



THE KENYA POWER
AND LIGHTING CO. LTD.

CODE OF PRACTICE

for

EARTHING OF MV/LV DISTRIBUTION SYSTEM (Voltage up to 33kV)

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REVISION RECORD

REVISION	DESCRIPTION OF REVISION	DATE	APPROVAL
<i>0</i>	<i>FIRST ISSUE</i>	<i>NOVEMBER 1996</i>	

EARTHING OF MV/LV DISTRIBUTION SYSTEMS

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P.M.E. EARTHING - OVERHEAD MEDIUM AND LOW VOLTAGE RETICULATION.

1. FOREWORD

- 1.1 This Instruction has been prepared by the Standards Section of the Technical Audit Division, KPLC and lays down the recommendations for the fixed earthing installation for medium/low voltage distribution network.
- 1.2 This Instruction is based on Engineering Instruction 2/72 of KPLC issued on 21st December 1972 and revised on 16th October 1979. It is subject to revision as and when required.
- 1.3 This Instruction supersedes all Instructions for MV/LV overhead earthing and PME - Earthing for overhead medium voltage reticulation issued before the revision date.

2. SCOPE

- 2.1 This Instruction is for basic requirements for fixed earthing on the indoor/outdoor distribution substations and MV/LV distribution lines.
- 2.2 This Instruction covers fixed earthing at the following installations
- (i) 33/0.433 kV distribution substations
 - (ii) 33/0.25 kV distribution substations
 - (iii) 11/0.433 kV distribution substations
 - (iv) 11/0.25 kV distribution substations
 - (v) 415 V, 4 - wire distribution lines
 - (vi) 240 V, 2 - wire distribution lines

3. DEFINITIONS

Earthing Is the total of all means and measures employed in making a connection of all electrically conducting parts to the general mass of earth.

Protective earthing Is the direct connection of conductive installation components not forming part of the normal circuit, to afford protection against unacceptably high touch voltages

Low Voltage (LV) The voltage from 0 potential to 1000 Volts (1 kV)

Medium Voltage (MV) The voltage from 1000 Volts to 52000 Volts
(1 kV to 52 kV)

PME Connection of the neutral conductor of the LV system to earth at several points, so that if a break or fault contact develops in the neutral conductor, there will still be a path for load current or fault current to flow back through earth to the neutral point of the supply transformer.

4. MATERIALS

4.1 The earth electrode will comprise of 12.5 mm (½ inch) diameter, 1.5 m (5 ft) long extensible copperclad rods and will comply with the requirement of KPLC ordering specifications for copperclad steel earthing rods.

5 REQUIREMENT

5.1 GENERAL

Earthing installation must be designed so that during normal or abnormal system conditions, there is no danger to persons in any place to which they have access or to consumer installation. The installation must be able to pass the maximum current from any fault point back to the relevant system neutral subject to the following conditions:-

- (i) It shall not cause dangerous potential gradient or difference between parts of the system.
- (ii) It shall not result in any thermal damage to connected equipment and apparatus.
- (iii) It shall allow correct operation of protective equipment.

PME will therefore be used in the following installations

- (a) On all new overhead network
- (b) On all new underground network
- (c) On all existing overhead network where need arises to improve the earthing facilities.
- (d) On all existing underground network where need arises to improve earthing facilities.

5.2 EARTHING SYSTEM

5.2.1. At every substation, two connections to earth must be installed. These are:-

- (a) An approved earth electrode connected to the metal tank of the transformer and any other metalwork supporting or enclosing the associated medium voltage conductors. (MV Earth)
- (b) An approved earth electrode connected to the neutral conductor of the low voltage network (LV Earth)

5.2.2. Every Low voltage single phase or three phase line must have its neutral conductor connected to earth electrode at the ends remote from the substation and at the end of every branch.

- 5.2.3. The MV and LV earths must be kept separate by installing the LV earth one span away from the substation pole. If there are more LV lines emanating from the substation, then LV earth one span from the substation on one line is required.
- 5.2.4. When the MV earth installation is completed, the resistance to earth will be measured . If the resistance is more than 20 Ω , additional earth rods will be installed to an extent that the resistance is reduced to 20 Ω .
- 5.2.5 When the installation of the LV earth and the construction of the LV distributors and the bonding of the neutral conductors at the substation structure have been completed, the total resistance to earth from any point on the neutral conductor of the LV system (preferably at one of the earthing points one span away from the substation) will be measured. Providing this measurement gives a reading of 10 Ω or less for the overall network no further action will be necessary. If the reading is greater than 10 Ω additional rods will be installed at points equally spaced between the substation and distributor end to the extent where the total resistance to earth is reduced to 10 Ω .

