POWER AND WATER AUTHORITY

STANDARDS BRANCH
-POWER DIVISION-

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PREPARED BY : TROY McKAY-LOWNDES

AUTHORIZED BY : BRIAN KENT

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SUBJECT : UNDERSLUNG EARTHWIRES IN MINOR CENTRES

During recent investigation into fusing and earthing practices in remote minor centers, attention was drawn to the earthing of "HV only" poles.

It is essential for public safety that an underslung earth wire be erected on all HV poles and bonded to the pole as per Standard Drawing S1-2-3-1.

The stepdown substation earths should comply with current substation earthing practices.

The step-up sub-station earthing should comply with drawings S1-2-3-5 and S1-2-6-4.

This system of earthing, where

a. all "HV only" poles are bonded to an earth wire;
b. the HV earth wire is connected to the substation earth mat;
c. the LV neutral is bonded to each pole;
d. the LV neutral is connected to the substation earth mat;
e. the HV and LV earth mats are combined; and
f. the overhead earthwires to be connected to the step-up substation neutral.

is known as a Combined Multiple Earthed Neutral system or CMEN system.

This is the standard earthing system for all minor centres.

New Minor Centres

In all new centres the following requirements will apply in respect of CMEN system - HV earth wires.

The underslung HV earth wire will have a strength not less than half the largest active conductor but in any case not less than 16000 newtons.

The recommended conductor is Raisin, 3/4/2.50 ACSR/GZ (stock code 1610).

The earth wire should be erected in accordance with standards Drg S1-2-3-1.

Existing Minor Centres

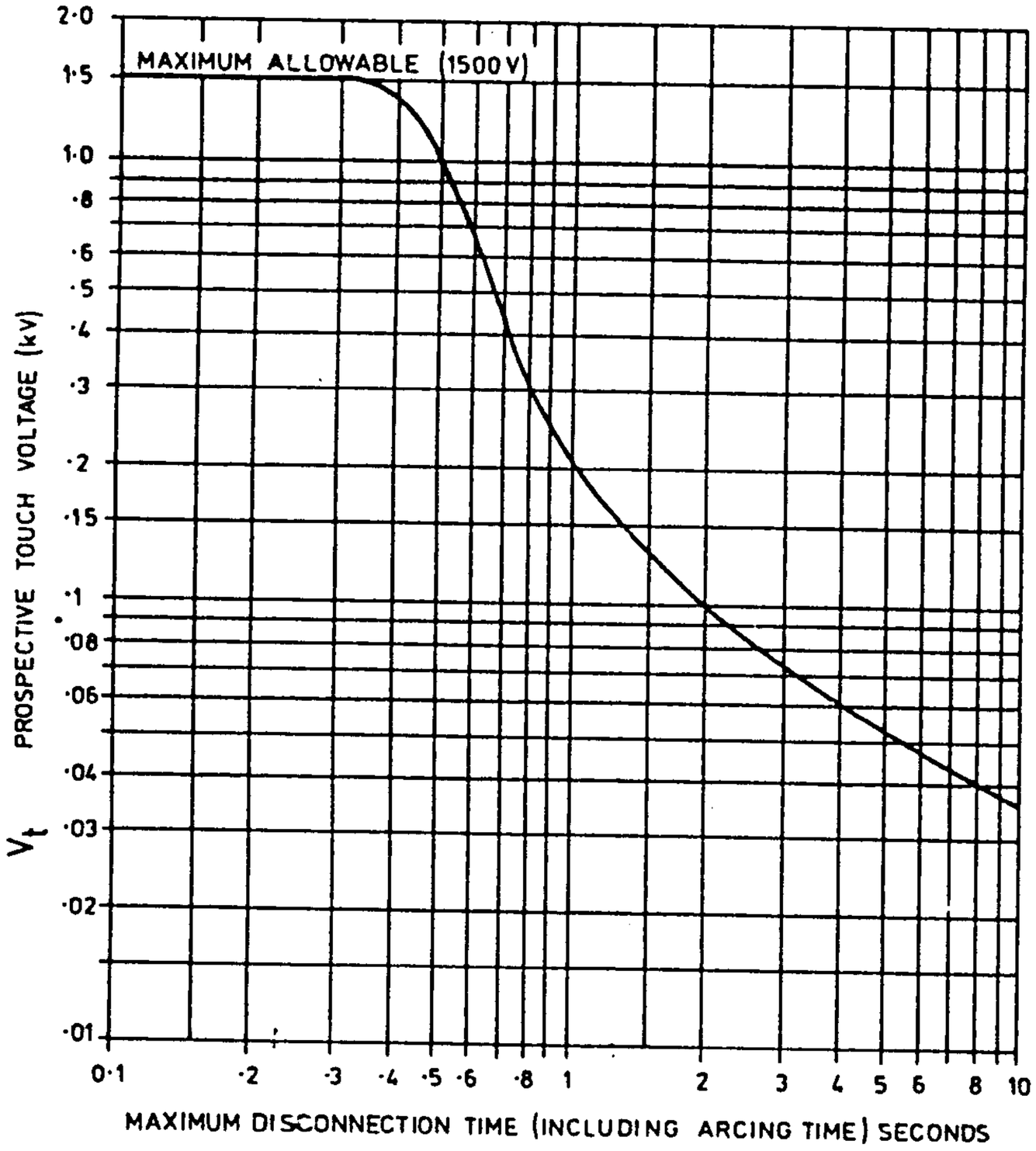
In all existing minor centres, an underslung earth wire is to be installed provided clearances to the ground are maintained. The earth wire on a "HV only" pole is to be considered as a part of the LV circuit in a CMEN system and the clearances specified in S1-4-1-2 are to be observed.

