



Kenya Power

TITLE:

**SPECIFICATION FOR
TERMINAL LUGS**

(Compression Type)

Doc. No.

KP1/3CB/TSP/05/029

Issue No.

3

Revision
No.

0

Date of
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2015-06-18

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0.1 Circulation List

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Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
Issue 2 Rev 0	2010-11-12	Cancels and replaces Issue 1 Rev 0 and all other previous issues	Eng. Simon Kimitei	George Owuor
Issue 3	2015-06-18	Cancels and replaces Issue 2 Rev 0 and all other previous issues	Michael Apudo	Dr. Eng. Peter Kimemia

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FOREWORD

This specification has been prepared by the Standards Department in collaboration with Network Management Division and Design and Construction Departments all of The Kenya Power and Lighting Company Limited (KPLC) and it lays down requirements for cable terminal lugs (compression lugs). It is intended for use by KPLC in purchasing the compression lugs.

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

1. SCOPE

- 1.1. This specification is for Terminal Lugs (Compression Lugs) for use on distribution power lines operating at a nominal voltage of up to 66kV and frequency of 50Hz. The lugs are class "A" connectors intended for electricity distribution or industrial networks which can be subjected to short-circuit of relatively high intensity and duration.
- 1.2. This specification covers the following:
 - a) Copper Tubular Compression Lugs;
 - b) Tinned Aluminium Tubular Compression Lugs;
 - c) Bi-metallic Tubular Compression Lugs.

NOTE: Particular requirements for each type of Compression Lugs as may be relevant for a specific requisition are given in section 4.3, 4.4 and 4.5.

- 1.3. The specification also covers inspection and test of the lugs as well as schedule of Guaranteed Technical Particulars to be filled, signed by the supplier and submitted for tender evaluation. The specification stipulates the minimum requirements for lugs acceptable for use in the company (KPLC) and it shall be the responsibility of the Manufacturer to ensure adequacy of the design, good workmanship and good engineering practice in the manufacture of the lugs for KPLC.
- 1.4. 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.

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- ISO 25239-1 to 5: Friction stir welding – Aluminium (All parts)
- ISO 2859-1: Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection
- BS EN 61238-1: Compression and mechanical connectors for power cables for rated voltages up to 36 kV (Um = 42 kV)—Part 1: Test methods and requirements
- BS EN 13600: Copper and copper alloys. Seamless copper tubes for electrical purposes.
- BS EN 754-1&2: Aluminium and aluminium alloys. Cold drawn rod/bar and tube –Part 1: Technical conditions and inspection –Part 2: Mechanical properties
- DIN 46235: Cable lugs for compression connections cover plate type, for copper conductors
- DIN 46329: Cable lugs for compression connections, ring type for aluminium conductors.

3. TERMS AND DEFINITIONS

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

4. REQUIREMENTS

4.1. SERVICE CONDITIONS

The lugs shall be suitable for continuous operation 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.

4.2. GENERAL REQUIREMENTS

- 4.2.1. The lugs in this specification shall be classified as Class A connectors and shall undergo both heat cycle and short-circuit tests in accordance with BS EN 61238-1;

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- 4.2.2. The lug shall be tubular type and be suitable for jointing to insulated cables and stranded conductors by use of compression tools. It shall correctly fit the cable or conductor it is intended for use with.
- 4.2.3. The lug shall comprise a barrel (tube) and a straight palm. The palm shall have a hole for making connection between the cable and apparatus by means of a bolt or stud.
- 4.2.4. To prevent entry of water/moisture in outdoor applications, inspection/filling hole shall not be provided.
- 4.2.5. The faces on each side of the palm shall be sufficiently parallel and flat to provide a suitable contact surface.
- 4.2.6. The lug shall have a current rating at least equal to that of the cable it is to be used with and a mechanical breaking load not less than 60% of that of the conductor it is to be used with.
- 4.2.7. All parts of the lug including the stud hole shall go through deburring and polishing operations (during manufacture) to eliminate all sharp edges.
- 4.2.8. The connectors shall be able to pass the tensile tests prescribed in Table 3 of BS EN 61238-1 and the crimping force for each category shall be as follows:
 - a) Up-to 240 mm² - 1.2 x 10⁵ N.
 - b) 300 mm² to 630 mm² - 2.0 x 10⁵ N
 - c) Above 630 mm² - 4.0 x 10⁵ N

4.3. COPPER TUBULAR COMPRESSION LUGS

4.3.1. Design and construction

- 4.3.1.1. The copper tubular compression lugs shall be made from oxygen-free high purity copper that is immune against hydrogen embrittlement suitable for use in a high electrical and thermal conductivity requirement in accordance with BS EN 13600.
- 4.3.1.2. Annealed and electrolytically tin-plated with a minimum thickness of 3µm to avoid oxidation. The annealing process optimizes the structural features of the material and allows an easier crimping and guarantees the use of the connector even with mechanical solicitations of various nature

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- 4.3.1.3. The copper shall easily be joined with all welding and brazing methods and shall be suitable for manufacturing processes requiring extreme deformability.
- 4.3.1.4. The chemical, physical, electrical/thermal and jointing and machinability characteristics of the copper tube shall be as per Table 1.

Table 1: Characteristics of the tube as per BS EN 13600

Sr. No.	Particulars	Requirements	
A	Chemical properties		
1	Chemical composition, Cu + Ag, %	99.95	
B	Physical properties		
1	Coefficient of linear expansion, 1/k	0.0000177	
2	Specific heat capacity, J/(kg x K)	385	
3	Melting temperature	1083	
4	Hardness (Soft temper), HV	35 - 65	
5	Tensile strength, N/mm ²	200 - 220	
6	0.2% Yield Strength, N/mm ²	35 - 65	
7	Elongation at break, min, %	12	
C	Electrical and thermal properties		
1	Electrical conductivity	Volume, % IACS, min	100.6
		Mass, % IACS, min	100.0
		MS/m, min	58.3
2	Electrical resistivity	Volume, Ωmm ² /m	0.0171
		Mass, Ω.g/m ²	0.1532
	Thermal conductivity, W/m.K	390	
D	Jointing and machinability		
1	Machinability rating (free cutting brass =100)	20	
2	Soldering	Excellent	
3	Brazing	Good	
4	TIG and MIG	Good	

4.3.2. Dimensions

- 4.3.2.1. The copper tubular compression lugs shall have a barrel to accommodate stranded copper conductor and palm with a single stud hole. The dimensions are according DIN 46235 and Table 2.

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4.3.2.2. The barrel shall be counter-bored to accommodate the insulation of cable. As per Table 2 suitable for cable sizes 1.5mm² – 630mm².

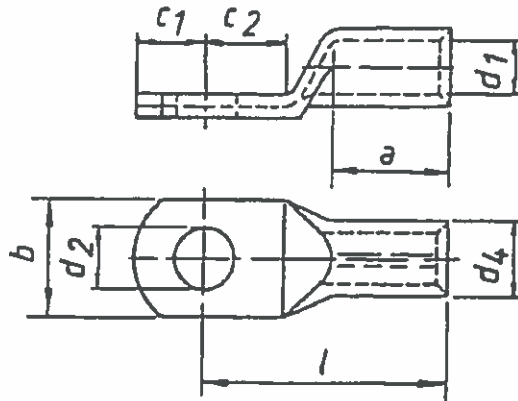


Fig. 1: Illustration of tinned tubular copper compression lugs to DIN 46235

Table 2: Copper Tubular Compression Lugs to (dimensions as per DIN 46235)

