POWER AND WATER AUTHORITY

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PREPARED BY : A GREENWOOD

AUTHORISED BY : BRIAN KENT

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POLE SUBSTATION EARTHING

SUBJECT:

In order to reduce the risk of electric shock from conducting distribution poles and to provide a high standard of public safety it is essential that earthing of distribution substations comply with the new requirements for step and touch potential rises which are documented in the new ESAA publication c(b)1-1991 Section 12. The following bulletin describes procedures to be followed and should be read in conjunction with drawings S1-2-3-11, S1-2-3-12 and S1-2-3-13.

Definitions

(i) "**Multiple Earthed Neutral System** (MEN)" - means a system of earthing in which the earthing conductor within an installation is connected to the neutral conductor as well as an earthing electrode. In this system the distribution system neutral provides a continuous electrical path between the customers' electrical installation and the substation earth connection.

(ii) "**Common Multiple Earthed Neutral System** (CMEN)" - means an MEN system of earthing in which the earthing circuits of different voltage levels are the same. In this system, conducting poles that carry high voltage circuits or both high voltage and low voltage circuits are bonded to the low voltage neutrals.

(iii) "**Local Earth**" - means an earthing system for a particular item of equipment and includes the earth connections but not the CMEN connections.

(iv) "**Auxiliary Earth**" - is an earth installed to improve the resistance to earth of the CMEN earthing system.

(v) "**Step Voltage**" - means the voltage which may appear between any two points on the surface of the ground spaced one metre apart.

(vi) "**Touch Voltage**" - means the voltage which may appear between the hand or any other part of the body of a person in contact with uninsulated metal work and the feet when the feet are placed together on the ground and centred at a distance of one metre measured as a projection horizontally from the surface being touched.

(vii) "**Surface Soil Resistivity**" - is the specific resistance of the soil with the test electrodes spaced 1 metre apart. Soil resistivity tests are taken with various electrode spacings to represent a depth profile of soil resistance. Soil resistance generally lowers with depth. To err on the side of safety the value of soil resistivity with test electrodes spaced 1m apart should be used in choosing correct earthing arrangement.

(viii) "**Special Location**" - means within a school's grounds or within a childrens playground, or within a public swimming pool area or at a popularly used beach or water recreation area, or in a public thoroughfare within 100 metres of any of the above named locations.

(ix) "**Frequented Location**" - means any urban areas associated with a city or town other than a special location.

(iix) "**Remote Location**" - means an area not defined as frequented or special.

The basic requirements are;

(i) In an existing CMEN area:-

(a) a distribution substation's local earth is required to have a maximum resistance to ground of 30 ohms.

(b) with distribution substation's LV neutral bonded to the local earth and the CMEN conductor the maximum resistance to ground is required to be 1 ohm.

(c) a relaxation can be applied to this 1 ohm value if Step and Touch potentials in the area comply with Section 12 ESAA c(b)1 - 1991 document. Refer to Regional Engineer or Standards Branch.

(d) all extensions within "frequented locations" are required to have an LV neutral conductor or underslung aerial earthwire bonded to all poles.

(e) extensions traversing "remote locations" do not require underslung aerial earthwires if the feeder is protected by sensitive earth fault protection and there is no cost benefit in bonding the remote location to an existing CMEN system. Major feeders supplied from remote generation sources do require aerial earthwire to improve system fault levels, see Standard Bulletin S1-035.

(f) an auxiliary earth may be installed and bonded to the CMEN conductor at diverse locations to reduce the resistance to ground for the CMEN system.

(ii) In a non-established CMEN area:-

(a) a distribution substation's local earth is required to have a maximum resistance to ground of 30 ohms.

(b) with the local earth connected to a customer's LV neutral or the neutral conductor of existing LV reticulation the desired maximum resistance to ground is 1 ohm. However, if this value cannot be economically achieved then an investigation into Step and Touch Potentials in accordance with Section 12 ESAA c(b)1 - 1991 is needed to determine the minimum earthing requirements.

(iii) Testing Soil Resistivity

The first step in establishing an efficient and effective earth system is to measure the soil resistivity at the installation site. If the soil resistivity is known then:-

(a) the best substation site can be chosen.

(b) the appropriate earthing arrangement can be chosen.

(c) an estimate of materials and labour for the installation can be achieved more accurately.

(d) the difficulties in meeting the required resistance values can be predicted before wasting materials, time and money.

(iv) Choice of Earthing Arrangement

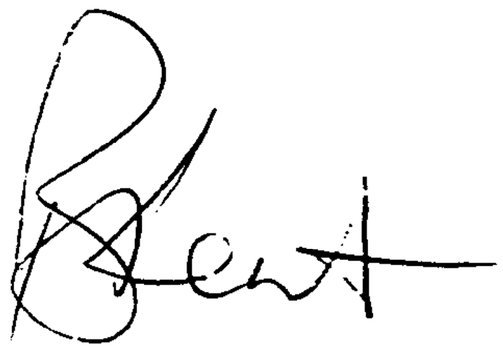
(a) For surface soil resistivity values of up to 200 ohm metre use the earthing arrangement as per drawing S1-2-3-11 which consists of six driven standard electrodes spaced 3 metres apart.

(b) For surface soil resistivity values between 200 and 350 ohm metre use the earthing arrangement as per drawing S1-2-3-12 which consists of ten driven standard electrodes spaced 3 metres apart.

(c) For surface soil resistivity betweem 350 and up to 500 ohm metres use the earthing arrangement as per drawing S1-2-3-13 with six bored holes spaced 8 metres apart. Where bored holes are less than 75mm diameter a backfill mixture is required to be poured into the bored holes, where it forms a conductive gel. The backfill mixture is required to be either lo-ohm or earthron w /water, ratios being 2-3 (10kg) bags/10-15 litres water. This gel forms a good conducting medium between the electrode and the sides of the bored hole. The conductive gel will not leach away.

Where bored holes are larger than 75mm diameter it is recommended that a mixture of selected soil and lo-ohm or earthron at a 1:1 ratio be placed in the hole dry and progressively watered.

The above earthing arrangements will achieve 30 ohm local earthing resistance for the majority of installations. In cases of high surface soil resistivity (ie. above 500 ohm metre) advice should be sought from the Regional Engineer or Standards Branch to design individual earthing arrangements for that particular case.



BRIAN KENT
STANDARDS MANAGER POWER