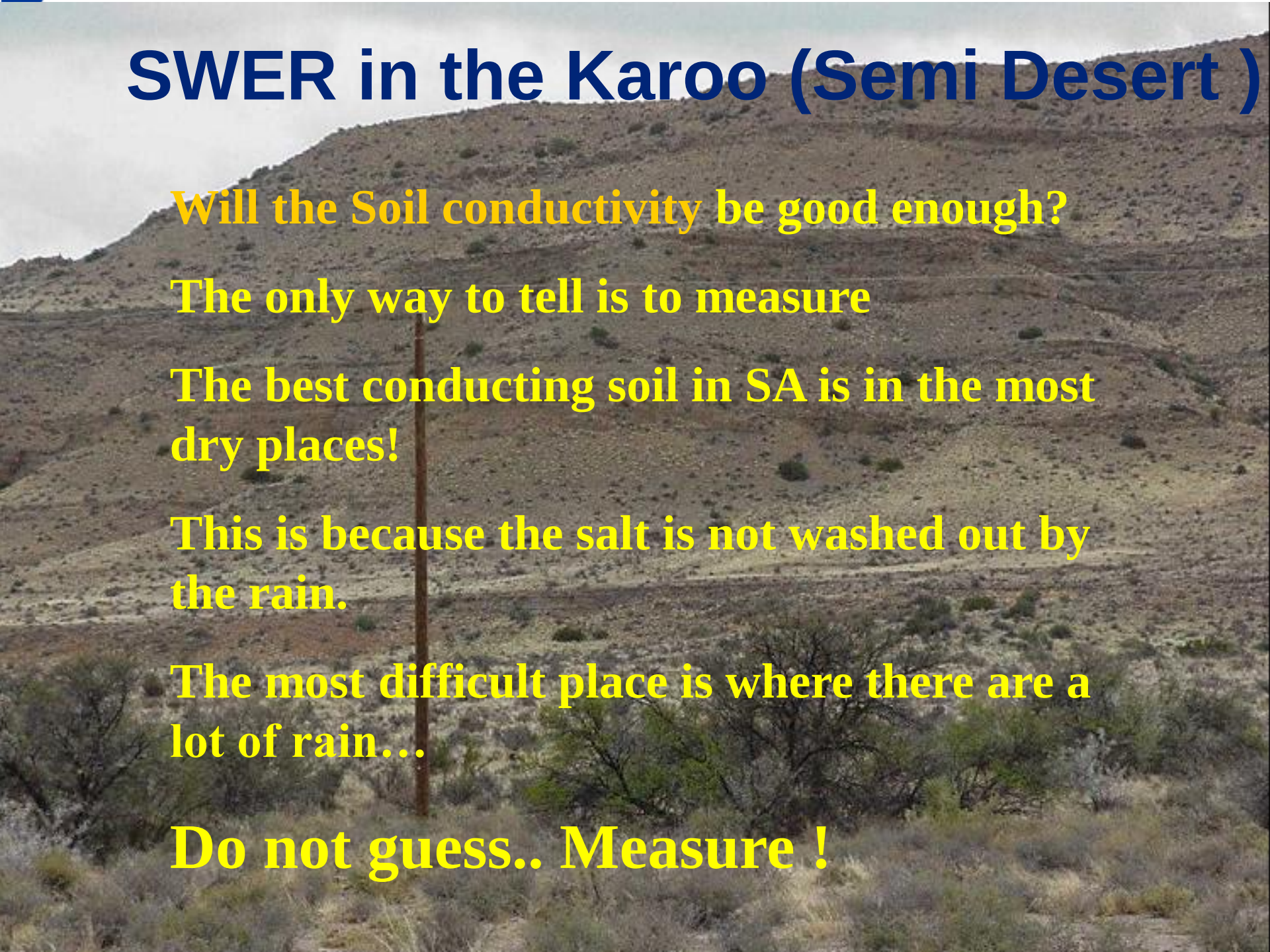
Earth Electrode Design

Dr Hendri Geldenhuys PrEng
Eskom Distribution Technology

SWER in the Karoo (Semi Desert)



Will the Soil conductivity be good enough?

The only way to tell is to measure

The best conducting soil in SA is in the most dry places!

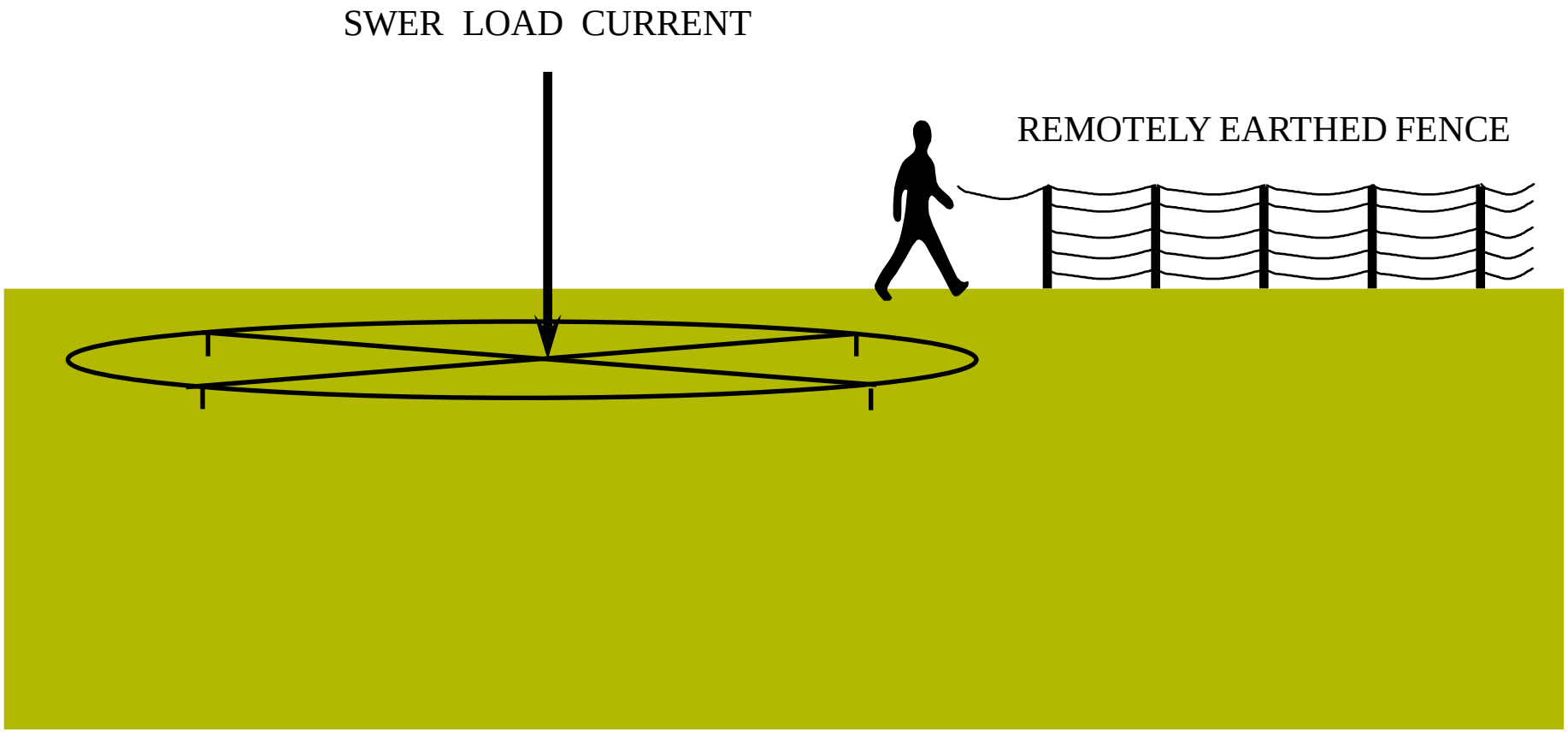
This is because the salt is not washed out by the rain.