6. INSTALLATION.

6.1 LV Earth

One (or more than one when necessary) multi-unit rods shall be installed at the base of the pole holes concerned (or as deep in the hole as soil conditions will permit). A sufficient length of P.V.C insulated hard drawn copper of not less than 16.0 sq. mm cross-sectional area shall be connected to the electrode. The length of lead shall be such as to reach the test connection point at approximately 3 metres above ground level. The remainder of the lead up to the overhead neutral conductor shall comprise of bare hard drawn all-aluminium conductor of the same equivalent cross-sectional area as the neutral conductor itself. The P.V.C. insulated copper earthing lead shall be further protected with a P.V.C. channel (earth guard) between just below ground level and approximately 2.4 metres above ground level.

6.2. MV Earth

The transformer tank (MV earth) shall comprise of earth electrodes installed at the base and at the outer corner of the substation structure as in 6.1 above. Where the substation structure comprises of an H-pole assembly there shall be one rod in each pole hole bonded together via a copper lead buried in a slit trench between the two holes at a depth of not less than 0.5 metre below ground level.

6.3 Surge Diverter Earth

For distribution substations having surge diverters on the MV. side, the surge diverter earth terminals shall be linked with 16 sq. mm copper conductor which in turn shall be connected to 16 sq. mm copper conductor down lead stapled to the pole in as straight a manner as possible. At the foot of the pole the down lead shall be connected to its own electrode(s) installed at the base of the substation structure pole hole in the manner described in Section 6.2 above. The surge diverter down lead must in addition be connected to the transformer tank (MV. earth) at the transformer platform level. The value of the surge diverter earth alone, before connection to the transformer MV. earth, shall not be more than 20 ohms.

The surge diverters shall be installed between the isolation point (fuse isolator or solid link) and the transformer bushing.

For 33kV/LV distribution transformers installation of suitably rated surge diverters shall be as for 11kV/LV distribution transformers but 33kV clearances shall be maintained.

6.5. Construction

All distribution substation and LV. earthing design and installation drawings shall clearly indicate substation earthing and P.M.E. positions as detailed in this instruction, for appropriate execution during construction. All earthing costs shall be included in detailed scheme estimates.

6.6 U/G Network Earth

Where an LV cable emanates from the substation, the armour of the LV cable shall be connected to the neutral electrode (LV earth). The tank electrode (MV earth) shall be positioned at least 9 metres from the underground cable and use insulated earth lead to connect it to the transformer tank. This will ensure electrical separation of the two earth electrodes.

Where the transformer is supplied by an MV cable, the LV cable will be PVC oversheathed for at least the first 9 metres to insulate them from the earth. The neutral conductor will be bonded to the cable armour.

7 CONSUMER INTAKE

7.1 The PME earth terminal made available to the consumer must be securely bonded to the neutral conductor, and a warning notice fixed adjacent to the consumer intake stating that the installation is connected to the network employing PME

8. REFERENCE

8.1 CP 1013: Earthing

8.2 KPLC Engineering Instructions 2/72:
PME Earthing - Overhead Medium Voltage Reticulation

8.3 Cooper Power Systems:

The Lightning Protected Transformer:

How to improve distribution transformer reliability, safety, and economics through a co-ordinated approach to overcurrent and overvoltage protection.

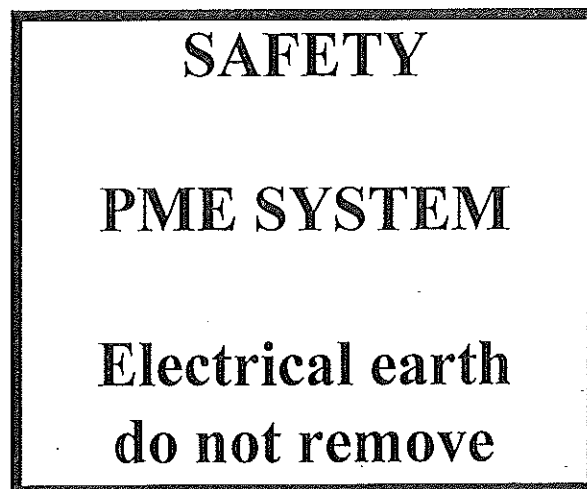
APPENDIX 1

MATERIAL SCHEDULE FOR P.M.E.