Conductor nominal cross section	Size of bolt ø	Len. a mm	Len. b Mm	Dia. d1 Mm	Dia. d2 mm	Dia. d4 mm	Dia. c1 mm	Dia. c2 mm	Len. l mm	Tube thick. mm	Palm thick. mm	Weight/ 100 pcs. ~ kg
Tolerance		min	±2	0, +4	min	min	0, -3	min.	+2.0	±0.5	±0.5	max
1.5	M6	8	11.0	1.8	6.4	2.4	6.0	5.0	15	0.3	1.0	0.07
2.5	M6	8	12.0	2.7	6.4	3.5	6.0	5.0	15	0.4	1.2	0.11
4	M6	10	12.0	3.3	6.4	4.3	6.0	5.5	17.5	0.5	1.5	0.18
6	M8	10	14.0	3.8	8.4	5.5	10.0	10.0	24	0.6	1.5	0.3
10	M8	10	15.0	4.5	8.4	6.0	10.0	10.0	27	1.0	1.5	0.38
16	M12	20	17.0	5.5	13.0	8.5	12.0	13.0	36		2.5	1.30
25	M12	20	19.0	7.0	13.0	10.0	13.0	13.0	38		3.0	1.66
50	M16	28	28.0	10.0	17.0	14.5	16.0	16.0	52		4.0	4.57
70	M16	28	30.0	11.5	17.0	16.5	16.0	16.0	55	2	4.5	6.13
95	M16	35	32.0	13.5	17.0	19.0	16.0	16.0	65		5.0	9.00
120	M20	35	38.0	15.5	21.0	21.0	21.0	22.0	70		5.5	11.03
150	M20	35	40.0	17.0	21.0	23.5	21.0	22.0	78		6.0	15.90
185	M20	40	40.0	19.0	21.0	25.5	21.0	22.0	82		6.0	18.69
240	M20	40	45.0	21.5	21.0	29.0	21.0	22.0	92		6.5	26.88
300	M20	50	46.0	24.5	21.0	32.0	22.0	22.0	100	7.0	33.24	
400	M20	70	54.0	27.5	21.0	38.5	25.0	25.0	115	2	7.5	63.019
500	M20	70	60.0	31.0	21.0	42.0	25	25.0	125		8.0	75.264
630	M20	80	64.0	34.5	21.0	44.0	25.0	27.0	135	3	10.0	79.69

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4.4. TINNED ALUMINIUM TUBULAR COMPRESSION LUGS

4.4.1. General design requirements

- 4.4.1.1. The tinned aluminium tubular compression lugs shall be manufactured from a forged high purity electrolytic EC grade Aluminium 99.5% tubes in accordance with DIN 46329 and shall have a tin coating with minimum tin coating thickness of 150µm.
- 4.4.1.2. The tinned aluminium tubular compression lugs shall be suitable for connecting to aluminium and copper bus-bars/terminations the following types of conductors:
 - (i) Stranded copper and aluminium cables;
 - (ii) Stranded all aluminium conductors
 - (iii) Stranded aluminium conductor steel reinforced (ACSR)
 - (iv) Stranded all aluminium alloy conductor (AAAC)
- 4.4.1.3. The barrel shall be packed with abrasive neutral high melting point soft grease (oxide inhibiting compound) and the ends sealed (capped). The quantity of grease shall be approximately half the volume of the bore.
- 4.4.1.4. The tinned aluminium tubular compression lugs shall be attached to the aluminium conductor by compression jointing and recommended compressing positions shall be clearly marked on the barrel.
- 4.4.1.5. The palm faces shall be flat and shall have a single hole for termination. The palm shall be protected with oil impregnated strippable plastic or other strippable suitable coating.

4.4.2. Sizes and dimensions

- 4.4.2.1. The tinned aluminium tubular compression lugs shall have a barrel to accommodate 10 – 630mm² solid and stranded copper and aluminium cables, ASCR conductors as per clause 4.4.1.2 and the palm shall have a single stud hole. The dimensions shall be according to DIN 46329 and Table 3.
- 4.4.2.2. The barrel shall be counter-bored to accommodate the insulation of the corresponding cable sizes. The shape of the tinned aluminium tubular compression lugs shall resemble Fig. 2.

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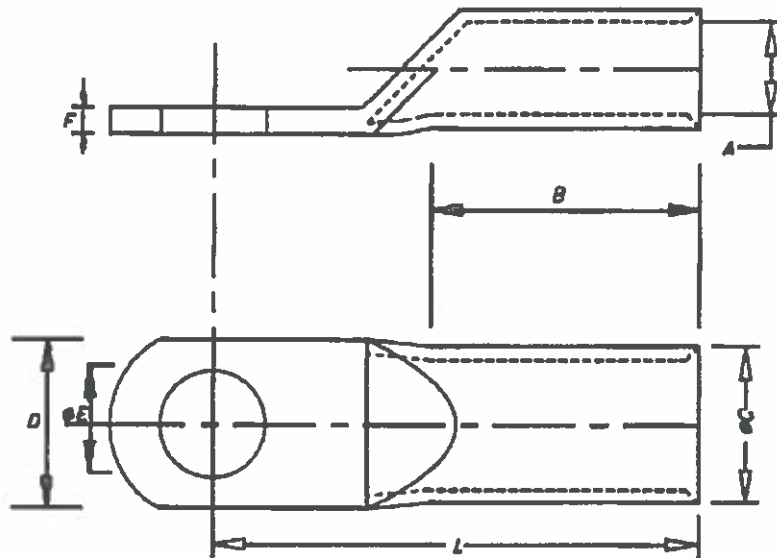


Fig. 2: Illustration of Tinned Aluminium Tubular Compression Lugs to DIN 46329

Table 3: Aluminium Tubular Compression Lugs (dimensions as per DIN 46329)

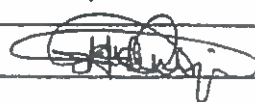
Sr. No.	Cable size	Stud Hole E	Bolt	Dimensions					Palm thickness f
				A	C	D	B	L	
Tolerance	mm ² Nominal	mm min		mm 0, +4	mm min	mm min	mm min	mm +2.0	mm min
1	10	8.4	M8	4.7	10	20	28	45	2.0
2	16	8.4	M8	5.8	12	20	30	50	2.5
3	25	10.5	M10	6.8	12	25	30	50	3.0
4	50	10.5	M10	9.8	16	25	42	62	3.5
5	70	13.0	M12	11.2	19	25	56	72	4.0
6	95	17.0	M16	13.2	22	25	56	75	5.0
7	120	17.0	M16	14.7	23	30	56	80	5.5
8	150	21.0	M20	16.3	25	30	60	90	6.0
9	185	21.0	M20	18.3	28.5	30	60	91	6.0
10	240	21.0	M20	21.0	30	38	70	103	6.5
11	300	21.0	M20	23.3	34	38	70	103	7.0
12	400	21.0	M20	26.0	38	38	73	116	7.2
13	500	21.0	M20	29.0	42	44	79	122	7.5
14	630*	23.0	M22	34.0	48	52	92	135	10.1

*- The tinned aluminium compression lug for sizes 10 and 630mm² cables shall not be to DIN 46329 but shall be as per KPLC requirement

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4.5. BI-METAL TUBULAR COMPRESSION LUGS

4.5.1. Construction requirements

- 4.5.1.1. The Bi-Metal tubular compression lugs shall be constructed from forged circular copper palm (grade of copper as per clause 4.3.1.1), friction welded to an EC grade Aluminium (grade of aluminium as per clause 4.4.1.1) circular barrel in accordance with ISO 25239 - thus achieving transition aluminium - copper bi-metal terminals.
- 4.5.1.2. The Bi-Metal tubular compression lugs shall be manufactured in accordance with DIN 46329 in shape and dimensions and shall be suitable for connecting stranded aluminium conductor to copper bus-bar or equipment with copper terminal studs.
- 4.5.1.3. The barrel shall be packed with abrasive neutral high melting point soft grease (oxide inhibiting compound) and the ends sealed (capped). The quantity of grease shall be approximately half the volume of the bore.
- 4.5.1.4. The lugs shall be suitable for use in cable sizes 10mm² to 630mm² as per Table 4.