The most difficult place is where there are a lot of rain…

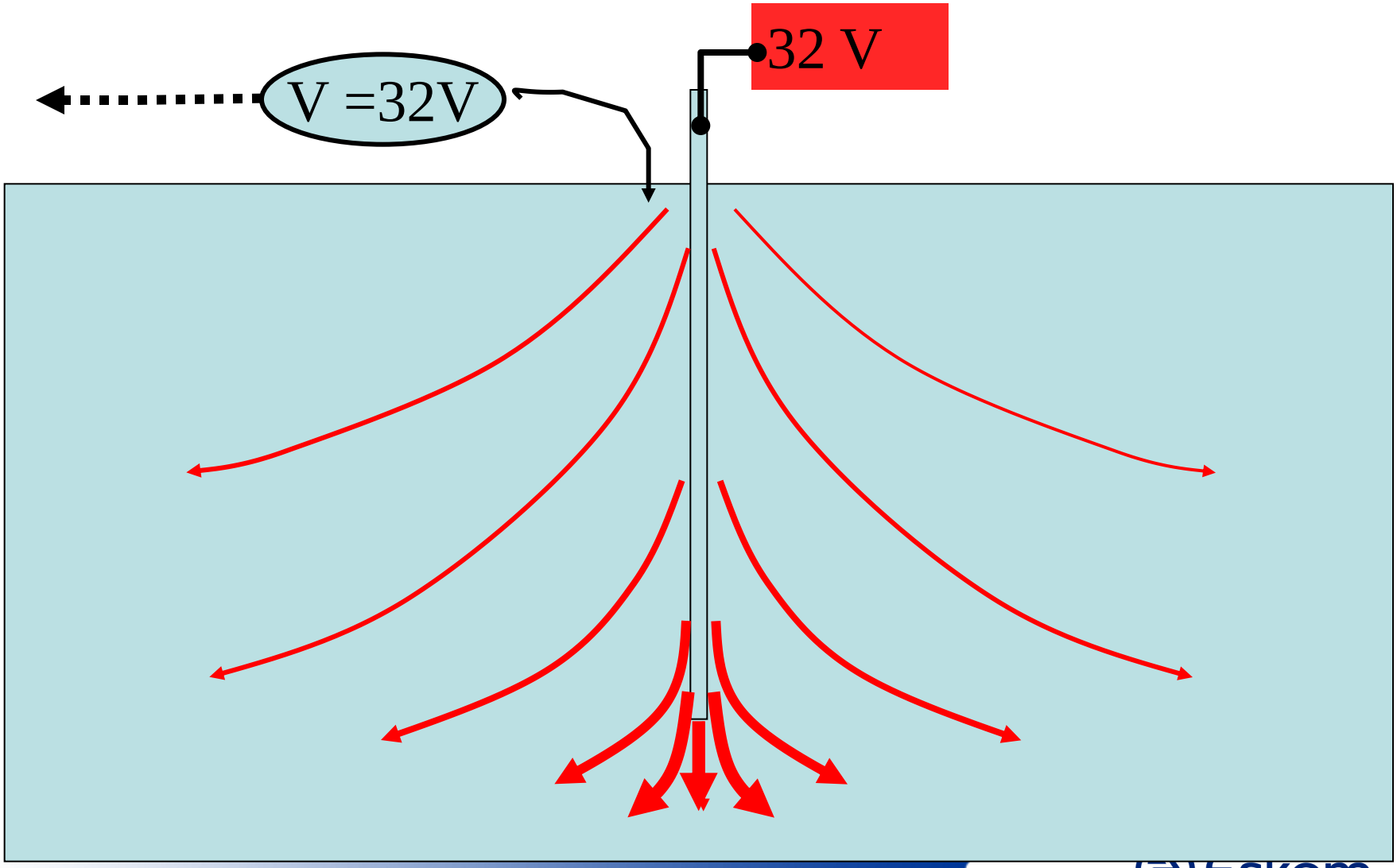
Do not guess.. Measure !

