Work on Overhead Lines Conductors – Notice to Industry

A fatal accident occurred at Arahura (West Coast, South Island) on the 66kV line between Otira and Hokitika on 10 January 2005. The Coroner has quoted the report presented to him by Bill Lowe (Energy Safety Service) for the two main factors to which the accident was attributed, these being:

(i) Failure to identify the risk of the conductor clashing when altering the tension of the line when transferring onto the new pole.

(ii) Failure to have effective earthing or equipotential bonding at the work site.

This Notice outlines the Electricity Engineers' Association (EEA) and the Safety Strategy and Policy Group (SSPG) response to the accident factors as it understands them from information available to it.

As well as highlighting requirements which were understood to be significant in this accident, this Notice also provides an overall reminder and refresher on the management of hazards and temporary earthing, particularly for work on overhead conductors.

The safety rules published by the EEA (Safety Manual – Electricity Industry (SM-EI)) establish general principles and minimum requirements for safety. SM-EI relies on training and supporting procedural documents to convey information to help in the application of the rules to specific circumstances. The guidance on earthing is being reviewed in the light of some new information, as described in this Notice. However, the present requirements of SM-EI are applicable as described in this Notice, with the key additional requirement being the bonding of a pole step (where fitted) to the equipotential zone.

The SSPG is actively evaluating the circumstances of the fatality and its implications for safety requirements, practices and procedures. This work is on-going, but the SSPG advises that the industry notes the following guidance, and acts on it immediately.

Background Information

The work planned on the twin circuit line at the accident site was not identified as potentially hazardous, and consequentially the safety precautions were not adequate.

In the span adjacent to the one being worked on, one of the isolated conductors ran parallel to and below an in-service conductor of the second circuit such that when tension was applied to the isolated conductor it's sag was reduced and the conductor lifted into contact with the in-service conductor.

A set of temporary earths was applied to the isolated conductors on each side of the worksite, and each set was connected to a separate driven earth spike. The pole on which the lineman was working also had a permanently fitted aerial lightning conductor with an earth lead running down the pole. The temporary earthing proved to be inadequate to prevent serious harm once contact with the in-service conductor was made.

(a) Temporary Earthing

(i) Publications

The EEA publications of relevance to temporary earthing at worksites are:

- Safety Manual – Electricity Industry (SM-EI) – July 2004. Section 6 of Part 3 covers 'Isolation and earthing for work on HV electrical equipment.'

- EEA Technical Guide '*Guide to Temporary Earthing of Distribution Overhead Lines'* (Jan 2005).

These publications need to be understood and complied with. Any comments or requests for clarification should be sent to the EEA at admin@eea.co.nz.

(ii) Equipotential Zones

The SSPG expects the industry to develop procedures and to provide the necessary equipment to enable equipotential zones to be established across working positions where risk of voltage rise exists.

SM-EI, and its predecessor editions, requires conductors being worked on to be earthed at the worksite, and that any earthed metal on a line support structure being worked on or from is bonded to the conductors being worked on. This effectively requires the establishment of an equipotential zone between the conductors, and the earthed metal.

SM-EI (July 2004) introduced the term 'equipotential zone' to describe this, as it is the commonly understood description of this requirement.

(b) Pole Earthing

SM-EI now also recommends in rule 3.603 f. ii. that wooden poles (and concrete poles without integral earthing) be earthed, and the reason for this is that they are not always good insulators.

SM-EI recommends that pole earthing be achieved by using a cluster mount clamped around the pole or structure at a level below the feet of the person(s) working on the conductors, and connected with the conductor temporary earths to a common earth. All earths must be bonded together, ie. the pole is also included in the equipotential zone.

An analysis of the Arahura accident, and research since then based on circumstances specific to Arahura, has identified that pole steps can provide a conductive path through the core of the pole, and the core must therefore be bonded into the equipotential zone by bonding at least one pole step (the lowest one) to the temporary earthing system. (At this stage, poles without pole steps are being evaluated and advice on them will be provided at a later date).