CODE	DESCRIPTION	QUANTITY
05563	Bolt brass 1" X 3/8	1
12631	Channel PVC 8' 6" X 1/2	1
44003	Copper scrap	3 kg
46221(2)	Cable lug 10D (11D)	2
82023	Crossby clips 7/8 to 9/6 DIA	2
82437	PVC aluminium covered conductor	10 m
82534	16 mm ² Copper conductor insulated	4 m
86544	Copperclad earth rod 5' X 1/2 section	4
86546	Earth, copper coupling 1/2	2
88742(3)	Aluminium line tap I (II)	1

APPENDIX 2

PME WARNING NOTICE



APPENDIX 3

ORDERING SPECIFICATION FOR EARTH RODS

COPPER CLAD STEEL EARTH ROD

ORDERING SPECIFICATION	INFORMATION																													
<p>Copperclad earthing rod with a minimum of 99.9% pure copper, bonded molecularly around a steel rod so as to form a homogeneous jacket of minimum thickness 0.25mm, as per UL 467:1984, BS 6651:1985 or KS04-744:1990</p> <p>The steel core shall be low carbon high tensile, grade 43A as classified in BS 4360:1979 - with maximum carbon content of 0.25% and tensile strength of 430/510 Mpa (N/mm²) range.</p> <p>The threading shall be Unified Coarse (UNC) and shall be formed by rolling after application of the copper jacket.</p> <p>The complete rod shall have the following dimensions:**:</p> <table><tr><th colspan="2">ROD LENGTH</th><th colspan="2">DIAMETER</th><th rowspan="2">KPLC CODE</th></tr><tr><th>(ft)</th><th>(m)*</th><th>(in)</th><th>(mm)*</th></tr><tr><td>4</td><td>1.2</td><td>1/2</td><td>12.5</td><td>186555</td></tr><tr><td>5</td><td>1.5</td><td>1/2</td><td>12.5</td><td>186544</td></tr><tr><td>7</td><td>2.1</td><td>5/8</td><td>16.0</td><td>186545</td></tr><tr><td>12</td><td>3.6</td><td>7/8</td><td>22.0</td><td>186539</td></tr></table>	ROD LENGTH		DIAMETER		KPLC CODE	(ft)	(m)*	(in)	(mm)*	4	1.2	1/2	12.5	186555	5	1.5	1/2	12.5	186544	7	2.1	5/8	16.0	186545	12	3.6	7/8	22.0	186539	<p>An earthing rod is for connecting electrical installations or lightning protection or lightning protection schemes to the earth. It provides a low impedance path for earth-fault currents and other earth bound currents such as in the neutral conductor of an unbalanced polyphase system or single phase system with earth return.</p> <p>There are three basics types of earthing rods:-</p> <p><u>Copperclad Steel Rod:</u> Intended for normal soils. A properly made earthrod will have the copper jacket molecularly bonded to the steel core, the threads rolled and the steel ends protected. When correctly installed, such a rod should last between 20 and 25 years in normal soils.</p> <p><u>Solid Copper Rod:</u> Intended for aggressive soils such as those with high salt content.</p> <p><u>Stainless Steel Rod:</u> Intended for situations where dissimilar metals or soils are buried in close proximity that would cause galvanic corrosion of copper or copperclad rod.</p>
ROD LENGTH		DIAMETER		KPLC CODE																										
(ft)	(m)*	(in)	(mm)*																											
4	1.2	1/2	12.5	186555																										
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7	2.1	5/8	16.0	186545																										
12	3.6	7/8	22.0	186539																										
<p>NOTE</p> <p>Please delete the sizes not relevant to the particular order.</p> <p>* Metric values (m & mm) are approximate.</p> <p>Other codes and sizes may also supply.</p> <p>** Preferred sizes.</p>																														