Touch Potential

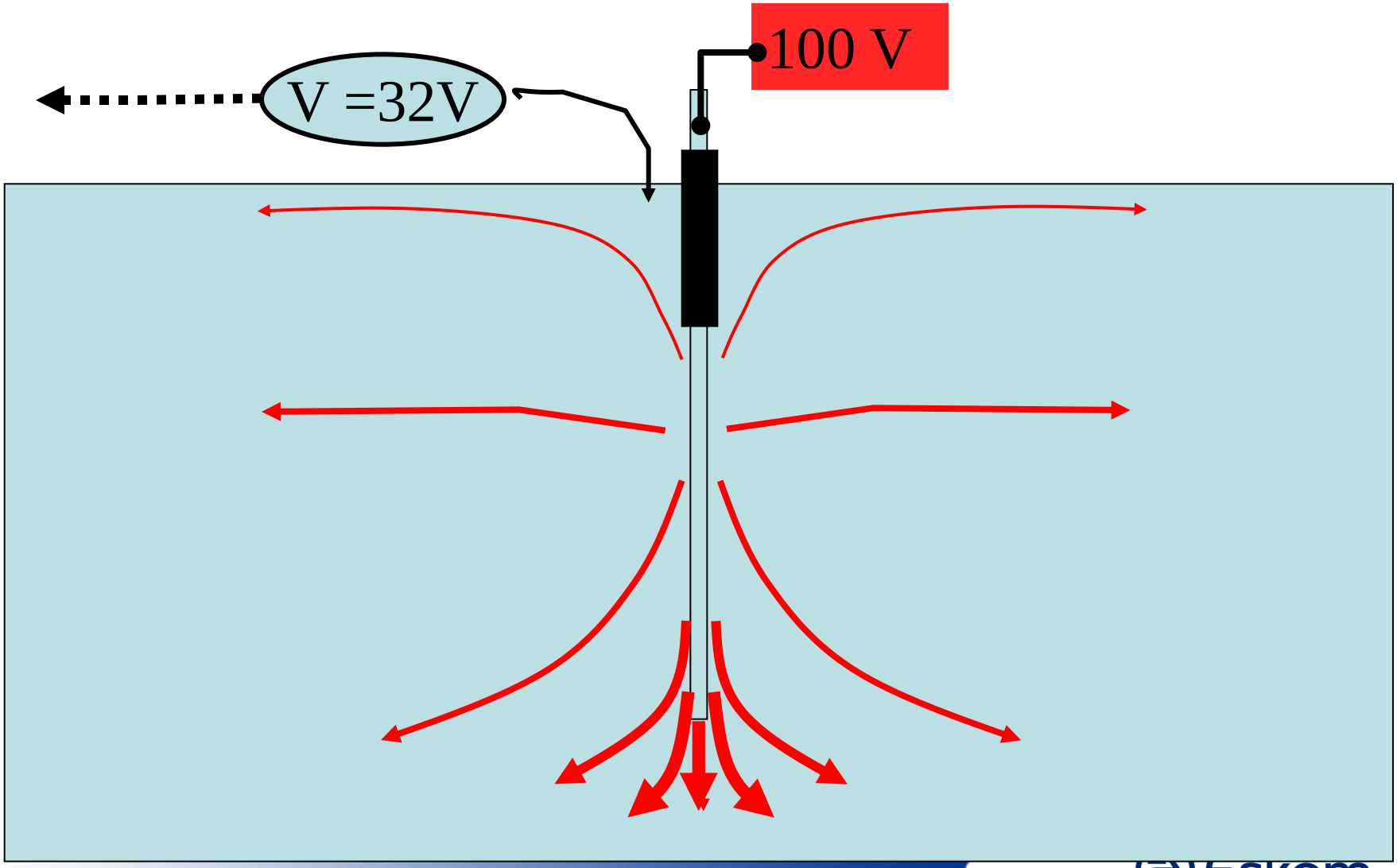
V < 32 V



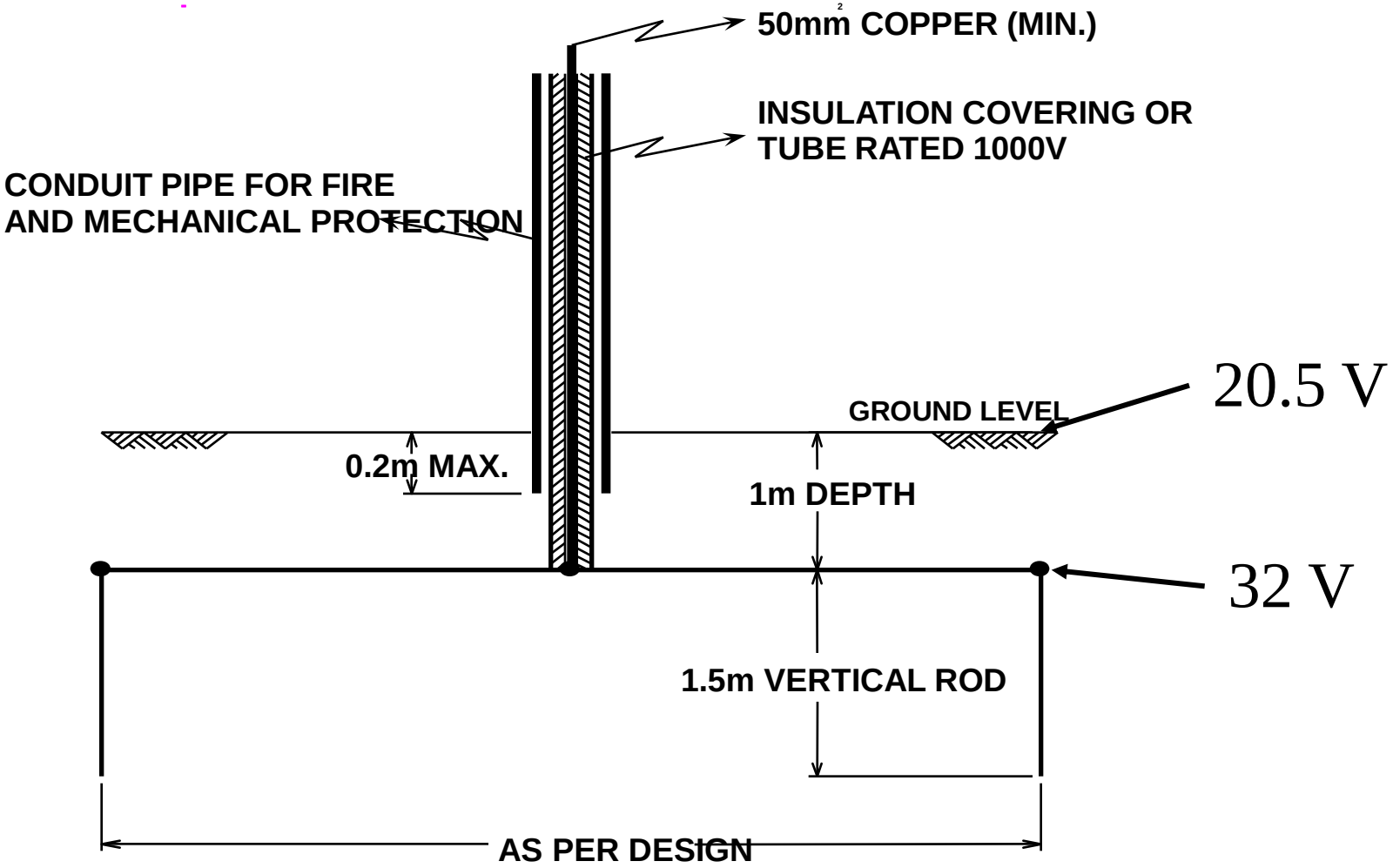
Deep Drilled Vertical Electrode



Deep Drilled Vertical Electrode



Insulation of the Earth Down Lead



Transformer Earth Electrode Resistance

Based on Earth Potential Rise < 32 V

Table 1: The design resistance required for various transformer sizes. This is based on a Ground Potential rise of 32V.

Transformer	Earth return current	SWER Required resistance	Design resistance
5 kVA	0.26 A	122.2 ohm	30.0 ohm
15 kVA	0.79 A	40.7 ohm	30.0 ohm
25 kVA	1.31 A	24.4 ohm	24.0 ohm
50 kVA	2.62 A	12.2 ohm	12.0 ohm
200 kVA	10.5 A	3.1 ohm	3.0 ohm
400 kVA	20.9 A	1.5 ohm	1.5 ohm

Eskom

Insulated Vertical Rod Electrode

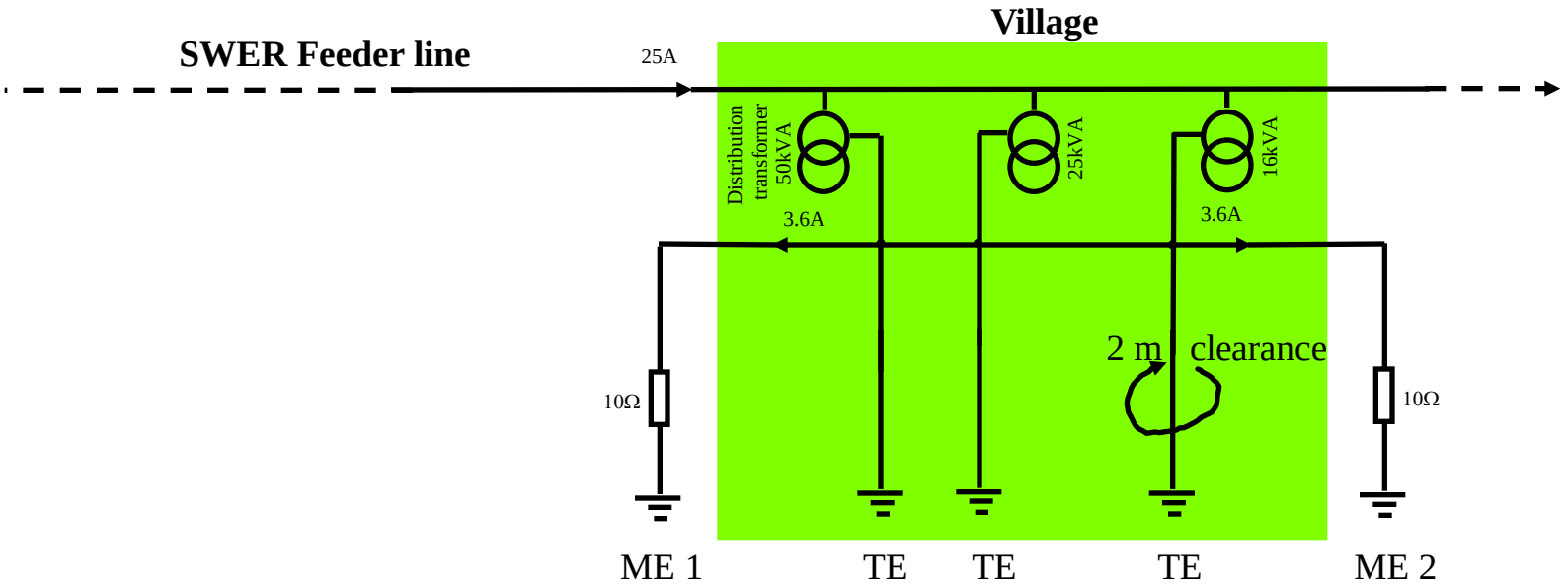
Based on Earth Potential Rise < 100V

Table 1: The design resistance required for various transformer sizes. This is based on a Ground Potential rise of 100V.

