RESOURCES AND STRATEGY

DISTRIBUTION TECHNOLOGY ENGINEERING PROCESSES

EQUIPOTENTIAL EARTHING

AMEU PRESENTATION: ABSTRACT

TABLE OF CONTENTS

1 BACKGROUND

Staff at Eskom were shocked by the circrumstances leading to the death of an Eskom employee who was thought to be a diligent worker. The incident tested the understanding of the objective for earthing and resulted in a major review of earthing practices in the business.

2 EARTHING DEFINED

Earthing is the primary method employed by electricity utilities the world over to secure a safe environment for their staff working on apparatus of an electrical network. It is a fundamental precaution specified by the General Machine Regulation 5(2) incorporated by the OHSA.

2.1 DEFINITION OF EARTHING

Earthing is defined as "The connecting of apparatus electrically to the general mass of earth in such a way that it will ensure an immediate and safe discharge of electrical energy at all times". (NRS 042 -3)

2.2 DEFINITION OF EQUIPOTENTIAL ZONE

"A safe work area created to ensure that any two or more conducting parts that can be touched by a person simultaneously are bonded together by approved earthing leads to ensure a zone of equal potential between different parts of the working Area" (NRS040-3)

2.3 OBJECTIVE OF EARTHING: THE POPULAR PERSPECTIVE

The bridging of all the phase conductors and connecting them to an earth electrode at both sides of the workplace, provide an equipotential zone and secure the safety of staff.

2.4 OBJECTIVE OF EARTHING: THE RIGHT PERSPECTIVE

The objective of earthing is to devoid the work area on electrical networks of 'step' and 'touch' potentials. This process is much more complex than the popular interpretation leads on.

3 INCIDENT RECALL

A work team was instructed to replace bolted connectors with crimped sleeve joints on the jumpers of the overhead conductors of an 11 kV power line.

The 11 kV supply breaker was opened, the line isolated and earthed at the substation

A Principle Technical Official (A certified Professional Engineering Technician) did the following earthing after the line was proven dead, prior to the commencement of the work.

a) He inserted an earthing electrode into the ground, at the base of a wood pole.

b) He then connected two long earth leads to the earth electrode and the other side on a phase on either side of the work place/structure.

c) Specially provided bonds were used to short the phases at both sides of the work place so that all were connected to earth

While this was in progress, a mobile equipment operator introduced a cherry picker onto the work site, which is equipped with an equipotential footplate and earth. He earthed as follows.

a) Removed and placed the foot-plate on the ground. The latter is electrically connected to the vehicle chassis and an earthing electrode.

b) He installed a second earth electrode into the ground approximately 7 metres from the electrode installed by the Authorised person. Finally, he connected the vehicle earth to the earth electrode.

From the perspective of the Authorized person on site (also the deceased) this completed the earthing in preparation for the work.

The Principle Technical Official got into the cherry picker and started to replace the PG clamps with compression joints along with another person in the cherry picker. (See crimper in the picture)

4 THE 66 KV EARTH FAULT

At the time of the incident, an earth fault developed on a 66 kV line approximately 2 km from the work site. The fault developed as follows:

a) A Jumper clamp also failed on the 66 kV line, and a centre phase jumper separated.

b) It momentary touched the structure when it swung out to a rest position, clear from the structure.

Note: It is a lattice steel structure which is earthed at the base.

Supervisory (SCADA) indicated the time of the 66 kV line fault (trip and auto-reclose) to coincided with the time that the deceased was holding the clamp on the line to be crimped by the second person in the bucket.

5 FACTS OBTAINED FROM THE INCIDENT INVESTIGATION

a) Two earth electrodes were installed at the work site.

b) The earth resistance between the earth electrodes were 640 Ohm.

c) The one earth electrode was installed in virgin soil while the other was installed in disturbed soil.

d) Both electrodes were inserted to a depth less than 750mm, contrary to the prescription.

e) The two earth electrodes employed is in contradiction to the Eskom Earthing Standard which specifically calls for a common earth electrode.

f) The technician in control of the work-site and those persons that responded initially to the incident notification failed to identify the touch potential situation created by the two earth electrodes.

6 IMMEDIATE CAUSES TO THE ACCIDENT

Both the 11 kV and 66 kV line originate from the same substation and were effectively earthed to the substation earth mat. The earthed line connected through the substation earth mat presented an ideal earth return path to the source transformer from the 66 KV line fault.

The earth fault current divided between the parallel earth paths created as follows at the work site.

a) From the earth, through the earth electrode introduced at the pole base, the earthing leads through the line to the excellent substation earth, the overhead guard wire on the 66 kV line and back to the source transformer, which is solidly earthed on the 66 kV side, and the second earth path:

b) From the earth, through the cherry picker earth (7 meters away from the electrode at the pole base) through the vehicle mounted crane arm, the buttocks of the deceased, through his body onto the conductor and the rest of the return to the source transformer.

7 ROOT CAUSE OF THE INCIDENT

The root cause of the fatality was the introduction of a touch / step potential as a result of the second earth electrode being introduced at the place of work.

8 LEARNING POINT

The learning point does not constitute new knowledge; it is a painful reminder of a well documented phenomena.

Lack of understanding of the earthing requirement and the resultant introduction of the two separate earth electrodes at the work site was the cause of the incident. Hence this paper as a reminder of the risks, even though the exposure window is small, that this type of coincidental exposure is possible.

It is critical that you convey the message urgently to your staff that ONLY ONE Earth electrode must be used for earthing at every work site and that the introduction of a Second Earth electrode (earthing point) could be fatal.