



TITLE:
**SPECIFICATION FOR LIVE LINE
TOOLS**
Part 9: Live Working - Earthing
(Grounding) Sets and Clamps;

Doc. No.	KP1/3CB/TSP/09/043-9
Issue No.	1
Revision No.	0
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Issued by: Head of Section, Tech Standards & Specifications

Signed:

Date: 2013-09-26

Authorized by: Head of Department, Research & Development

Signed:

Date: 2013-09-26



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0.1 Circulation List

COPY NO.	COPY HOLDER
1	Research & Development Manager
2	Procurement Manager
Electronic copy (pdf) on Kenya Power Server (currently :Network-\\stima-fprnt-001\techstd&specs	

0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
0	2013/09/26	New Issue	Michael Apudo 	G. Owuor

Issued by: Head of Section, Tech Standards & Specifications

Signed:

Date: 2013-09-26

Authorized by: Head of Department, Research & Development

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Date: 2013-09-26

FOREWORD

This specification has been prepared by the Research and Development Department in collaboration with Common Services Section of The Kenya Power and Lighting Company Limited (abbreviated as KPLC) and it lays down requirements for Earthing (Grounding) Sets and Clamps rated 15kV and 35kV for live line work. It is intended for use by Kenya Power in purchasing items.

1. SCOPE

- 1.1. This specification is for earthing (grounding) sets and clamps for use in Live Line work along power lines, in substations and electrical installations.
- 1.2. This specification covers the following range of items for live line work:-
 - a) Earthing (Grounding) Sets;
 - b) Earthing (Grounding) Clamps.
- 1.3. The specification also covers inspection and test of the earthing (grounding) sets and clamps as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer and submitted for tender evaluation.
- 1.4. The specification stipulates the minimum requirements for earthing (grounding) sets and clamps; acceptable for use in the company and it shall be the responsibility of the supplier to ensure adequacy of the design, good engineering practice, adherence to the specification and applicable standards and regulations as well as ensuring good workmanship in the manufacture of the earthing (grounding) sets and clamps for The Kenya Power & Lighting Company.
- 1.5. **Brand names or catalogue numbers referred to in this specification are intended to be descriptive only and not restrictive. The Tenderer may adopt higher standards, brand names, and or catalogue numbers in its Tender, provided that it demonstrates to KPLC's satisfaction that the substitutions ensure equivalence to the requirements.**
- 1.6. The specification does not purport to include all the necessary provisions of a contract.

2. REFERENCES

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The following standards contain provisions which, through reference in this text, constitute provisions of this specification. Unless otherwise stated, the latest edition of the referenced documents (including any amendments) applies.

ASTM F855:	Standard Specification for Temporary Protective Grounds to Be Used on De Energized Electric Power Lines and Equipment
NEMA WC 74	Standard Specification for 5-46kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
ASTM B33:	Standard Specification for Tinned Soft or Annealed Copper for Electrical Purposes
ISO 1461.	Standard Specification for Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods.
IEC 61230:	Standard Specification Live working –Portable equipment for earthing or earthing and short circuiting.
OSHA Regulation standards 1910.269: Part J: Live Line Tools	
UL 467:	Ground and Bonding Equipment

3. TERMS AND DEFINITIONS

3.1. For the purpose of this specification, the definitions given in the reference standards shall apply together with the following abbreviations.

3.2. Abbreviations

- 3.2.1. **IEC:** International Electro-technical Commission
- 3.2.2. **ISO:** International Standards Organization
- 3.2.3. **OSHA:** Occupational Safety and Health Administration
- 3.2.4. **ASTM:** American Society for Testing and Materials
- 3.2.5. **UL:** Underwriters Laboratories
- 3.2.6. **Hollow tube:** An insulating tube that is manufactured from material such as synthetic materials that may be reinforced with mineral or artificial fibers.
- 3.2.7. **Solid rod:** An insulating rod that is manufactured from material such as synthetic materials that may be reinforced with mineral or artificial fibers.
- 3.2.8. **EPR** - Ethylene-propylene rubber.
- 3.2.9. **UNC** – Unified National Course Thread

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4. REQUIREMENTS

4.1. SERVICE CONDITION

4.1.1. Physical conditions

The Earthing (Grounding) Sets and Clamps shall be suitable for continuous use outdoors in tropical areas at;

- Altitudes of up to 2200m above sea level,
- Humidity of up to 90%,
- Average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C and
- Heavy saline conditions along the coast.