Transformer	Earth return current	SWER Required resistance	Design resistance
5 kVA	0.26 A	382.0 ohm	30.0 ohm
15 kVA	0.79 A	127.3 ohm	30.0 ohm
25 kVA	1.31 A	76.4 ohm	30.0 ohm
50 kVA	2.62 A	38.2 ohm	30.0 ohm
200 kVA	10.5 A	9.6 ohm	9.0 ohm
400 kVA	20.9 A	4.8 ohm	4.5 ohm

Eskom

Earth Safety in a Village.



The earthing practise and under running neutral conductor for a village.

Notes

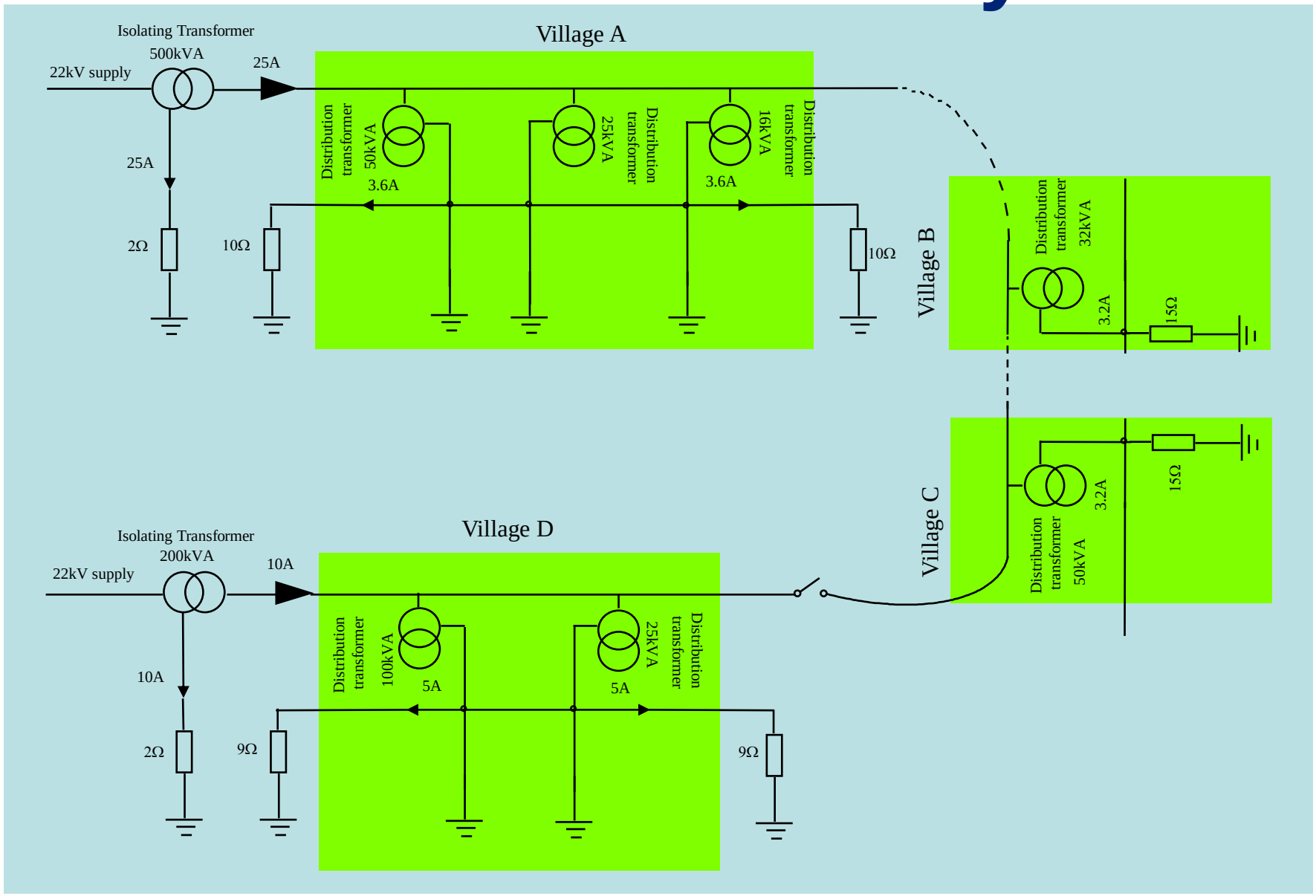
1) The main (low resistance) SWER earth electrodes (ME 1 and ME 2) are located outside the village to overcome the step and touch potential problems.

2) There are two main earth electrodes (ME) per village to give some redundancy.

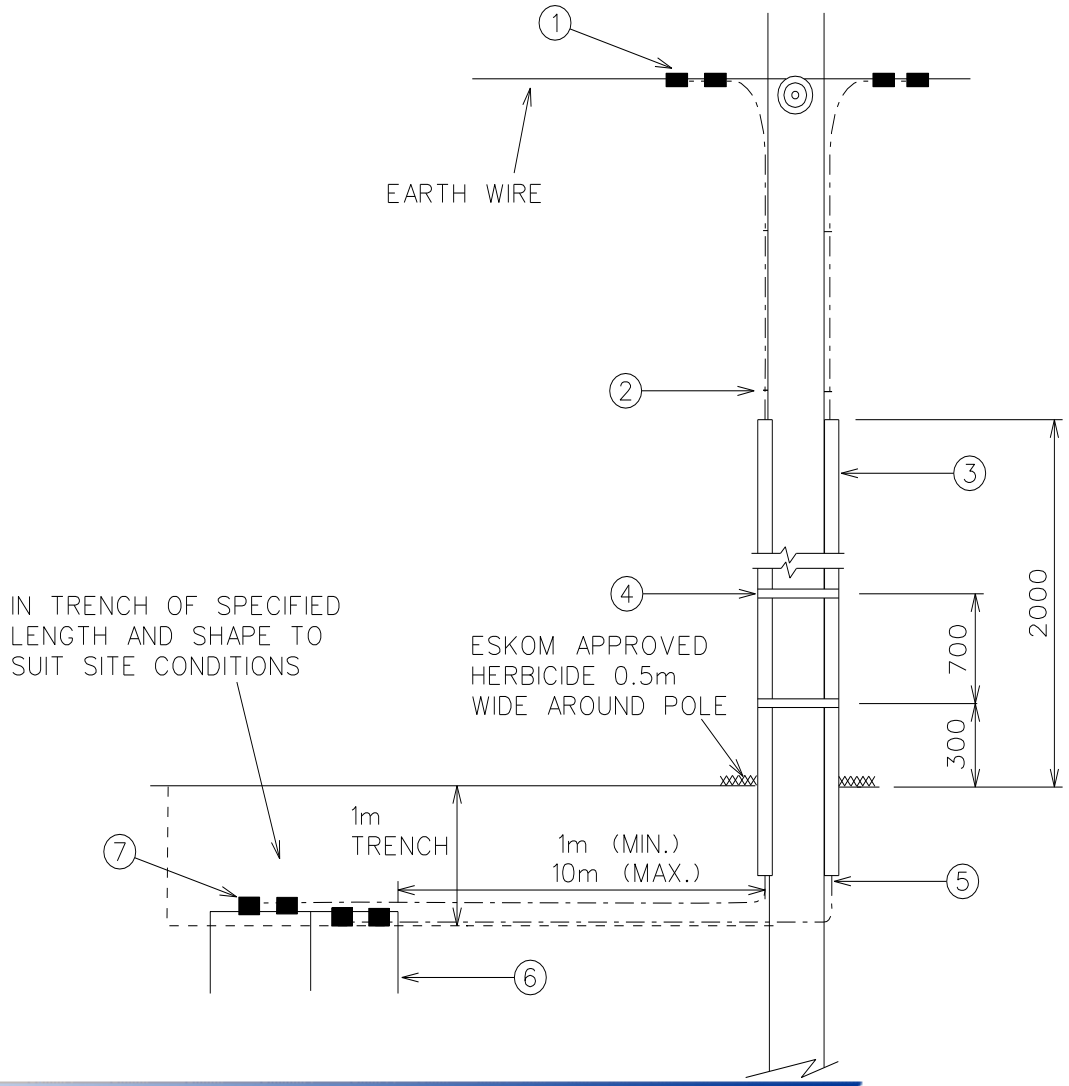
3) The transformer pole earth (TE) is simply a butt wrapped wire around the bottom of the pole. It must be small to avoid step and touch potential problems in the town.