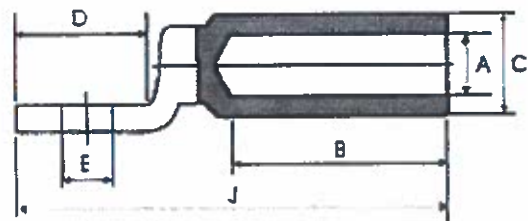
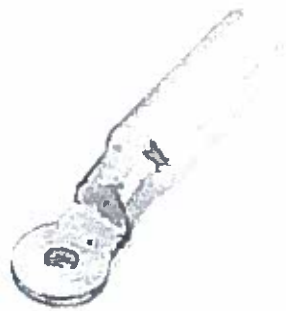


Fig. 2: Bi-Metal tubular compression lugs

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Table 4: Illustration of Bi-Metal tubular compression lugs (dimensions as per DIN 46329)

Sr. No.	Cable size mm ²	Stud Hole E mm	Bolt	Dimensions							
				A mm	C mm	D mm	E mm	J mm	B mm	Palm thickness mm	
Tolerance		min		0, +4	min	min	min	min	min	+2.0	min
1	10	10.5	M10	4.7	13	26	10.5	76	40		2.0
2	16	10.5	M10	5.8	15	26	10.5	76	40		2.5
3	25	13.0	M12	6.8	16	26	13.0	79	43		3.0
4	35	13.0	M12	8.0	16	32	13.0	79	43		3.0
5	50	13.0	M12	9.0	20	32	13.0	85	43		3.5
5	70	17.0	M16	11.0	20	32	17.0	85	43		4.0
6	95	17.0	M16	12.5	20	32	17.0	85	43		5.0
7	120	17.0	M16	13.7	25	36	17.0	108	59		5.5
8	150	21.0	M20	15.5	25	36	21.0	108	59		6.0
9	185	21.0	M20	17.0	32	36	21.0	115	59		6.0
10	300	21.0	M20	23.3	40	43	21.0	137	86		6.5
11	400	21.0	M22	26.0	40	44	21.0	153.5	86		7.0
12	630*	21.0	M20	33.5	47	60x60	4Ø9	196	95		10.0

*- The Bi-metal compression lug for sizes 10, 16 and 630mm² cables shall not be to DIN 46329 but shall be as per KPLC requirement.

4.6. SAMPLING FOR TESTS

4.6.1. Test specimens shall be selected at random from each inspection lot (or articles) in accordance with ISO 2859-1.

4.6.2. The number of samples selected from each lot shall comply with Table 5 of this specification.

Table 5: Number of test samples

Lot size	Sample size	Lot size	Sample size
25 or less	5	501 to 1,200	80
26 to 50	8	1,201 to 3,200	125
51 to 90	13	3,201 to 10,000	200
91 to 150	20	10,000 to 35,000	315
151 to 280	32	35,001 to over	500
281 to 500	50		

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4.7. Quality Management System

- 4.7.1. The supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the design, material, workmanship, tests, service capability, maintenance and documentation of the compression lugs, will fulfill the requirements stated in the contract documents, standards, specifications and regulations.
- 4.7.2. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008. 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.

5. TESTS AND INSPECTION

- 5.1 The compression lugs shall be tested in accordance with the relevant requirements of BS EN 61238-1, ISO 25239-1 to 5, BS EN 13600, BS EN 754-1&2, DIN 46235, DIN 46329 and this specification. It shall be the responsibility of the manufacturer to perform or to have performed all the tests specified.
- 5.2 Copies of previous Test Reports by the relevant International or National Testing/ Standards Authority of the country of manufacture or ISO/IEC 17025 accredited testing laboratory shall be submitted with the tender (including certificate of accreditation for laboratory) for the purpose of technical evaluation, all in English Language. The type test reports to be submitted shall include:
- a) Short circuit and heat cycle tests – BS EN 61238-1
 - b) Chemical composition of copper and aluminium – BS EN 13600 & BS EN 754-1&2
 - c) Friction stir welding – ISO 25239-1
 - d) Crimping force as per clause 4.2.8.
 - e) Dimensional checks to DIN 46235 & DIN 46329
- 5.3 Routine test reports for the compression lugs to be supplied shall be submitted to KPLC for approval before shipment/delivery of the goods. KPLC may witness acceptance tests at the factory. Supplier shall invite KPLC in adequate time to facilitate good preparation for the exercise. The witness/acceptance tests shall include:
- a) Crimping force as per clause 4.2.8.
 - b) Dimensional checks to DIN 46235 & DIN 46329
- 5.4 On receipt of the compression lugs, KPLC shall inspect and may perform tests in order to verify compliance with this specification. The supplier shall replace without charge to KPLC,

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

6. MARKING AND PACKING

6.1 MARKING

The following information shall be marked by engraving/etching and legibly, indelibly and in a permanent manner on each compression lug:

- (a) Name or trade mark of the manufacturer,
- (b) Type reference number,
- (c) Cable sizes applicable and inside diameters of the lug,
- (d) Crimping force and position,
- (e) The letters 'KPLC'.

6.2 PACKING

6.2.1 The compression lugs shall be packed in such a manner so as to avoid damage during transportation and storage.

6.2.2 Instructions for installation and details on applicable tools shall be included in each package, all in English Language.

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:

- a) Guaranteed Technical Particulars signed by the manufacturer;
- b) Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
- c) Sales records for the last five years and at least four customer reference letters;
- d) Details of manufacturing capacity and the manufacturer's experience;
- e) Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
- 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.

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

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Signed:

Date: 2015-06-18

Date: 2015-06-18



Kenya Power

TITLE:

**SPECIFICATION FOR
TERMINAL LUGS**

(Compression Type)

Doc. No. KP1/3CB/TSP/05/029

Issue No. 3

Revision No. 0

Date of Issue 2015-06-18

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- a) Guaranteed Technical Particulars signed by the manufacturer;
- b) Design Drawings with details of compression lugs 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) Marking details and method to be used in marking of the compression lugs;
- 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 compression lugs for The Kenya Power & Lighting Company;
- g) 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 compression lugs to KPLC stores.

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TITLE:

**SPECIFICATION FOR
TERMINAL LUGS**

(Compression Type)

Doc. No. KP1/3CB/TSP/05/029

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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 for past five years, four customer reference letters, details of manufacturing capacity, the manufacturer's experience, copies of complete type test reports and accreditation certificate to ISO/IEC 17025 for the third party testing laboratory for tender evaluation, all in English Language)

Tender No.

Clause	Description	KPLC REQUIREMENTS		Bidder's offer (indicate full details of the values offered)
	Bidder's Name and address			State
	Name of Manufacturer			State
	Country of manufacture			State
1	Scope			State
	Manufacturing standards applicable			State
4	Requirements			
4.1	Service conditions - compliance			State
4.2	General requirements			
	Compliance to all clauses			State
	Crimping force	Up to 240mm ²	1.2 x 10 ⁵ N	Provide a test report
		300mm ² - 630mm ²	2.0 x 10 ⁵ N	
		Above 630mm ²	4.0 x 10 ⁵ N	
4.3	Copper compression lugs			
	Type/Model Reference Number			State
	Compliance to all clauses			State
	Minimum thickness of tin	3µm		State
	Characteristics of the copper tube as per BS EN 13600			
A	Chemical properties			
	Chemical composition, Cu + Ag, %	99.95		State
B	Physical properties			
	Coefficient of linear expansion, 1/k	0.0000177		State
	Specific heat capacity, J/(kg x K)	385		State
	Melting temperature	1083		State
	Hardness (Soft temper), HV	35 - 65		State
	Tensile strength, N/mm ²	200 - 220		State
	0.2% Yield Strength, N/mm ²	35 - 65		State

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**SPECIFICATION FOR
TERMINAL LUGS**

(Compression Type)

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	Elongation at break, min, %	12	State
C	Electrical and thermal properties		
	Electrical conductivity	Volume, % IACS, min	100.6
		Mass, % IACS, min	100.0
		MS/m, min	58.3
	Electrical resistivity	Volume, $\Omega\text{mm}^2/\text{m}$	0.0171
		Mass, $\Omega\text{g}/\text{m}^2$	0.1532
	Thermal conductivity, W/m.K	390	Provide a test report
D	Jointing and machinability		
	Machinability rating (free cutting brass =100)	20	State
	Soldering	Excellent	State
	Brazing	Good	State
	TIG and MIG	Good	State
	Sizes and dimensions	As per fig. 1 and table 2	Provide a drawing
4.4	Tinned Aluminium Compression lugs		
	Type/Model Reference Number		State
	Compliance to all clauses		State
	Material	high purity electrolytic EC grade Aluminium 99.5%	State
	Thickness of tin coating	150 μm	Provide a test report
	Sizes and dimensions	As per table 3 and Fig. 2	Provide a drawing
4.5	Bi-metal compression lugs		
	Type/Model Reference Number		State
	Compliance to all clauses		Provide a test report
	Sizes and dimensions	As per table 4 and Fig. 3	Provide a drawing
4.6	Sampling		
	Number of test samples	As per table 5	Specify
4.7	Quality Management System		
	Quality Assurance Plan		Provide
	Copy of ISO 9001:2008 Certificate		Provide
5.1	Test standards and responsibility of carrying out tests		Provide
5.2	Copies of Type Test Reports submitted with tender		Provide
5.3	Acceptance /Routine tests to be witnessed by KPLC at factory before shipment		Provide
	Test reports to be submitted by supplier to KPLC for approval before shipment		Provide
5.4	Replacement of rejected lugs		State
6.1	Marking		State