Where an LV circuit is on the same pole as the HV circuit, the LV clearances in S1-4-1-2 will apply. The LV neutral is the earth wire and should be bonded at every pole.

Where it is possible to obtain the required clearances to the earth wire, a pole earth shall be installed. The pole footing resistance shall not exceed 5 ohms.

The pole footing resistance may be increased if the prospective touch voltage and associated clearing times comply with the values shown in the attached graph.

BRIAN KENT
STANDARDS MANAGER POWER



PROSPECTIVE TOUCH VOLTAGE/CLEARING TIME FOR METAL ENCLOSED APPARATUS

$V_t = 1000\ I_p$ Volts

BASIS OF GRAPH

THE GRAPH IS BASED UPON THE MAXIMUM TOUCH POTENTIAL THAT A PERSON IS ESTIMATED TO BE ABLE TO WITHSTAND FOR THE PERIODS INVOLVED. (BODY RESISTANCE ASSUMED 1000Ω.)

REFERENCE: DETERMINING TOLERABLE SHORT DURATION ELECTRIC SHOCK POTENTIALS FOR HEART VENTRICULAR FIBRILLATION THRESHOLD DATA BY W. O'KEEFE B.E., N. G. ROSS B.E.E., E. R. TRETHEWIE (UNIVERSITY OF MELBOURNE) ELEC. ENGG. TRANS.I.E. AUST. VOL. EE8, No. 1 APRIL, 1972.

APPLICATION

(1) Allowable Prospective Touch Voltage

The allowable prospective touch voltage must not be exceeded by any actual voltage that a person may experience under any earth fault condition.

Where voltage rises on the earthing installation are transferred by metalwork such as neutral conductors of an M.E.N. system, water pipes and the like to locations outside the voltage gradient area around the installation, then the prospective touch voltage should be regarded as being equal to the earthing installation voltage rise. Where, however, there is no such transfer of voltage, advantage may be taken of local voltage gradients.

(2) Calculation of Voltage Rise

In the simple case (e.g. a distribution centre fed from a radial overhead line and having a local earthing installation that does not include metal work such as interconnected neutrals or electrically continuous water piping or cable sheaths which connect it to the HV source earthing point) the voltage rise at the earthing installation is the product of the earth fault current and the local earthing impedance. The voltage rise should fall within the limits specified in the graph.

Where the installation (e.g. distribution centre) is supplied from multiple HV sources or earthed via multiple metallic networks such as interconnected neutrals, overhead earthwires, cable sheaths, water piping and the like, the accurate calculation of the voltage rise at the installation earth can become a very complex problem. However, approximations which err on the high side in respect of the impedance of an earthing installation involving multiple paths are satisfactory if the result so calculated complies with the limits specified in the graph. It is sufficient therefore to assume a pessimistic value of earthing impedance and to calculate the consequent voltage rise. If the voltage rise so calculated satisfies the limits specified in the graph, no further calculations are necessary. However, if the limits specified in the graph are not satisfied, then a closer assessment of the true earth impedance is necessary. In those cases where there is doubt that the earthing installation may comply, it will be necessary to carry out a complete mathematical analysis or to measure the voltage rise by methods such as current injection from a remote point or the like.

FIG. 1