4) A clearance of 2m to any conductors in the vicinity (such as fences) should be maintained around a transformer pole (earth) to avoid step and touch potential problems.

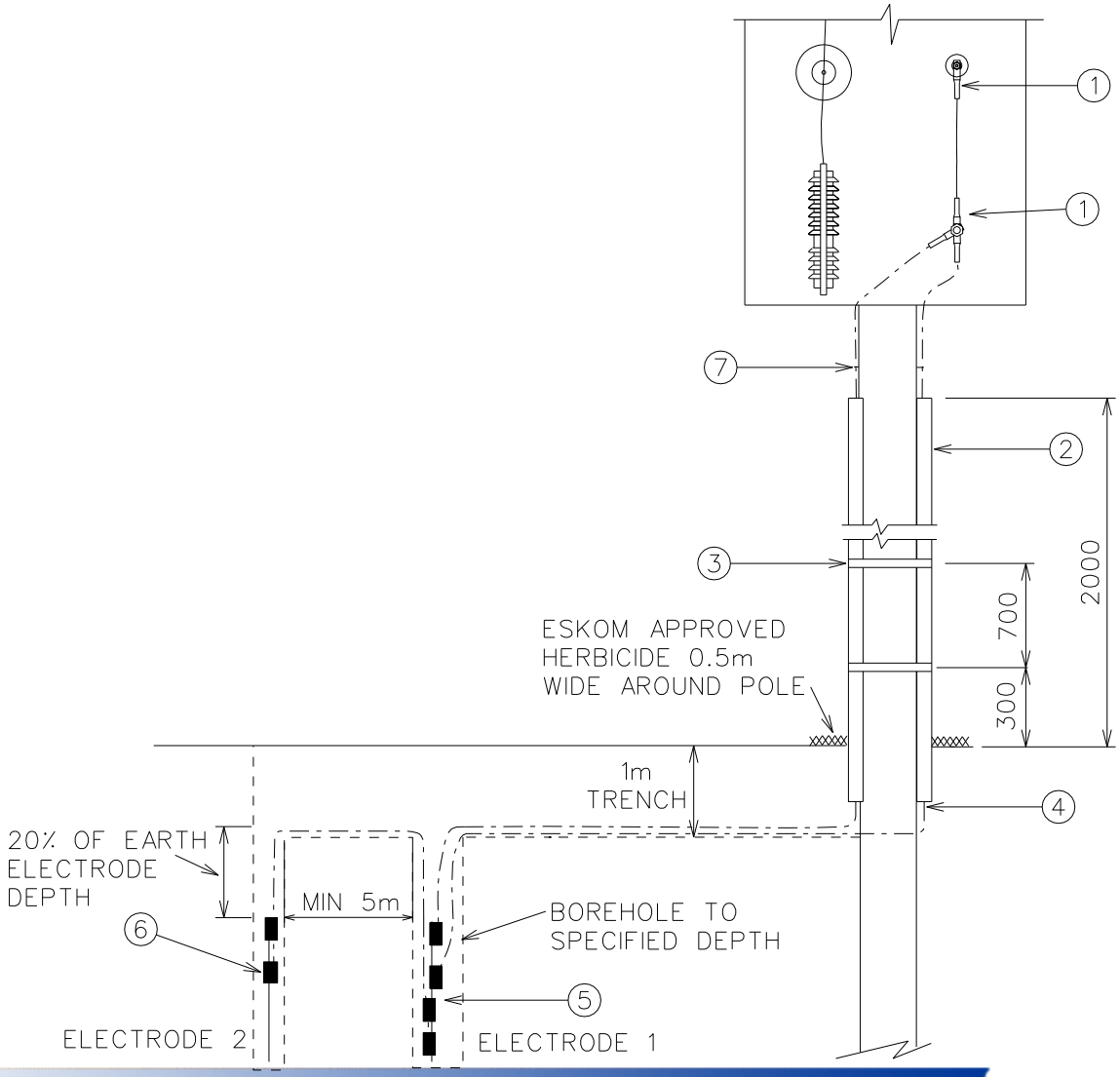
SWER Scheme Layout



Double Down Earth Conductor

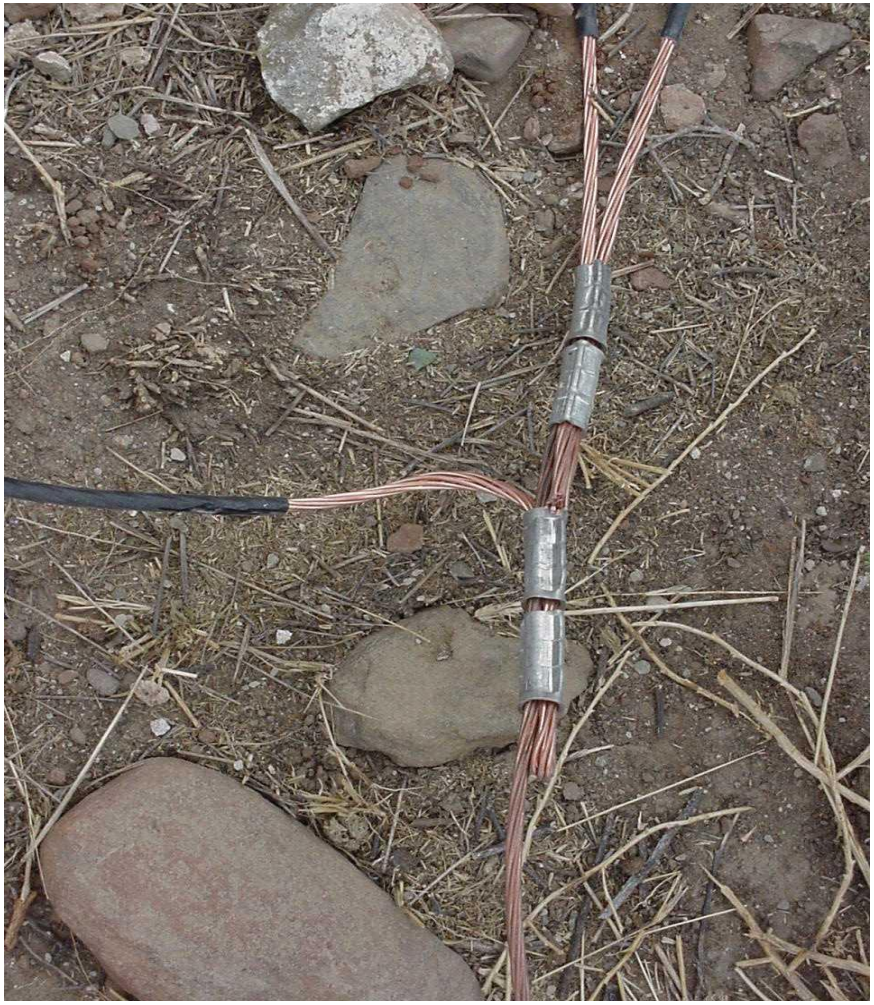


Customer Transformer Installation



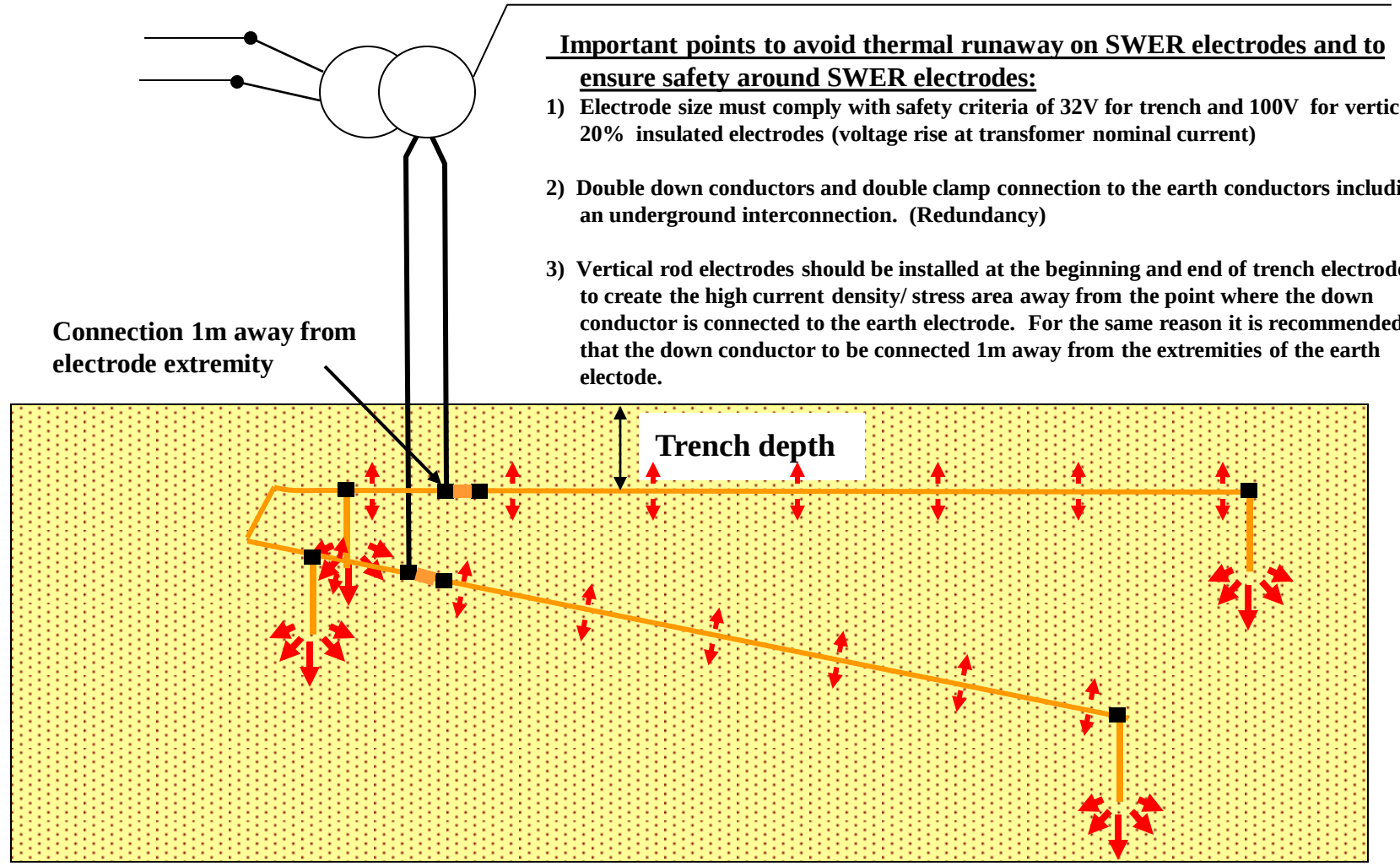
Eskom

Double Crimp on Earth Connections



Drilling a Vertical Electrode Hole

Trench Electrode for Isolation Transformer



Important points to avoid thermal runaway on SWER electrodes and to ensure safety around SWER electrodes:

1) Electrode size must comply with safety criteria of 32V for trench and 100V for vertical 20% insulated electrodes (voltage rise at transfomer nominal current)