4.1.2. Approach & Insulation Distance Information

- MAD** = Minimum Approach Distance is the minimum air gap or summation of air gaps measured between any part of the operator and live electrical apparatus as per OSHA Regulation standards 1910.269: Part J.
- Detailed information can be found in OSHA guidelines in Table R-6 of the Federal Register. A small extraction from this standard is shown below for minimum standard distances based on ideal circumstances.

Table 1: Live Working Recommended Minimum Distances at a Glance

Nominal Voltage AC (kV) Auto-reclose Distance	Minimum Approach Distance (MAD)	
	Phase to Earth	Phase to Phase
	OFF (mm)	OFF (mm)
11	350	400
33	450	550
66	600	800
132	900	1300
220	1300	2000

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4.2. GENERAL REQUIREMENTS

- 4.2.1. The earthings (grounding) set cables and clamps shall be manufactured as per the requirements of ASTM F855, IEC 61230 and this specification.
- 4.2.2. The jumper cables shall have extra flexible alloy-tin coated copper-stranded conductors, assembled in a unidirectional rope lay as per ASTM B-33 and meets the requirements of ASTM F855.
- 4.2.3. The earthings (grounding) set cables shall also be manufactured from insulation and conductor screen which meets and exceed NEMA WC 74 standard.
- 4.2.4. The cables shall possess a semiconducting shield surrounding it to relieve it from voltage stresses and improve on its dielectric strength and service life.
- 4.2.5. The cables and clamps shall be classified and rated as per Table 2 and 3, with a natural orange in colour and PVC (Poly Vinyl Chloride) jacketed.
- 4.2.6. The cable sizes (metric area (AWG)) and voltage ratings shall be embossed at 1.22m (4ft) intervals on the PVC insulated jacket of the cables for easy identification unless otherwise stated.
- 4.2.7. The cable characteristics shall be as per the following tables.

Table 2: Earthing Set Ratings as per ASTM F855 specifications

Earthing (Grounding) Set Ratings									
Grade	Short Circuit Properties ^A							Continuo us Current Rating, A RMS, 50Hz	Minimum Cable Size with Ferrule Installed Equal or Larger Than
	Withstand Rating, Symmetrical kA RMS, 50Hz			Ultimate Rating/Capacity, ^B Symmetrical kA, 50Hz					
	Copper Cable Size, (mm ²)	15 cycles (250ms)	30 cycles (500ms)	6 cycles (100ms)	15 cycles (250ms)	30 cycles (500ms)	60 cycles (1s)		
1	35	14	10	29	18	13	9	200	35
2	50	21	15	48	30	21	15	250	50
3	70	27	20	61	38	27	19	300	70
4	95	34	25	76	48	34	24	350	95
5	120	43	30	96	60	43	30	400	120
6	2x70	54	39	114	72	51	36	450	2x70
7	2x95	74	54	159	101	71	50	550	2x95

^A – Withstand and ultimate short circuit properties are based on performance with surges not exceeding 20% asymmetry factor.

^B – Ultimate rating represents a symmetrical current which the clamp shall carry for the specified time.

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Table 3: Earthing (Grounding) Cable characteristics – PVC Jacketed as per ASTM F855 specifications

No	Cable properties	35mm ²	70mm ²	95mm ²	120mm ²
1	Continuous current, A	200	250	300	400
2	Fault current, 15 cycles, kA	14	21	27	43
3	Fault current, 30 cycles, kA	10	15	20	30
4	Strands	665	1045	1330	2109
5	Cable diameter, mm	8	10	12	15
6	Approx. cable outer diameter, mm	24	17	19	22
7	Weight , kg/km	0.671	0.729	0.802	1.360

4.3. SPECIFIC REQUIREMENTS

4.3.1. Earthing (Ground) Clamps

- 4.3.1.1. This specification recommends the use of a duckbill-type (Snap-on) type earthing (grounding) clamp.
- 4.3.1.2. They shall be made of aluminum body, serrated jaws, bronze eye screw with fine threads, and a bronze pressure-type terminal as per ASTM F855 Type I Class B Grade 5.
- 4.3.1.3. The minimum and maximum opening of the jaws shall be 13mm (1") and 44mm (1 3/4") respectively.
- 4.3.1.4. The main line range for its application shall be 0.5" to 1.625" diameter conductors or 120mm² to 800mm² ACSR conductors.
- 4.3.1.5. Continuous current rating of the clamp shall be 400A; with a short circuit fault current for 15 cycles being 43kA and 30 cycles being 30kA.
- 4.3.1.6. The recommended torque for the clamp shall be 339 Nm for use with the jumpers ranging from 16 mm² to 120mm² with plain terminal.
- 4.3.1.7. The ground clamps shall be designed and manufactured as per Fig. 6.