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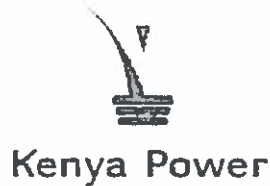
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Signed:

Date: 2015-06-18

Date: 2015-06-18



TITLE:
**SPECIFICATION FOR
TERMINAL LUGS
(Compression Type)**

Doc. No.	KP1/3CB/TSP/05/029
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6.2	Packing	State
7.1	Documents submitted with tender	State
7.2	Documents to be submitted by supplier to KPLC for approval before manufacture	State
7.3.	Recommendations for use, care, storage and routine inspection/testing procedures	Provide
8.0	Manufacturer's Guarantee and Warranty	Provide
9.0	List catalogues, brochures, technical data and drawings submitted to support the offer	Provide
10.0	List customer sales records and reference letters submitted to support the offer.	Provide
11.0	List Test Certificates submitted with tender	Provide
12.0	Manufacturer's experience and Manufacturing Capacity (units per month)	Provide
13.0	Statement of compliance to specification (indicate deviations if any & supporting documents)	Provide

NOTE:

- 1) Bidders shall give full details and the offered values of the items on order as per Annex A. The details provided shall conform to the test reports and their certificates as required by clause 5.2., well labeled drawings complete with dimensions, catalogues or brochures for the purpose of tender evaluation.
- 2) Bidder who shall have not complied by this requirement in bullet 1 shall be automatically disqualified from bidding this item.

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

Issued by: Head of Section, Standards Development

Authorized by: Head of Department, Standards

Signed:

Signed:

Date: 2015-06-18

Date: 2015-06-18



TITLE:
SPECIFICATION FOR
OVERHEAD LINE
FITTINGS PART 1:
FITTINGS FOR 150MM² -
300MM² CONDUCTORS

Doc. No.	KPLC1/3CB/TSP/06/036-4
Issue No.	1
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

0.1 Circulation List


0.2 Amendment Record

FOREWORD

1. SCOPE
2. REFERENCES
3. TERMS AND DEFINITIONS
4. REQUIREMENTS
5. TESTS AND INSPECTION
6. MARKING, LABELLING AND PACKING

ANNEX A: Technical Particulars

Issued by: Head of Power System Research	Authorized by: Head of Department , R & D
Signed: 	Signed: 
Date: 2011-10-17	Date: 2010-10-17



	TITLE: SPEGIFICATION FOR OVERHEAD LINE FITTINGS PART 4: FITTINGS FOR 150MM² - 300MM² CONDUCTORS	Doc. No.	KPLC1/3CB/TSP/06/036-4
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0.1 Circulation List

COPY NO.	COPY HOLDER
1	Research & Development Manager
2	Procurement Manager
3	Stores & Stock Control Manager
4	Transmission Manager
5	Deputy Manager, Technical Audit

0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)

Issued by: Hend of Power System Research	Authorized by: Head of Department , R & D
Signer: 	Signed: 
Date: 2011-10-17	Date: 2010-10-17



TITLE:

SPECIFICATION FOR
OVERHEAD LINE
FITTINGS PART 4:
FITTINGS FOR 150MM² -
300MM² CONDUCTORS

Doc. No.	KPLC1/3CB/TSP/06/036-4
Issue No.	1
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FOREWORD

This specification has been prepared by the Research and Development Department and it lays down the minimum requirements for overhead line fittings for 150mm² to 400mm² conductors. The specification is to be used by Kenya Power in procurement of the items.

It shall be the responsibility of the manufacturer to ensure adequacy of the design and good engineering practice in the manufacture of the overhead fittings for Kenya Power. The manufacturer shall submit information which confirms satisfactory service experience with products which fall within the scope of this specification.

1. SCOPE

1.1 This specification is for overhead line fittings for use on overhead power lines operating at voltages up to and including 66KV (66,000 volts) A.C 50Hz.

1.2 This specification covers the following overhead terminations

- (i) Conductor terminations
- (ii) Joints(non-tension joints)
- (iii) Suspension clamps

The particular requirements for each type of fittings as may be relevant for specific requisition are given in clause 4.0

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 Kenya Power	TITLE:	Doc. No.	KPLC1/3CB/TSP/06/036-4
	SPECIFICATION FOR OVERHEAD LINE FITTINGS PART 4: FITTINGS FOR 150MM ² - 300MM ² CONDUCTORS	Issue No.	1
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The specification also covers inspection and test for overhead line fittings as well as Guaranteed Technical particulars to be filled, signed by the manufacturer and submitted for tender evaluation

The specification stipulates the minimum requirements for overhead line fittings acceptable for use in the company and it shall be the responsibility of the supplier and manufacturer to ensure adequacy of the design, good workmanship and good engineering practice in the manufacture of the fittings for KPLC.

This specification does not purport to include all the necessary provisions of a contract.

2. REFERENCES

2.1. The Following documents were referred to during the preparation of this specification and may be referred to. In case of conflict, the provision of this specification shall take precedence. Unless otherwise specified, the latest revision, edition and amendments shall apply.

ISO 1461: Metallic coatings-Hot dip galvanization coatings on ferrous products requirements



IEC61284: Overhead lines requirements and test for fittings

BS3288: Insulator and conductor fittings for Overhead Power Lines

ESI 43-92: Conductor terminations, joints and insulator binds for overhead lines up to and including 132KV

3. TERMS AND DEFINITIONS

The definitions given in the reference standards shall apply.

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TITLE:

SPECIFICATION FOR
OVERHEAD LINE
FITTINGS PART 4:
FITTINGS FOR 150MM² -
300MM² CONDUCTORS

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4. REQUIREMENTS

4.1. SERVICE CONDITIONS

The fittings shall be suitable for continuous outdoor and indoor application in tropical areas with the following atmospheric conditions:-

(a) Altitude, from sea level up to 2200m above mean sea level.

(b) Humidity, heavily polluting saline atmosphere in coastal areas and where humidity is 90% and up country area where air is relatively clean and humidity not below 50%.

© Ambient temperatures of +30°C average (-1°C Min and 40°C Max).

4.2. MATERIALS AND FABRICATION

4.2.1. The fittings shall be designed and manufactured to IEC61284 and BS3288 and the requirements of this specification and shall be suitable for use on 150mm-300mm² Aluminum Conductor Steel Reinforced(ACSR) and 150-300mm² All Aluminum conductor(AAC) and cables

4.2.2. The fittings shall be free from defects which would likely cause them to be unsatisfactory in service

4.2.3. All parts of each fitting shall be either inherently resistant to atmospheric corrosion, both during storage and in service.

4.2.4. All ferrous parts except those made of stainless steel shall be protected by hot dip galvanization as per requirement of ISO1461. The minimum average coating weight for any test individual test area shall be not be less than values given in ISO 1461

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 Kenya Power	TITLE: SPECIFICATION FOR OVERHEAD LINE FITTINGS PART 4: FITTINGS FOR 150MM² - 300MM² CONDUCTORS	Doc. No.	KPLC1/3CB/TSP/06/036-4
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4.2.5. The threads of nuts and tapped holes shall be cut after galvanizing and shall be well oiled or greased. All other threads shall be formed before galvanizing.

4.2.6. The general arrangement drawings for the various types of fittings will be attached in annex B of this specification. Drawings with BS 3288 reference numbers are available in the standard

4.3. PARTICULAR REQUIREMENTS

4.3.1. Conductor terminations

4.3.1.1.(a) Ball ended hook, socket clevis and socket tongue shall be suitable for use on aluminum conductor Steel Reinforced (ACSR) and all aluminum alloy conductors (AAAC) overall diameter between 18.2mm and 24.70mm. These will be used together with standard disc insulator of ball and socket type with the ball pin diameter of 16mm.