2) Double down conductors and double clamp connection to the earth conductors including an underground interconnection. (Redundancy)

3) Vertical rod electrodes should be installed at the beginning and end of trench electrodes to create the high current density/ stress area away from the point where the down conductor is connected to the earth electrode. For the same reason it is recommended that the down conductor to be connected 1m away from the extremities of the earth electode.

End

Earth Resistivity and Electrode Resistance Measurement

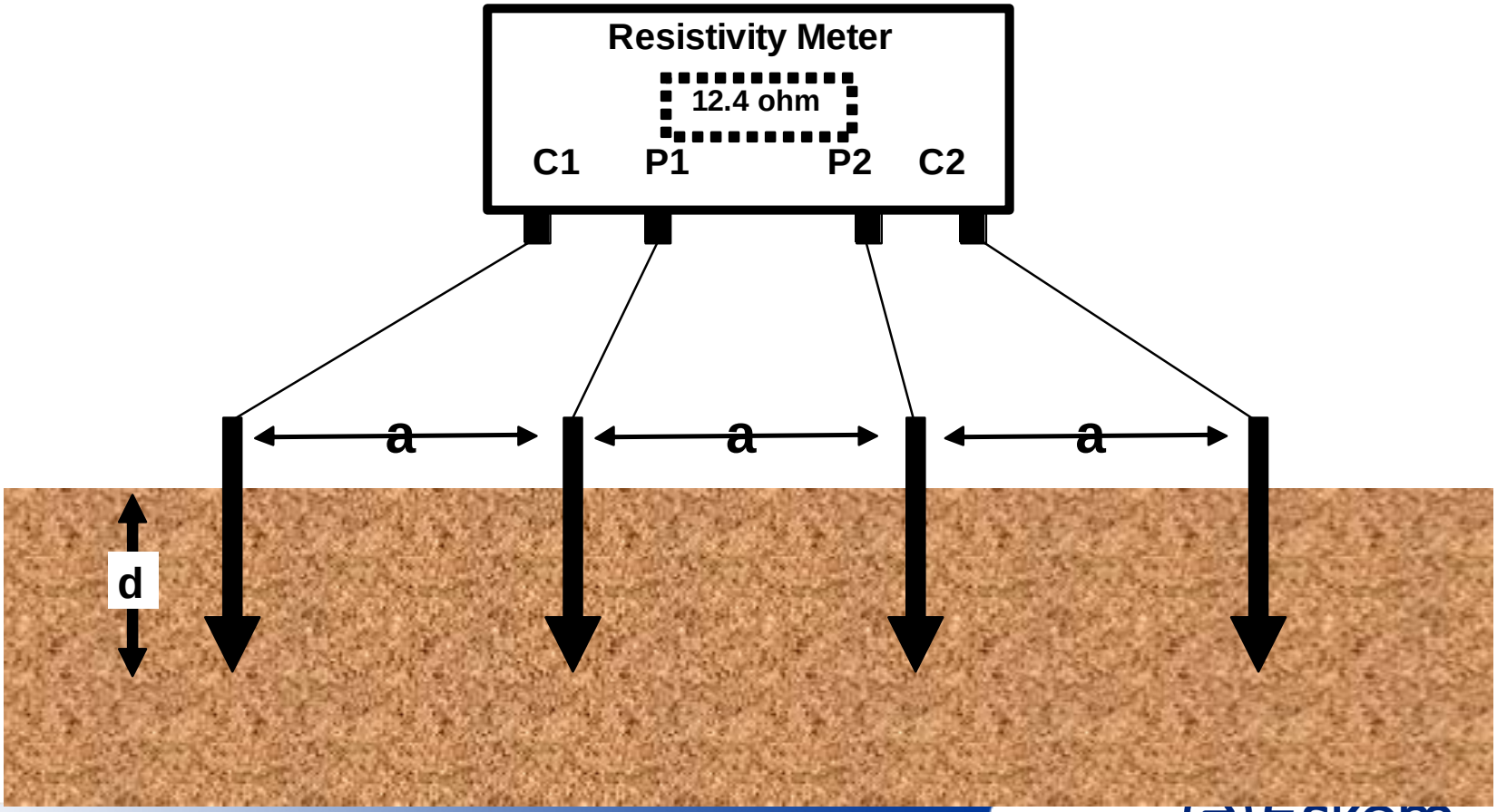
Dr Hendri Geldenhuys PrEng
Eskom Distribution Technology