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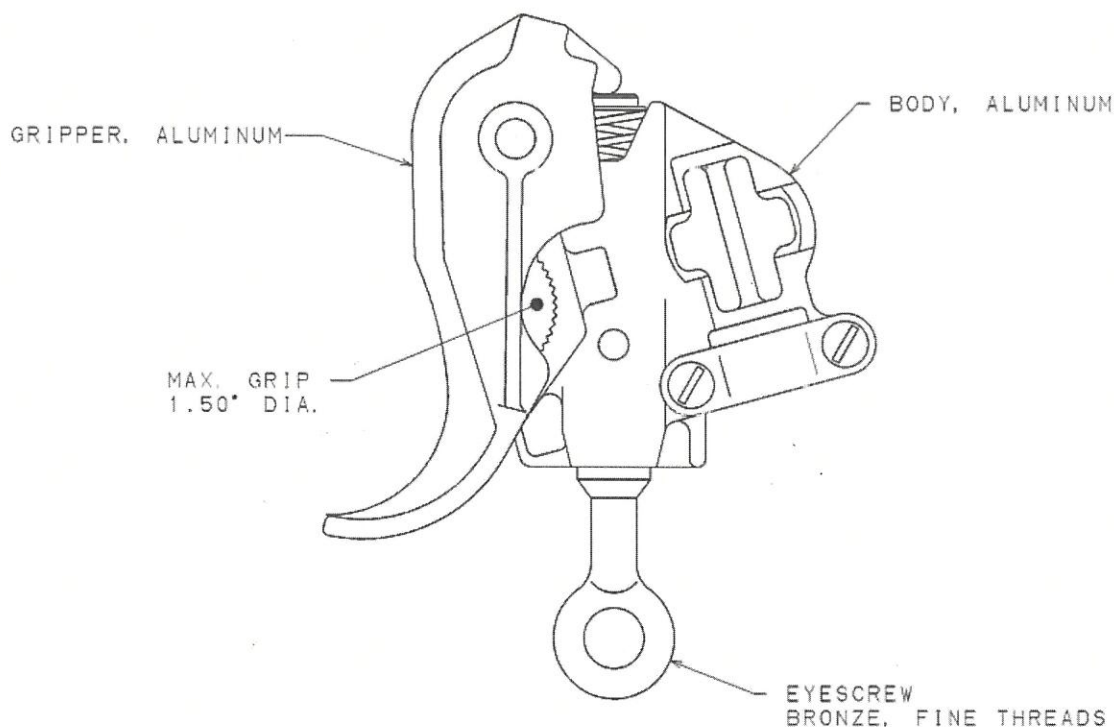


Fig. 6: Earthing clamp

4.3.2. Earthing (Ground) Sets

- 4.3.2.1. Earthing sets shall include three upper heads that can easily and safely be attached to the line using fiberglass handles. They shall be designed to be functionally fit for use with the clamps described in clause 4.3.1.
- 4.3.2.2. They shall have adequate capacity to withstand maximum potential system fault current magnitudes at full time duration, for both the clamp and the cable.
- 4.3.2.3. The set shall be designed to have coordinated connectors with threaded type terminals selected for clamps which shall be fit to use on plain cable ferrules to match.
- 4.3.2.4. Each earthing set shall be supplied complete with the following parts:

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4.3.2.4.1. Clamps

- 4.3.2.4.1.1. The total number shall be ten (10) serrated duckbill type earthing clamps per set; designed to meet ASTM designations for Type, Class and Grade as detailed in clause 4.3.1.
- 4.3.2.4.1.2. These clamps shall be applied to angle irons, flat busses as well as on-line wires.