(b) The ball ended hook, socket clevis and socket tongue shall be of malleable iron or ductile, hot dip galvanized to ISO 1461.

(c) Ball ended hook, socket clevis and socket tongue shall be as per BS 3288. Reference Numbers given below.

Description	BS 3288 Reference Number
Ball ended hook	15/81
Ball clevis	15/83
Socket clevis, single hole	15/84
Socket clevis, double hole	15/25
Socket tongue, single hole	15/85
Socket tongue, double hole	15/35

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TITLE:

SPECIFICATION FOR
OVERHEAD LINE
FITTINGS PART 4:
FITTINGS FOR 150MM² -
300MM² CONDUCTORS

Doc. No.

KPLC1/3CB/TSP/06/036-4

Issue No.

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Note: Drawings for Ball Ended Hook, Socket Clevis and Socket Tongue shall be as per BS 3288

4.3.1.2. Tension clamp (Gun Clamp)

- (a) Tension clamp shall be bolted type and shall be suitable for use on Aluminium Conductor Steel Reinforced (ACSR) of outer diameter between 18.20mm and 24.7mm (150mm² and 300mm²)
- (b) The clamp body and keeper piece shall be of high strength and heat treated cast aluminum alloy.
- (c) The clamp body and keeper shall be of high strength and heat treated cast aluminum alloy. The number of U-bolts will be a minimum of 4
- (d) The clamp shall have slip strength of not less than 85% of the rated ultimate strength of conductor it is intended for use with.
- (e) The ultimate breaking load of the complete assembly shall be at least 100KN

4.3.2 Suspension Clamps

Suspension clamps shall be suitable for use on Aluminium Conductor Steel Reinforce (ACSR) of outer diameter between 18.2.00mm and 24.7mm (150mm² and 300mm²).

- (a) Clevis ended hook type, tongue ended hook type and pivoted type (similarly known as envelope type and trunnion type respectively).
 - (i) The clamp body and keeper piece shall be of high strength, heat-treated cast aluminum alloy.
 - (ii) The clamp cotter bolts hangers, brackets and U-bolts shall be of galvanized steel and the cotter pin shall be of stainless steel.
- (b) Angle suspension clamp type (similarly known as side opening type).

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Signed:


A. K. Singh

Signed:

[Signature]

Date: 2011-10-17

Date: 2010-10-17

	TITLE: SPECIFICATION FOR OVERHEAD LINE FITTINGS PART A: FITTINGS FOR 150MM² - 300MM² CONDUCTORS	Doc. No.	KPLC1/3CB/TSP/06/036- <i>A</i>
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- (i) The clamp shall be suitable for use on turning angles from 10 to 120 degrees.
- (ii) The clamp body and keeper shall be of malleable iron or ductile iron, hot dip galvanized.
- (iii) The clamp cotter bolts and bolt shall be galvanized steel and the cotter pin shall be stainless steel.


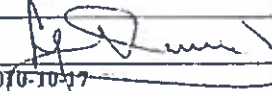
4.3.3 Joints (Non-tension)

4.3.3.1 Parallel Groove Clamp (PG Clamp)

- a) PG clamp shall be suitable for use on aluminum conductor steel-reinforced and all aluminum conductors of outer diameter in the range of 18.2mm to 24.7mm for ACSR conductors and AAC conductors.
- b) The groove of the PG clam shall correctly fit the conductor it is intended for use with. It shall have adequate cross sectional area and length.
- c) The PG clamp shall be of electrolytic, high strength, corrosion resistant aluminum alloy.
- d) The number of bolts shall be a minimum of 4.

5. TESTS AND INSPECTION

- 5.1. The fittings shall be inspected and tested in accordance with the requirements of IEC 61284, BS 3288 and this specification. It shall be the responsibility of the manufacturer to perform or to have performed all the tests specified.
- 5.2. Copies of previous Type Test Reports issued by an independent and ISO/IEC 17025 accredited testing laboratory shall be submitted with the tender for the purpose of technical evaluation, al in English language.

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TITLE:
SPECIFICATION FOR
OVERHEAD LINE
FITTINGS PART 4
FITTINGS FOR 150MM² -
300MM² CONDUCTORS

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Copies of Test Reports (to IEC 61284, BS 3288-) to be submitted shall include the results of the appropriate type tests made on not less than three fittings identical in all essential details with those to be supplied; and shall include the following:

- Mechanical Type Tests
- Electrical type tests (Resistance and Electrical Heating Cycle Test)

5.3. Complete Test Reports for Sample & Routine Test to IEC 61284 and BS 3288 for each item shall be submitted to The Kenya Power for approval before shipment and delivery.

The test reports shall include:

- Verifications for Dimensions
- Mechanical Type Tests
- Electrical Type Tests (Resistance and Electrical Heating Cycle Test)


5.4. On receipt of the conductor fittings/accessories, Kenya Power will inspect them and may perform or have performed any of the relevant tests in order to verify compliance with the specification. The supplier shall replace/rectify without charge to Kenya Power, items which upon examination, test or use fail to meet any or of the requirements in the specification.

6. INSTRUCTION & MARKING

6.1 Each item shall be marked (during manufacture) legibly and indelibly with following information.

a. Manufacturer's identity

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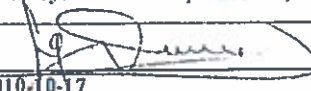
 Kenya Power	TITLE: SPECIFICATION FOR OVERHEAD LINE FITTINGS PART A: FITTINGS FOR 150MM² - 300MM² CONDUCTORS	Doc. No.	KPLC1/3CB/TSP/06/036- <u>A</u>
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- b. Type reference number
- c. Applicable conductor sizes (mm²)
- d. Failing load
- e. Property of "Kenya Power"

6.2 Instruction for installation and details on applicable tools shall be included in each package, all in English Language.

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ANNEX A: Guaranteed Technical Particulars *(to be filled and signed by the Supplier and submitted together with copies of manufacturer's catalogues, brochures,*

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Date: 2011-10-17	Date: 2010-10-17



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**SPECIFICATION FOR
 OVERHEAD LINE
 FITTINGS PART 4:
 FITTINGS FOR 150MM² -
 300MM² CONDUCTORS**

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drawings, technical data, sales records and copies of certificates/test reports for tender evaluation)

Tender No.

Clause number	Bidder's offer (indicate full details of the offered equipment for each requirement of the specification)
1. (1.1-1.2)	
2	
3	
4.2.1	
4.2.2	
4.2.3	
4.2.4	
4.2.5	
4.2.6	
4.3.1.1	
4.3.1.2	
4.3.2	
4.3.3.1	
4.3.3.2	
5.1	
5.2	
5.3	
5.4	
6.1	
6.2	

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

Issued by: Head of Power System Research	Authorized by: Head of Department , R & D
Signed:	Signed:
Date: 2011-10-17	Date: 2010-10-17



Kenya Power

SPECIFICATION FOR EARTH RODS AND THEIR CONNECTORS

Part 1: Copper Clad Earth Rods and their connectors

Doc. No.	KP1/3CB/TSP/06/ 31-1
Issue No.	3
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Date of Issue	2014-04-06
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1. SCOPE
2. REFERENCES
3. TERMS AND DEFINITIONS
4. REQUIREMENTS
5. TESTS AND INSPECTION
6. PACKING, MARKING AND INSTRUCTIONS

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 for previous five years, four customer reference letters, details of manufacturing capacity, the manufacturer's experience and copies of complete type test certificates and type test reports for tender evaluation, all in English Language)*

K. P. & L. Co. LTD
RECEIVED
 28 APR 2014
 SUPPLY CHAIN MANAGER
 (PROCUREMENT)

Issued by: Head of Section, Technical Standards and Specifications

Signed:

Date: 2014/04/06

Authorized by: Head of Department, R&D

Signed:

Date: 2014/04/06



**SPECIFICATION FOR EARTH
RODS AND THEIR
CONNECTORS**

Part 1: Copper Clad Earth Rods
and their connectors

Doc. No.	KP1/3CB/TSP/06/031-1
Issue No.	3
Revision No.	0
Date of Issue	2014-04-06
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0.1 Circulation List

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

0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
0	2014-04-06	Cancel and replaces issue No. 2 dated 2013/05/13	Michael Apudo 	George Owuor

Issued by: Head of Section, Technical Standards and Specifications

Signed:

Date: 2014/04/06

Authorized by: Head of Department, R&D

Signed:

Date: 2014/04/06



Kenya Power

SPECIFICATION FOR EARTH RODS AND THEIR CONNECTORS

Part 1: Copper Clad Earth Rods and their connectors

Doc. No.	KP1/3CB/TSP/06/031-1
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FOREWORD

This specification has been prepared by the Research and Development Department of The Kenya Power and Lighting Company Limited (abbreviated as KPLC). It lays down requirements for Copper Clad Earth Rods and their connectors for use in Kenya Power distribution network and substation earthing. It is intended for use by KPLC in purchasing the items.