Eskom

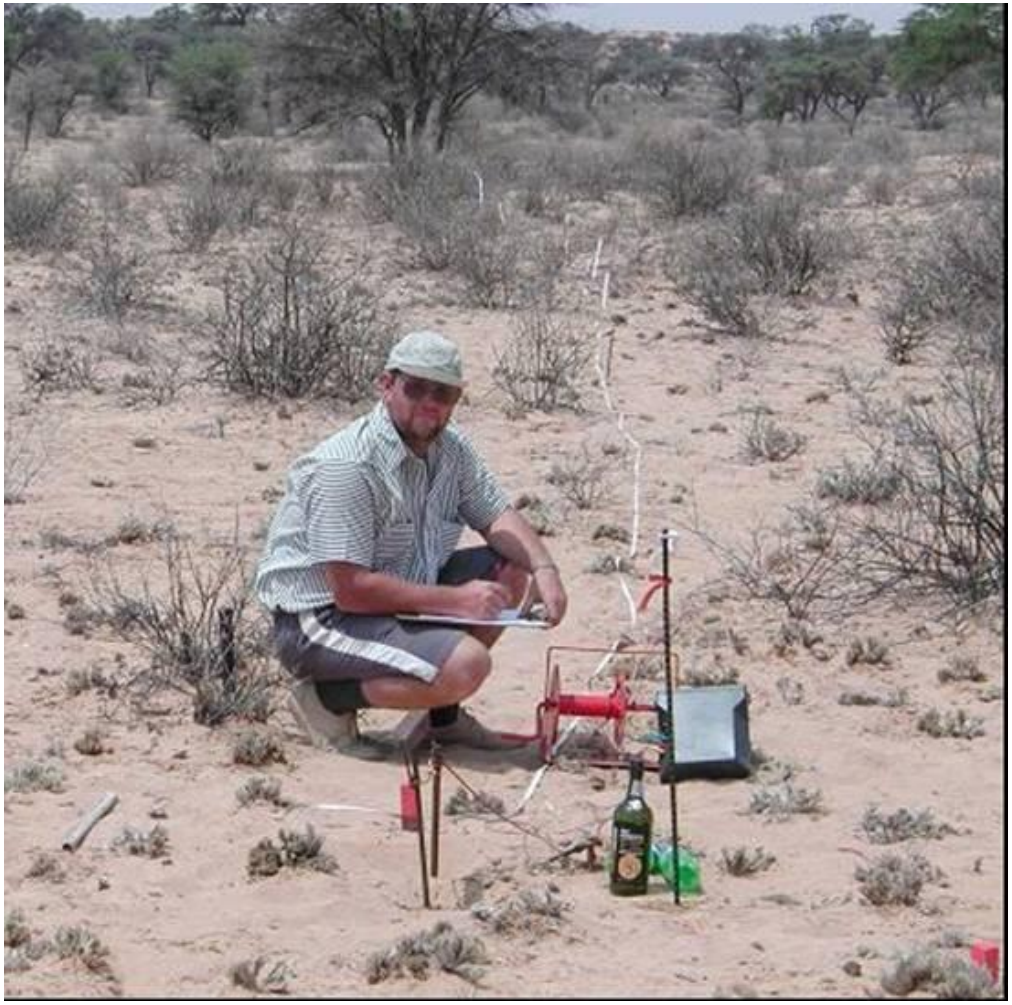
Earth Resistivity Meter

Eskom

Soil-Resistivity Measurement



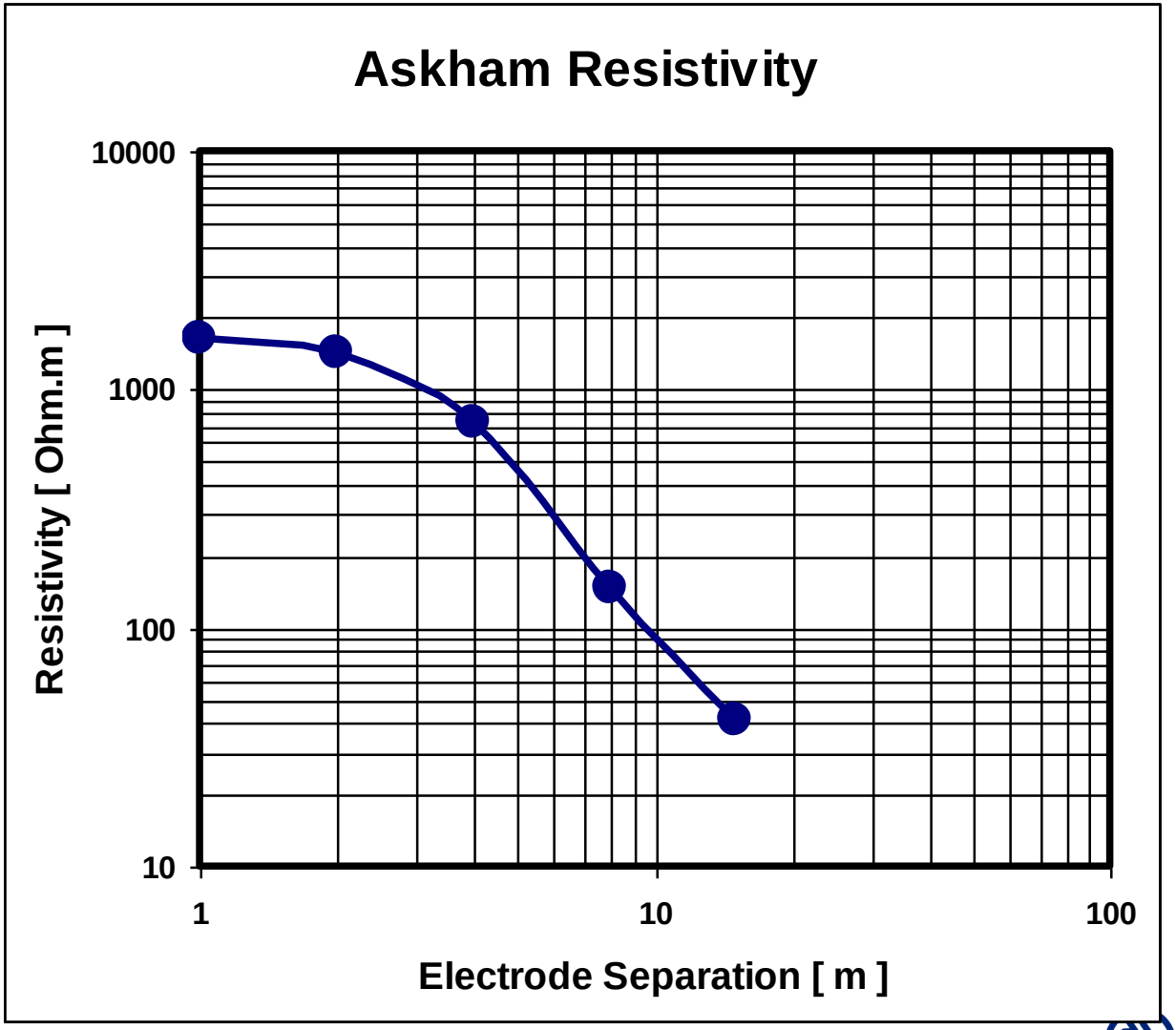
Resistivity Tests



Resistivity Measurement- Calculation

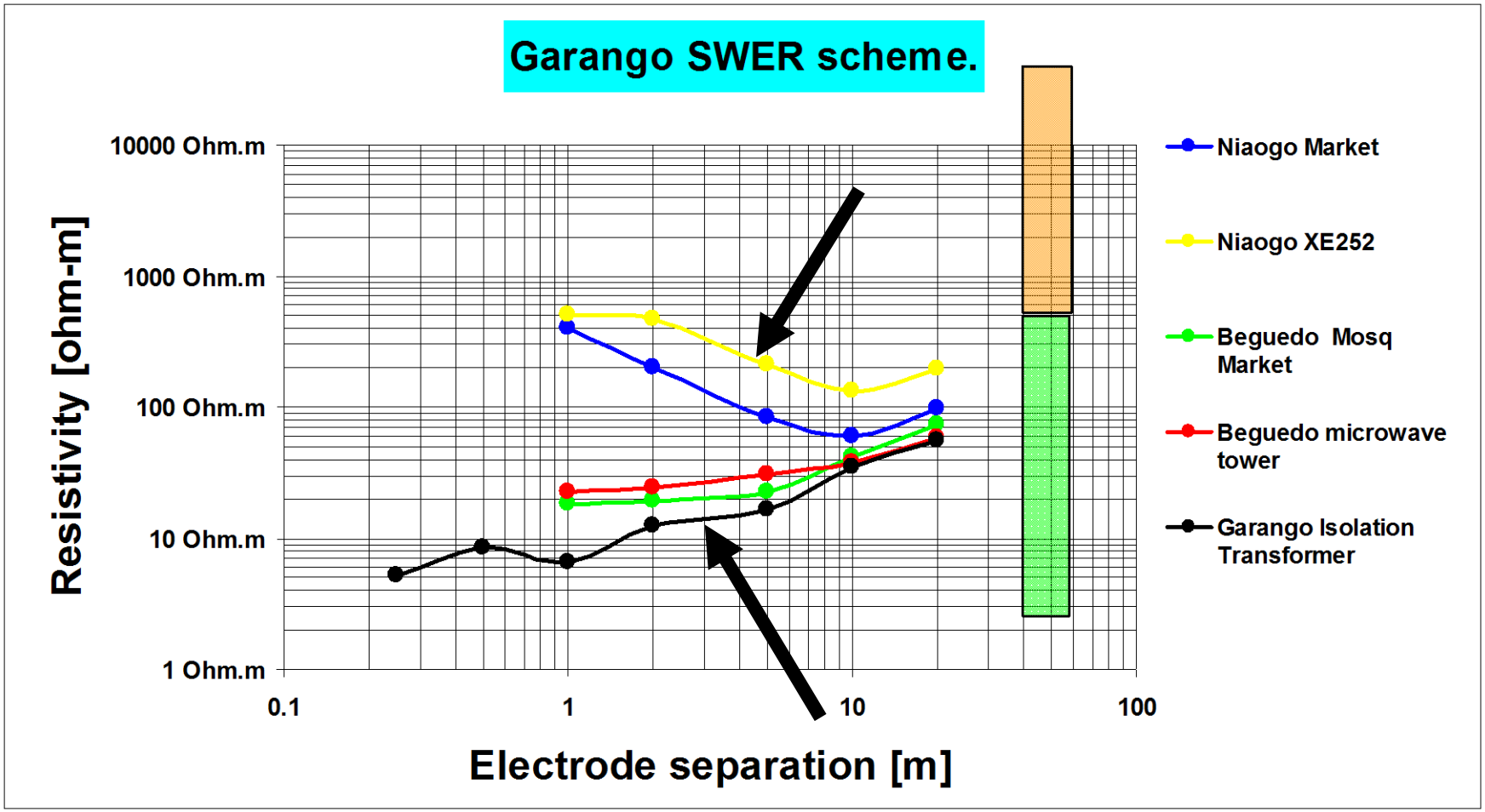
Electrode Separation [m]	Resistance [Ohm]	Factor	Resistivity
1	R1	a x 2.Pi	a x 2.Pi x R1
2	R2	a x 2.Pi	a x 2.Pi x R2