4.3.2.4.2. Plain Plug Ferrules

- 4.3.2.4.2.1. Plain plug type ferrules made of tinned copper shall be ten (10) per set. The ferrules shall be shrouded type and shall overlap onto the grounding cable jacket for stress relief to the terminal.
- 4.3.2.4.2.2. They shall have two crimps to secure the ferrule against the bare strands and one crimp to be applied on the jacket.
- 4.3.2.4.2.3. They shall be available as either factory-installed in pairs on any cable length specified or as separate individual units and shall be installed simply with a hydraulic crimping tool.
- 4.3.2.4.2.4. A complete illustrated installation instruction shall be provided with the ferrules and shall include a table for the crimping die sizes to use.

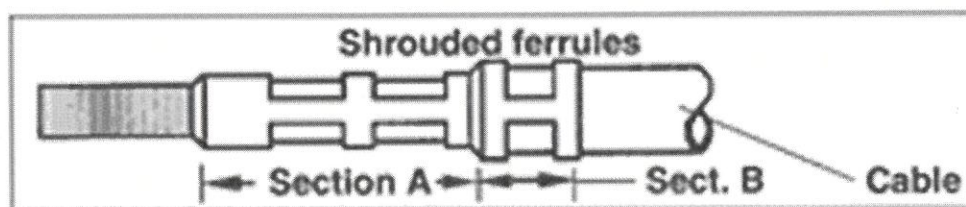


Fig. 8: Plain plug ferrules

4.3.2.4.3. Copper Earthing (Ground) Cable

- 4.3.2.4.3.1. Copper earthing cable shall be 18.288m (60') in length, extra-flexible (as per ASTM B33), strong and tough for easy handling and long wear.

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- 4.3.2.4.3.2. It shall be subdivided in three categories:
- 3no cables of 1.8288m (6') long,
 - 1no cable of 3.6576m (12') long
 - 1no cable of 9.144m (30') long
- 4.3.2.4.3.3. The jacketing of the cable shall be smooth; abrasion, weather and oil resistant in accordance with ASTM F855 specifications and it shall be marked as per clause 4.2.6 with characteristics shown on Tables 3 and 4.
- 4.3.2.4.3.4. The jackets shall be clear (which allow visual inspection of strand conditions) with ultraviolet inhibited Poly Vinyl Chloride (PVC). Recommended low temperature for PVC-jacketed cable shall be 0°F.
- 4.3.2.4.3.5. Since the cables are extra-flexible with extra-fine strands, they shall be terminated using ferrules to accommodate ground clamps.

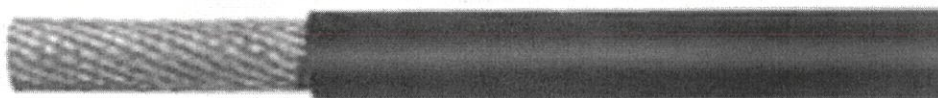


Fig. 9: PVC jacketed copper cable.

4.3.2.4.4. Clamp Support Stud

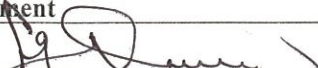
- 4.3.2.4.4.1. There shall be three (3) support studs per set installed on any pressure type terminal earthing clamp, in place of the restraining strap immediately below the pressure terminal.
- 4.3.2.4.4.2. The studs shall also serve as a mechanical parking stand for a second clamp, preventing the clamp from making contact with the conductor or ground.
- 4.3.2.4.4.3. They shall have features that are particularly beneficial in three-phase grounding application.
- 4.3.2.4.4.4. The clamp support stud shall be designed and manufactured as per Fig. 10.

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Fig. 10a: Clamp support stud



Fig. 10a: Three-way earthing clamp with support stud on conductors

4.3.2.4.5. Screw Earthing Rod

- 4.3.2.4.5.1. One (1) screw earthing rod per set shall be provided which shall offer a temporary earth where a system earth is not available.
- 4.3.2.4.5.2. The copper weld (copper jacketed steel) rod shall be 17 ±1mm diameter and 1,500mm total length with a steel-tube handle, dismountable for easier conditioning , a brass-thread and a wing nut made of bronze.
- 4.3.2.4.5.3. When installed the spiraled (helical) screw earthing rod shall develop less resistance than the straight earth rods.
- 4.3.2.4.5.4. The earth rod shall meet the requirements of UL 467 standard specification. Its approximate weight shall be 3.16 kg.