This specification supersedes all specifications for earth rods issued before the revision date. The specification for earth rods and their connectors is issued in parts as follows:

- Part 1: Copper Clad Earth Rods and their connectors
- Part 2: Stainless Steel Earth Rods and their connectors
- Part 3: Galvanized Steel Earth Rod and their connectors

1. SCOPE

- 1.1. This specification is for copper-clad earth rods and the associated connectors. It covers only extensible copper-clad earth rods and connectors which constitute the following items:
 - a) Copper clad earth rod
 - b) Connectors which include:
 - (i) Couplings,
 - (ii) Driving head,
 - (iii) Bull-dog grip clamp.

NOTE: The required quantities of the items shall be stated in the tender.

- 1.2. The specification stipulates the minimum requirements for copper-clad earth rods and the associated connectors 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 items for The Kenya Power & Lighting Company.
- 1.3. 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.

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SPECIFICATION FOR EARTH RODS AND THEIR CONNECTORS

Part 1: Copper Clad Earth Rods and their connectors

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- ISO 2859-1: Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection
- ISO 9001: Quality management systems -- Requirements
- BS 7430: Code of practice for protective earthing of electrical installations
- BS PD 970: Wrought steels for mechanical and allied engineering purposes. Requirements for carbon, carbon manganese and alloy hot worked or cold finished steel
- BS 2874: Specification for copper and copper alloy rods and sections (other than forging stock)
- BS EN 12163: Copper and copper alloys. Rod for general purposes
- BS 4168-1: Hexagon socket screws and wrench keys: metric series Specification for hexagon socket head cap screws
- BS 3643-2: ISO metric screw threads — Part 2: Specification for selected limits of size.
- UL 1439: Tests for Sharpness of Edges on Equipment
- KS 04 – 744: Specification for earth rods and their connectors. Part 1: Copper clad earth rods

3. DEFINITIONS

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

4. REQUIREMENTS

4.1. Service Conditions

4.1.1. The copper-clad earth rods and associated connectors shall be suitable for installation in tropical areas at

- (i) Altitudes of up to 2200m above sea level,
- (ii) Humidity of up to 90%,

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- (iii) Ambient temperatures of -1°C to $+40^{\circ}\text{C}$, average ambient temperature is 30°C . and
- (iv) A wide range of soils.

4.1.2. All components shall be manufactured from metal or metals such that when installed under conditions of actual service and exposed to moisture shall not be adversely affected by electrolysis or galvanic corrosion.

4.2. Design and Construction

4.2.1. General

4.2.1.1. To ensure compatibility of component parts of the earth rod and connectors, the items to be supplied under this specification consist of copper-clad earth rod, coupling, driving head and bull dog clamp which form a "total system" conforming to BS 7430: 2011 standard requirements. This will include an assessment of the safety, reliability and long term performance of the items tendered.

4.2.1.2. The design of the earth rod assembly (including couplings, driving head and bull dog clamp) shall be of such mechanical strength that they shall withstand the stresses and abrasions present during installation with either electric/pneumatic hammer or direct hammering.

4.2.1.3. The design of the rods and couplings shall be such that during installation, the connection between the rod and the coupling shall "self-tighten". This self-tightening effect shall improve the electrical and mechanical performances of the rod/coupling combination. The Tenderer shall state the design features of the rod and accessories which verify the following features:

- Self-tightening;
- Improved electrical connection; AND
- No damage to the copper sheath on installation.

4.2.1.4. The rod system shall be extendable by the use of appropriate couplings. All items including rods, couplings, driving points and clamps shall be clean, free of burrs, cracks and sharp edges.

4.2.1.5. Tenderers shall provide the recommended procedure for the correct assembly of the various components of the earthing system including the earth rod, coupling, driving head and clamps.

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4.2.2. Threading

- 4.2.2.1. Threads on the earth rods, couplings and hardware assembly (bull dog clamp bolts and driving heads) shall be formed by roll process ("roll thread" type) giving extra strength to the threads and eliminating the risk of chipping of threads while driving the ground rod in the ground.
- 4.2.2.2. The earth rods, bull dog clamp bolts and driving heads shall be externally threaded and matched with couplers and bull dog clamp nuts which shall be internally threaded and shall conform to each end of the rod electrode as per Fig. 1 and Table 1.
- 4.2.2.3. The threading system shall be to BS 3643 for ISO metric screw threads; class 3 (high accuracy, fine fits), with external thread designation of 4h for earth rods and internal thread designation of 5H for couplings as per Table 1; bolts and nuts thread tolerance class shall be standard (general assembly) of 6h and 6g respectively conforming to the values in Table 1 of BS 3643-2.

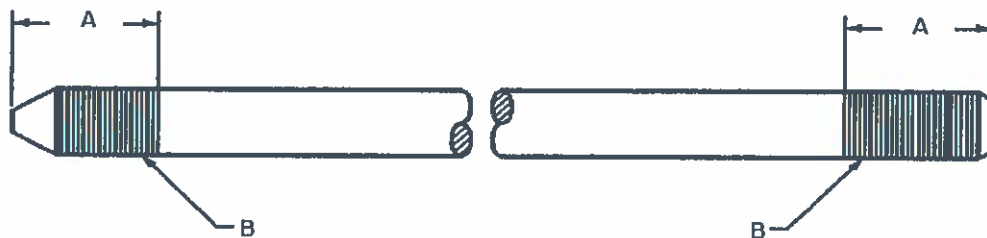



Fig. 1: Threading dimensions

Table 1: Thread dimensions as per BS 3643-2

Nominal diameter, mm		12.5	16	20	25	
Pitch		1.5	1.0	1.0	1.0	
Thread "A" length, mm	min	27.000	30	32	45	
	tol.	-1.6; + 3.2				
External threads of the rod; "B"	Tolerance class		4h			
	Fundamental deviation		0.032			
	Major diameter, mm	max	12.500	16.000	20.000	25.000
		tol.	0.112			
	Pitch diameter, mm	min	12.388	15.888	19.888	24.888
		max	11.850	15.350	19.350	24.350
	Minor diameter, mm	tol.	0.075			0.080
		min	11.775	15.275	19.275	24.270
	min	11.159	14.659	18.659	23.654	

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Nominal diameter, mm		12.5	16	20	25	
Internal threads of the couplers	Tolerance class	5H				
	Fundamental deviation	0				
	Major diameter, mm	min	12.500	16.000	20.000	25.000
		max	11.975	15.475	19.475	24.482
	Pitch diameter, mm	tol.	0.125			0.132
		min	11.850	15.350	19.350	24.350
		max	11.607	15.107	19.107	24.107
	Minor diameter, mm	tol.	0.190			
		min	11.417	14.917	18.917	23.917

4.3. Specific requirements

4.3.1. Copper-Clad Rods

- 4.3.1.1. The copper clad earth rod shall be manufactured from a steel rod reference symbol P of a grade with tensile strength of 550 MPa to 700 MPa in accordance with BS PD 970: 2005 standard requirements; a Brinell hardness shall be 248 to 302 HBW as recommended by BS 7430:2011 standard.
- 4.3.1.2. An earth electrode shall be designed to have a loading capacity adequate for the system of which it forms a part, i.e. it shall be capable of dissipating the electrical energy in the earth path at the point at which it is installed under any condition of operation on the system.
- 4.3.1.3. Copper-clad steel earth rods shall be made by molecularly bonding 99.9% pure copper onto the high carbon, low tensile steel rods to achieve a minimum copper thickness of 0.254 mm (254 µm). The application of the copper sheath shall prevent any electrolytic action to be initiated by moisture ingress between the copper and the steel.
- 4.3.1.4. Tenderers shall state the method used to apply the copper sheath to the rod together with the design features to verify the prevention of moisture ingress.
- 4.3.1.5. To prevent oxidation of copper bonding, each rod shall be treated with Benzol Triazole derivatives. A proof of the same shall be provided by the tenderer.
- 4.3.1.6. Both ends of the rods shall be tapered as per Figure 2. The taper shall be approximately 3:100 on diameter and the minimum dimensions of the taper shall be as per Table 2 (as measured parallel to the axis of the earth rod).

