per IEC 60664-1, table 1	
	Overvoltage category	Class IV 600 V as per IEC 61010-1	
	Pollution category	Degree 2 as per IEC 60664-1 clause 2.5.1	
	Insulation material group	Group II - 400≤CTI<600 (PLC=1) as per IEC 60112 and IEC 60664-1 clause 2.7.1	
	Minimum clearances for equipment to withstand steady state voltages, temporary over-voltages and to avoid partial discharge	As per IEC 60664-1, section 3, clause 3.1 and Table 1	
	Partial discharge requirements	As per IEC 60664-1 Annex C	
	Solid insulation design	Shall withstand short term and long term stresses as per IEC 60664-1 clause 3.3	
4.3	Specific Requirements		
4.3.1	High voltage phase comparators (Phasing out stick) – 0 – 72.5 kV		
	4.3.1.1 – Design and construction		
	4.3.1.1.1 - 4.3.1.1.1.7		
	4.3.1.2 Features		
	4.3.1.2.1 - 4.3.1.1.2.4		
	4.3.1.3 Phasing measurements		
	4.3.1.3.1 - 4.3.1.3.4		
	4.3.1.4 Readings		
	4.3.1.5 Results		
	4.3.1.5.1 - 4.3.1.5.4		
	4.3.1.6 Accessories		
Insulation rod mechanical and electrical parameters			

	Length of insulating element – Ai mm	> 1600	
	Length of handle – Li + LH, mm	> 800	
	Frequency withstand voltage test	100kV/3mm	
	Leakage current, μA	30	
	Minimum rod diameter, mm	24	
	Impact resistance, MPa/cm	>147	
	Buckling resistance, MPa	>343	
	Surface resistivity (after water-immersed), Ω	$>10 \times 10^{11}$	
	Volume resistivity, Ω/cm	$.10 \times 10^{31}$	
4.3.2	High voltage phase comparator		
	4.3.2.1 Design and construction		
	4.3.2.1.1 - 4.3.2.1.6		
	4.3.2.2 Principles of operation		
	4.3.2.2.1 - 4.3.2.2.7		
	4.3.2.3 Accessories		
Two-pole phase comparators design parameters			
	System voltage, kV	11 (33)	
	Full scale voltage, kV	12 (36)	
	Maximum voltage, kV	15 (40)	
	Display type	Neon and digital panel meter	
	Total resistance, MΩ	6.78 (19.68)	
	Tolerance	±5 %	
	Response time, s	< 1	
	Neon threshold, kV	±1.2	
	Neon fully lit, kV	±1.5	
	Handle material	Composite material with polyurethane	
	Front end material	Fiberglass wound tubing	
	Deflection of meter	The contact electrodes shall not be deflected by more than 150 mm when loaded at the electrode by 10 N	
	Connection lead cord strength	Each pole connected shall withstand 10,000 swing with 10 N load applied and a vertical pull with 200 N applied.	
	Insulation rod mechanical and electrical parameters		
	Handle material	Composite material with Polyurethane	

	Front end material	Fiberglass wound tubing	
	Length of insulating element, mm 11 kV (33 kV)	> 400 (> 800)	
	Length of handle, mm	> 800	
	Frequency withstand voltage test	100kV/3mm	
	Leakage current, µA	30	
	Minimum rod diameter, mm	24	
	Impact resistance, MPa/cm	>147	
	Buckling resistance, MPa	>343	
	Surface resistivity (after water-immersed), Ω	$>10 \times 10^{11}$	
	Volume resistivity, Ω/cm	$>10 \times 10^{31}$	
4.3.3	Voltage Detector (Tester) : 0 – 72.5 kV		
4.3.3.1	General		
	4.3.3.1.1 - 4.3.3.1.3		
4.3.3.2	Operating voltage range & electrical characteristics		
	4.3.3.2.1 - 4.3.3.2.7		
4.3.3.3	Indication		
	a - h		
4.3.3.4	Self-Testing Facility		
	4.3.3.4.1. - 4.3.3.4.2		
4.3.3.5	Attachment to insulating stick		
	4.3.3.5.1 - 4.3.3.5.4		
4.3.3.6	Insulating stick		
	a. Insulating element handle		
	b. Hand guard and limit mark		
	c. Operating head		
4.3.3.7	Probe		
4.3.3.7.1	General		
4.3.3.7.2	Overhead mechanical strength		
4.3.3.8	Silicon cloths		
4.3.3.9	Wet weather use		
4.3.3.10	Specific features		
Technical particulars of Voltage Detector (Tester)			
	System Voltage	33 kV (66 kV)	
	Highest system Voltage	36 kV (66 kV)	
	Threshold Set with Range	3.3 kV to 4.95 kV (1.65 kV to 14.6 kV)	
	Voltage range	0 – 36 kV (0 – 72.5 kV)	
	Measurement accuracy	Manufacturer to state	

	Indication group	Group I	
	Frequency range	0 – 200 Hz	
	Surge voltage strength	>150 kV (> 300 kV)	
	Response Time	< 1 s	
	Auto- OFF, min	± 3 min	
	Bridging protection	Yes	
	Spark protection	Yes	
	Power source	9 V block IEC 6 LR61 alkali-manganese indication of battery condition	
	Battery low	>7 V	
	Battery current	< 30 mA	
	Green - Armed	Yes	
	Red – V detected	Yes	
	Test/Arming button	Yes	
	Self-test	Continuous and automatic testing	
	Construction	For indoor and outdoor installations	
	Protection against enclosure	IP 65, device suitable for use in moist environments	
	Insulation rod mechanical and electrical parameter		
	Handle material	Composite material with polyurethane	
	Front end material	Fiberglass wound tubing	
	Length of insulating element – Ai 36 kV (72.5 kV), mm	> 900 (> 1600)	
	Length of handle – Li + LH, mm	> 800	
	Frequency withstand voltage	100kV/3mm	
	Leakage current, µA	30	
	Minimum rod diameter, mm	24	
	Impact resistance, MPa/cm	>147	
	Buckling resistance, MPa	>343	
	Surface resistivity (after water-immersed), Ω	$>10 \times 10^{11}$	
	Volume resistivity, Ω/cm	10×10^{31}	
4.4	Quality Management System		
	4.4.1 – 4.4.3		
5.0	Tests and Inspection		
	5.1 – 5.6		
6.0	Marking and packing		
	6.1 Packing		
	6.1.1 – 6.1.3		

	6.2 Marking	
7.0	Documentation	
	7.1– 7.3	
8.0	Manufacturer's Guarantee and Warranty	
9.0	List catalogues, brochures, technical data and drawings submitted to support the offer.	
10.0	List customer sales records and customer reference letters submitted to support the offer.	
11.0	List Test Certificates submitted with tender	
12.0	List test & calibration reports to be submitted to KPLC for approval before shipment	
13.0	Statement of compliance to specification (indicate deviations if any & supporting documents)	
14.0	List Acceptance Tests to be witnessed by KPLC Engineers at the factory	

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Manufacturer's Name, Signature, Stamp and Date