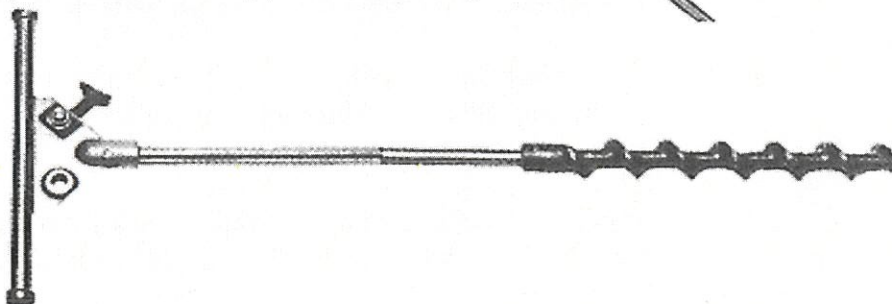


Fig. 11: Screw Earthing Rod

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4.3.2.4.6. Earthing (Ground) Cluster Support

- 4.3.2.4.6.1. This shall only be one (1) per set. It shall be a compact 127mm (5") aluminum-alloy bar 16mm (5/8") in diameter that accepts a "C" type or duckbill clamps for phase-to-phase earthing (grounding) technique.
- 4.3.2.4.6.2. It shall possess an adjustable wheel binder and a 914.4mm (36") chain for wood-pole applications.
- 4.3.2.4.6.3. Continuous current rating shall be 400A with short circuit fault current for 15 cycles being 43kA and 30 cycles being 30kA.



Fig.12: Earthing Cluster Support.

4.3.2.4.7. Shrink Tubing

- 4.3.2.4.7.1. The 15cm (6") long shrink tubing shall be eight (8) per set for use with the shrouded ferrules described in clause 4.3.2.4.2.
- 4.3.2.4.7.2. They shall clear heat-shrink tubes and shall act as corrosion-inhibitor by excluding moisture and stress-relief for cable jacket and ferrule-to-stranding connection
- 4.3.2.4.7.3. The shrink tubing shall be used as a terminal connection strain relief that fits in a 35mm² through 120mm² terminals and ground cable.



Fig. 13: 150mm (6") shrink tubing inserted in a ferrule.

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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 earthing (grounding) sets and clamps design, material, workmanship, tests, service capability, maintenance and documentation, will fulfill the requirements stated in the contract documents, standards, specifications and regulations.
- 4.4.2. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008.
- 4.4.3. 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.
- 4.4.4. The bidder shall indicate the delivery time of the earthings (grounding) sets and clamps, manufacturer's monthly & annual production capacity and experience in the production of the type and size of items being offered.

5.0. TESTS AND INSPECTION

5.1. Type Tests

- 5.1.1. The earthing (grounding) sets and clamps shall be inspected and tested in accordance with the requirements of IEC 61230, NEMA WC 74, ASTM F855, ASTM F711, ISO 1461 and OSHA Regulation 1910.269 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.
- 5.1.2. 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)
- 5.1.3. Copies of type test reports to be submitted with the tender (by bidder) for evaluation shall be as stated below:
- Aging test.
 - Voltage test.
 - Insulation resistance tests.
 - Discharge residence tests.
 - Partial Discharge Extinction (Corona) Level

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- f) Fatigue and humidity penetration tests on cable with end fittings
- g) Tension tests on cable end fittings
- h) Tests on clamps, permanent connections points and connection
- i) Short circuit current tests.

5.2. Routine Tests

5.2.1. Routine and sample test reports for the earthing (grounding) sets and clamps to be supplied shall be submitted to KPLC for approval before shipment/delivery of the goods. KPLC Engineers will witness tests at the factory before shipment.

5.2.2. On receipt of the goods KPLC may perform any of the tests specified in order to verify compliance with this specification. The supplier shall replace without charge to KPLC the earthing (grounding) sets and clamps which upon examination, test or use; fail to meet any of the requirements in the specification.

5.2.3. Tests to be witnessed by KPLC Engineers at the factory before shipment shall be in accordance with IEC 61230, NEMA WC 74, ASTM F855, ASTM F711 and OSHA Regulation 1910.269 standards and this specification and shall include the following:

- a) Visual and dimensional inspection
- b) Durability of marking
- c) Voltage test.
- d) Insulation resistance tests
- e) Discharge residence tests.
- f) Robustness of connecting lead and connections tests.
- g) Tests for the selection of cables
- h) Fatigue and humidity penetration tests on cable with end fittings
- i) Tension tests on cable end fittings
- j) Tests on clamps, permanent connections points and connection
- k) Short circuit current tests.