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Fig. 2: Earth rod

Table 2: Table of taper lengths

Nominal diameter, mm	Point end "A" (mm)	Chamfer end "B" (mm)
12.5	4.70	2.40
16	4.70	3.20
20	6.35	3.20
25	9.50	5.55

4.3.1.7. The finished product shall have the following sizes as per KS 04 – 744 and Table 3 :

Table 3: Earth rod sizes

Nominal size		Rod length	
mm	Inches*	mm	Feet*
12.5	½"	1,200	4'
16.0	5/8"	1,500	5'
20.0	¾"	2,100	7'
25.0	1"	3,000	12'

* The imperial sizes have been replaced by the metric sizes in this specification for clarity.

4.3.2. Connectors

4.3.2.1. Couplings

4.3.2.1.1. The couplings shall be manufactured from phosphor bronze, grade C102 or equivalent in accordance with BS 2874 and shall be suitable for direct burial.

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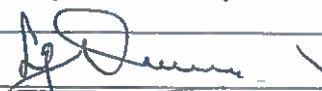
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- 4.3.2.1.2. The coupling shall be a threaded joining device which joins two earth rods together for extending earth rods in an earthing system. The threading system shall be as per clause 4.2.2, Table 1.
- 4.3.2.1.3. The coupling device shall be designed to ensure that a good permanent electrical conductivity is maintained between the joined earth rods throughout a service life of 35 years for the installed earth rod assembly.
- 4.3.2.1.4. The couplings in the assembled mode shall exhibit no less than 95% of the conductivity of an unspliced ground rod of equal length.
- 4.3.2.1.5. The material used shall be selected to ensure that electrolytic action and/or stress corrosion cracking will not occur. In addition, the surfaces of the couplings exposed to the soil, shall be corrosion resistant.
- 4.3.2.1.6. The couplings design shall be hexagonal in shape as per Fig. 3. The thickness shall be at least 3 mm and lengths of 50, 60 and 70 mm to suit the sizes of the earth rods as per Table 4. Tenderers shall state the material(s) used.



Fig. 3: Hexagonal shape coupling

Table 4: Standard coupling sizes

Nominal size		Coupling length
mm*	Inches	mm
12.5	½ "	50
16.0	5/8"	50
20.0	¾ "	60
25.0	1"	70

* Only the metric system shall be used at tender

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4.3.2.2. Driving Head

- 4.3.2.2.1. Driving heads shall be made of toughened, quenched and tempered stainless steel with reference symbol Z; in accordance with BS PD 970:2005 and as recommended by BS 7430:2011.
- 4.3.2.2.2. The steel shall have a tensile strength of 1150 MPa to 1300 MPa and shall be able to withstand hammer blows used while hammering an earth rod into ground.
- 4.3.2.2.3. It shall dimensionally conform to BS 4168-1 (knurled head) and finished standard blue/black.
- 4.3.2.2.4. The threading system shall match with those of the couplings specified in clause 4.2.2 and shall match with the respective coupling sizes.
- 4.3.2.2.5. The diameter of the driving head shall NOT be LESS THAN the diameter of the earth rod/coupler assembly.
- 4.3.2.2.6. The driving head shall be designed to reduce the driving effort on the earth rod and to prevent damage to the copper sheath during the installation process.



Fig. 4: Driving head

4.3.2.3. Earth Rod Clamps

- 4.3.2.3.1. Earth rod clamps shall be of bull dog-type; its material shall be made of phosphor bronze, grade C102 in accordance with BS 2874, and it shall be suitable for direct burial and compatible with the coupling material.
- 4.3.2.3.2. The surface finish of the completed clamps shall be smooth and free of cracks, burrs and sharp projections. Conformance to no sharp projections shall be tested using a Sharp Edge Tester device calibrated to UL Standard 1439.

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4.3.2.3.3. The clamp in the assembled mode shall exhibit no less than 95% of the conductivity of a solid earth conductor.

4.3.2.3.4. The joined clamp/grounding conductor/rod electrode assembly shall withstand a pullout force of no less than 2.0 kN before separation. This test shall be performed by pulling on the grounding conductor with the rod held firmly in place, the clamp providing a securing function only.

4.3.2.3.5. Earth Rod/Conductor clamp shall satisfy the following requirements:

- a) Be suitable for direct burial in the ground.
- b) Be suitable for connecting the specified rods with one or two stranded copper conductors of the following sizes:
 - Minimum conductor size: 50 mm² (19/1.80)
 - Maximum conductor size: 70 mm² (19/2.10)
- c) Be of materials which are resistant to corrosion and parts of the connector which are in direct contact with the conductor and earth rod shall be of material which does not cause interface corrosion.

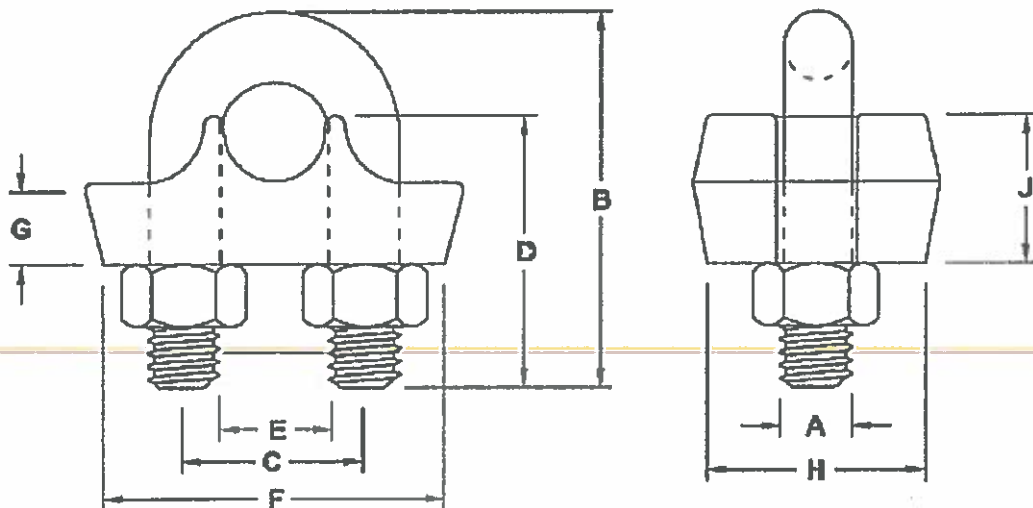


Fig. 5: Bull Dog type connector.

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Table 5: Recommended dimensions of bull-dog clamp.

Recommended earth rod size mm	A mm	B mm	C mm	D mm	E mm	F mm	G mm	H mm	J mm
M12.5	Φ12	64	27	32	15	51	12	28	22
M16, M20, M25	Φ14	82	36	36	40	22	64	32	25

- 4.3.2.3.6. The U-bolt, nut and washers shall be made from phosphor bronze designation CW451K conforming to BS EN 12163:2011 as recommended by BS 7430:2011 and shall be suitable for direct burial and compatible with the coupling material.
- 4.3.2.3.7. Assembly torque for bull-dog clamps shall be 70 Nm as the screw thread pitch for the bolts shall be as per clause 4.2.2. The tenderer shall advise the minimum and maximum recommended tightening torques as well as the specified tightening technique/procedure.
- 4.3.2.3.8. Recommended sizes of the bull dog clamp shall be as per Table 5.

4.4. Sampling for tests

Test specimens shall be selected at random from each inspection lot (or articles) in accordance with ISO 2859-1. The number of samples selected from each lot shall comply with Table 6 of this specification.