5	R5	a x 2.Pi	a x 2.Pi x R5
10	R10	a x 2.Pi	a x 2.Pi x R10
20	R20	a x 2.Pi	a x 2.Pi x R20
50	R50	a x 2.Pi	a x 2.Pi x R50

Resistivity At Askham: Kalahari Desert



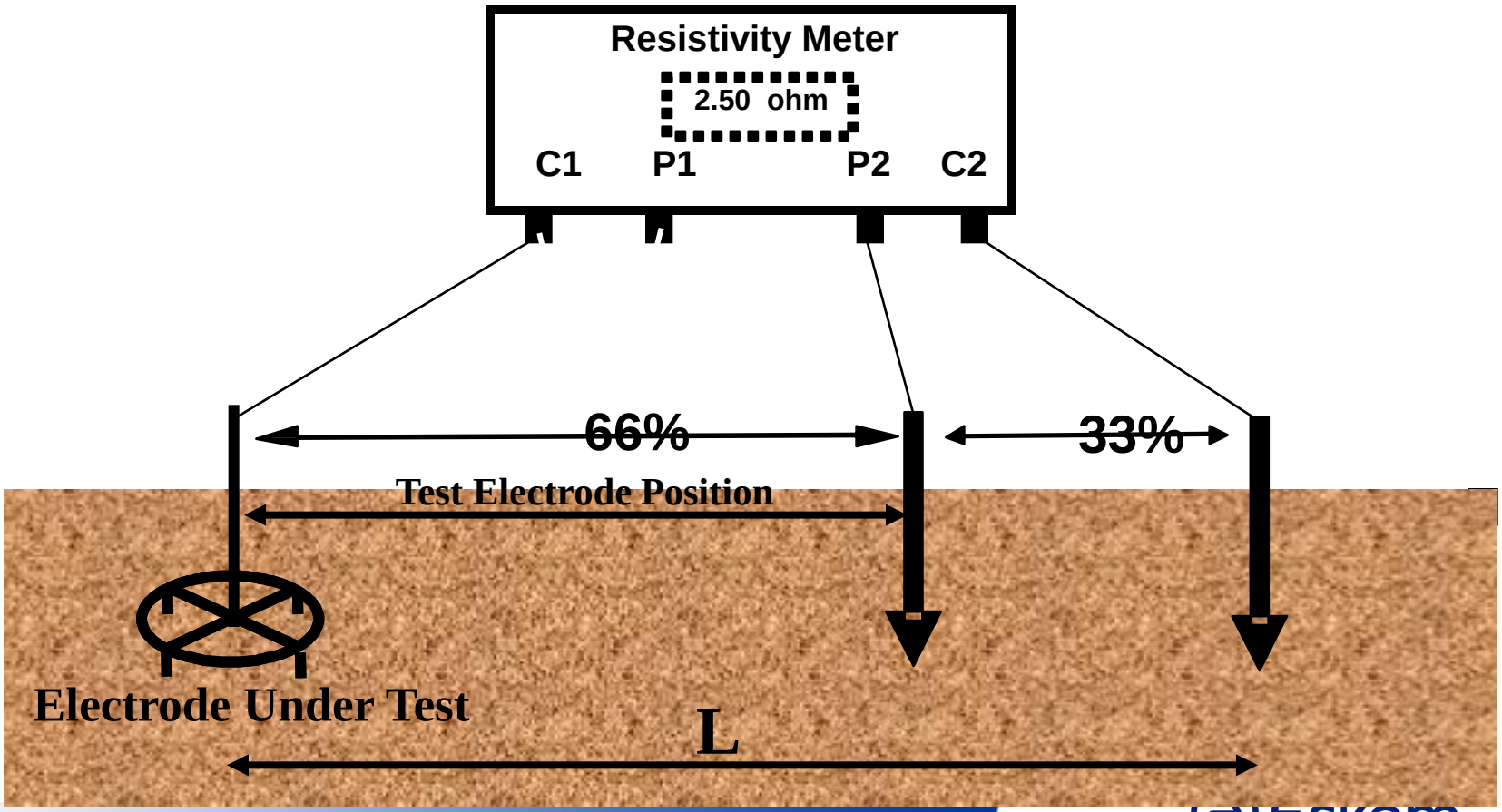
Eskom

Burkina Faso Resistivity



Eskom

Electrode Resistance Measurement



Electrode Resistance Measurement

Test Electrode Position	Resistance
.2L	
.4L	
.6L	
.8L	

Eskom

End