6.0. MARKING AND PACKING

6.1. MARKING

6.1.1. The earthing (grounding) sets and clamps shall be marked in a permanent manner with the following information (in English Language):

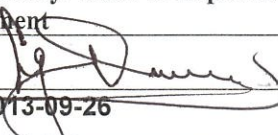
- a) Marking on earthing and short-circuiting devices

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- Short circuit current rating
 - BIL rating
 - Continuous current rating
 - Operating voltage
- b) Marking on clamps
- Tensile strength
 - Continuous current rating
 - Cable size in terms of cross-sectional area and total length
- c) Marking on cable
- The cable shall clearly and permanently be embossed with the following information throughout the length of the oversheath:
- Maximum rated current
 - Voltage rating
 - The number of cores, type and nominal area of conductors
 - Uo/U kV xxxxx (insulation type) xxxx (material type) CABLE PROPERTY OF KPLC e.g. 8.3/15kV 35 SQ. MM EPR CU CABLE PROPERTY OF KPLC
 - Weight per kilograms
- d) Marking on other components.
- Identity of the manufacturer
 - Type reference or catalogue number of the tool.
 - The standard of manufacture (ASTM F855 etc.)
 - Warning or notices if applicable for specific tools.
 - Words "**PROPERTY OF KPLC**".

6.2. PACKING

- 6.2.1.** The packaging for earthings (grounding) sets and clamps shall be on an easy-to-see, bright-yellow protective bag made of double vinyl-laminated open-weave nylon cloth which shall be lightweight and durable with nylon stitching throughout.
- 6.2.2.** It shall have a plywood bottom which is covered inside and out with metal skids on the bottom of the bag and a full-separating closure constructed with heavy-duty snaps and heavy webbing handles.
- 6.2.3.** The cases shall be furnished with an illustrated operating and maintenance instructions for the items.

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7. DOCUMENTATION

- 7.1 The bidder shall submit its tender complete with technical documents required by Annex A (Guaranteed Technical Particulars) for tender evaluation. The technical documents to be submitted (all in English language) for tender evaluation shall include the following:
- Guaranteed Technical Particulars signed by the manufacturer;
 - Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
 - Sales records for the last five years and at least four customer reference letters;
 - Details of manufacturing capacity and the manufacturer's experience;
 - Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
 - Copy of accreditation certificate to ISO/IEC 17025 for the third party testing laboratory;
 - Manufacturers letter of authorization, ISO 9001:2008 certificate and other technical documents required in the tender.
- 7.2 The successful bidder (supplier) shall submit the following documents/details to The Kenya Power & Lighting Company for approval before manufacture:
- Guaranteed Technical Particulars signed by the manufacturer;
 - Design Drawings with details of earthing (grounding) sets and clamps to be manufactured for KPLC.
 - 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
 - Detailed test program to be used during factory testing;
 - Marking details and method to be used in marking the earthing (grounding) sets and clamps;
 - 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 earthing (grounding) sets and clamps for The Kenya Power & Lighting Company;
 - Packaging details (including packaging materials).
- 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 earthing (grounding) sets and clamps to KPLC stores.

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

Tender No.

Clause number	Bidder's offer (indicate full details of the offered earthing (grounding) sets and clamps for each requirement of the specification)
Manufacturer's Name and address	
Country of Manufacture	
Bidder's Name and address	
1. Scope	
1.1-1.6	
2. Applicable Standards	
3. Terms & Definitions	
3.1: Definition in the standards	
3.2 Abbreviations	
3.2.1-3.2.9	
4. Requirements	
4.1 Service Conditions	
4.1.1-Physical conditions (a-d)	
4.1.2- Approach & Insulation Distance Information	
4.1.2.1-4.2.2	
4.2 General Requirements	
4.2.1 – 4.2.6	
4.3.5 Earthing (Ground) Clamps	
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TITLE:
SPECIFICATION FOR LIVE LINE TOOLS
Part 9: Live Working - Earthing (Grounding) Sets and Clamps;

Doc. No.	KP1/3CB/TSP/09/043-9
Issue No.	1
Revision No.	0
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Clause number	Bidder's offer (indicate full details of the offered earthing (grounding) sets and clamps for each requirement of the specification)
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Manufacturer's Name, Signature, Stamp and Date

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