Table 6: Number of test samples

Lot size	Sample size	Lot size	Sample size
25 or less	5	501 to 1,200	80
26 to 50	8	1,201 to 3,200	125
51 to 90	13	3,201 to 10,000	200
91 to 150	20	10,000 to 35,000	315
151 to 280	32	35,001 to over	500
281 to 500	50		

4.5. Quality Management System

4.5.1. The supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the design, material, workmanship, tests, service capability, maintenance and documentation of the copper-clad earth rod and their connectors, will fulfill the requirements stated in the

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

4.5.2. 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.

4.5.3. The bidder shall indicate the delivery time of the copper-clad earth rod and their connectors, 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. Performance and Testing

5.1.1. Couplings

5.1.1.1. Two 450 mm rod samples shall be coupled and held vertically in a tubular fixture that is at least 0.25 mm greater than the rod diameter.

5.1.1.2. The penetrating end of the bottom ground rod shall be rested on a fixed plate of a weight sufficient to withstand the impact test, and located in a hole at least 100 mm in depth.

5.1.1.3. The coupling shall not rest on or be contained within the tubular fixture or fixture plate. The top ground rod shall be subjected to an impact force of 55 Nm. After 25 impacts, the couplings shall not break, split, or be subjected to damage that impairs performance.

5.1.1.4. The joined coupling/rod assembly shall be able to withstand a pullout force of no less than 6.5 KN before separation.

5.1.2. Earth rod clamp

5.1.2.1. The clamps shall be installed in accordance with the manufacturer's instructions. The complete test procedure shall be as given below:

- a) The earth rod/connector/conductor combination shall be tested in still air. The locations of the connections for injecting the test current shall be positioned not less than twenty (20) times the diameter of the earth rod from the centre of the connector for all tests.

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- b) Tests shall be carried out on the following connection combinations for the connectors as detailed below:
- 50 mm² conductor to earth rod,
 - 70 mm² conductor to earth rod,
 - 50mm² conductor to 50 mm² conductor,
 - 50 mm² conductor to 70 mm² conductor,
 - 50 mm² cable conductor to 50 mm² cable conductor,
 - 50 mm² cable conductor to 70 mm² cable conductor ,
 - 70 mm² cable conductor to 70 mm² cable conductor.
- c) A minimum average test current of 5 kA, 50 Hz for 1 second (I^2t of 25 MA²/second) shall be used for each test.
- d) Visual inspection after the test shall ensure that there is no damage to the connector and there is no severe discolouration to the connector and surrounding areas. There should be no loosening of the connection between the cable and the rod or between the cable and the cable.

5.1.2.2. The successful tenderer shall provide test reports that verify the requirements detailed above before the first deliveries are accepted under the contract.

5.2. The copper-clad earth rod and their connectors shall be inspected and tested in accordance with the requirements of BS PD 970, BS 2874, BS EN 12163, BS 3643-2 and KS 04-744 standards and provisions of this specification. 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.

5.3. 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)

5.4. Copies of type test reports to be submitted with the tender (by bidder) for evaluation for the copper-clad earth rod and their connectors shall be as stated below:

- a) Adherence of copper clad to steel core
- b) Current carrying capacity tests
- c) Mechanical Strength – ultimate tensile strength tests
- d) Chemical composition – Check Analysis
- e) Hardness Test

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f) Impact Test

5.5. Routine and sample test reports for the copper-clad earth rod and their connectors 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.

5.6. Tests to be witnessed by KPLC Engineers at the factory before shipment shall be in accordance with of BS PD 970, BS 2874, BS EN 12163, BS 3643-2 and KS 04-744 standards and provisions of this specification and shall include the following:

- a) Verification of dimensions
- b) Adherence of copper clad to steel core
- c) Current carrying capacity tests
- d) Mechanical strength – ultimate tensile strength tests
- e) Checking the condition of the threads (earth rod, coupling, driving head and bull dog clamp U-bolt and nut) and copper cladding after performing a driving (in to hard soil) operation.
- f) Bending test

5.7. 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 copper-clad earth rod and their connectors, which upon examination, test or use; fail to meet any of the requirements in the specification.

6.0. MARKING AND PACKING

6.1. Marking

6.1.1. Each copper-clad earth rod shall be indelibly marked with the following information (in English Language):

- Name or trade mark of the manufacturer
- The length of the rod in meters or millimetres,
- The diameter of the rod in millimetres,
- Any information which the manufacturer considers necessary for the correct installation service.
- Letters "KPLC"

6.1.2. Couplings and connectors shall be marked with :

- Name or trade mark of the manufacturer
- Trade size

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- Letters "KPLC"

6.1.3. The driving head shall be marked as per the requirements of BS 4168-1.

6.2. PACKING

6.2.1. The copper clad earth rods, couplings, connectors and driving heads shall be suitably packed separately in reinforced wooden boxes firmly secured with metallic straps and the quantity of items in a package is as in a), b), c), or d) given below.

- a) Copper Clad Earth Rods - 50 per box
- b) Couplings - 100 per box
- c) Connectors - 100 per box
- d) Driving Heads - 100 per box

6.2.2. Each Packing shall be clearly and indelibly marked with the following;

- a) Name of Item
- b) Quantity
- c) Gross Weight
- d) The boxes shall be marked with manufacturer's identification and property class and the words "PROPERTY OF KPLC".

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:

- 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, drawings and technical data which shall include:
 - Model/Reference number, Code Name,
 - Current carrying capacity and the % of current through the coupling.
 - Constructional features and material used for components, the standards to which the items are manufactured and relevant technical literature.
- c) Sales records for the last five years and at least four customer reference letters;
- d) Details of manufacturing capacity and the manufacturer's experience;
- e) Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
- f) Copy of accreditation certificate to ISO/IEC 17025 for the third party testing laboratory;

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g) 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:

- a) Guaranteed Technical Particulars signed by the manufacturer;
- b) Design Drawings with details of copper-clad earth rod and their connectors 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) Marking details and method to be used in marking of the copper-clad earth rod and their;
- 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 copper-clad earth rod and their connectors for The Kenya Power & Lighting Company;
- g) 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 copper-clad earth rod and their connectors to KPLC stores.

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Kenya Power

SPECIFICATION FOR EARTH RODS AND THEIR CONNECTORS

Part 1: Copper Clad Earth Rods and their connectors

Doc. No.	KP1/3CB/TSP/06/031-1
Issue No.	3
Revision No.	0
Date of Issue	2014-04-06
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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 values offered)
Manufacturer's Name and address	
Country of Manufacture	
Bidder's Name and address	
1. Scope	
1.1-1.4	
2. Applicable Standards	
3. Terms & Definitions	
4. Requirements	
4.1 Service conditions	
4.1.1 – 4.1.2	
4.2 Design and construction	
4.2.1 General	
4.2.1.1 – 4.2.1.3	
Self-tightening	
Improved electrical connections	
No damage to the copper sheath on installation	
4.2.1.4 – 4.2.1.5	
4.2.2 Threading	
4.2.2.1 – 4.2.2.3	
System of threading	
• Earth rods	
• Coupling	
• Connectors	
• Bolts and nuts	
4.3 Specific requirements	
4.3.1 Copper clad earth rods	
4.3.1.1 – 4.3.1.6	
• Taper lengths	
• Earth rod sizes	

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Clause number	Bidder's offer (indicate full details of the values offered)
4.3.2 Connectors	
4.3.2.1 Couplings	
4.3.2.1.1 – 4.3.2.1.6	
• Coupling sizes	
4.3.2.2 Driving Head	
4.3.2.2.1 - 4.3.2.2.6	
4.3.2.3 Earth rod clamps	
4.3.2.3.1 – 4.3.2.3.8	
4.4 Sampling	
4.5 Quality Management Systems	
4.5.1 – 4.5.3	
5.0 Tests and Inspection	
5.1 Performance and testing	
5.1.1 Couplings	
5.1.1.1 – 5.1.1.4	
5.1.2 Connectors	
5.1.2.1 – 5.1.2.2	
5.2 – 5.7 Routine and type tests	
6. Marking & Packaging	
6.1. Marking	
6.2 Packaging	
6.2.1 – 6.2.3	
7. 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 Reports 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)	

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

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