The requirement for earthing wooden poles (and concrete poles without integral earthing) and including them in the equipotential zone was introduced into SM-EI as a recommendation to enable employers to purchase or manufacture the equipment necessary for the pole earthing. It has always been the intent that this requirement will become mandatory in the next issue of the rules (as it has always been for steel towers).

It is now over 12 months since SM-EI was introduced and employers should by now have the necessary procedures and equipment for pole earthing, or have a programme for implementing procedures and obtaining the necessary equipment.

(c) Earthed Metal

Rule 3.603 f. i. requires that any earthed metal on a structure must be bonded to the conductors being worked on.

The EEA Technical Guide '*Guide to Temporary Earthing of Distribution Overhead Lines'* identifies a number of examples of earthed metal/conductive items on a wooden pole (or unearthed concrete pole), including:

- Street lamps and street lighting fixtures.
- Co-axial cable catenary wires.
- Telecommunication catenary support wires.
- Pilot wires.
- Wooden ladders (when used for access to or work on the pole).

In addition the following examples of earthed metal/conductive items are to be included in the bonding arrangement:

- Aerial earthing conductors.
- Stay wires (if there is no insulator or the earthed section is reachable from the working position).
- Lightning conductors (down the pole).
- Any separately earthed conductors running down the pole for any purpose, eg. equipment, MEN, etc.
- Crossarm (metal).
- Spacer bars.
- Bonding leads.

Note that if the work is being carried out on two poles, eg. a replacement pole and an old pole, and a person can be electrically or physically in contact with both poles simultaneously, eg. during conductor transfer, then both poles and all their earthed metal must be connected into the same equipotential zone.

(d) Mobile Plant

The '*Guide to Temporary Earthing of Distribution Overhead Lines'* advises that any non-insulated elevating work platform used for work on the pole or conductor must have the frame of the vehicle bonded to the portable earths (but not the bucket or platform). (The operator is also required to stand on the mobile plant, or on an insulated mat, or on a plate or screen bonded to the mobile plant).

The mobile plant must therefore be a part of the equipotential zone within which it is operating, and must not move from one equipotential zone to another without being transferred into that equipotential zone.

(e) Breaking Conductors

Where conductors are to be broken or are broken, a set of portable earths should be fitted each side of the break (as close as practicable to the worksite) and the tails bonded together. (Other requirements for equipotential zones apply).

(f) Entering and Leaving an Equipotential Zone

Equipotential zones protect workers within the zone against hazard should an inadvertent relivening of supply or introduction of voltage occur while work is in progress. In the unlikely event that a single phase relivening inadvertently occurs, the equipotential zone can be at an elevated potential with respect to the ground or to earthed metal outside the zone boundary during the time single phase fault current flows. Workers leaving or entering, or passing tools or equipment into or out of the equipotential zone, during a single phase relivening event, may be exposed to hazard.

Therefore, an entry point should be established, eg. by the use of an insulated mat or insulated ladder, to enable persons, tools, equipment, etc to enter or leave the equipotential zone where work is carried out on overhead conductors:

(i) located above or below live conductors and carried on common support structures for the adjacent spans on either or both sides of the work position; and

(ii) which cross over or under live conductors located within two spans of the conductor span being worked on.

(g) Identifying Hazards from Adjacent Live Circuits

While the adjacent circuit at Arahura was known to be live, the hazard associated with the circuit configuration on some sectors of the line whereby a live conductor was immediately above or below an isolated conductor had not been identified at any stage of the job planning or when carrying out the job.

The configuration of lines must be assessed in all circumstances where a live circuit is carried on the same structures as those being worked on. Such assessment needs to consider the possibility of contact occurring, and the configuration between strain structures particularly where the conductors are supported on hinged insulators. An assessment should be carried out prior to or at the planning stage to ensure that the work can be safely carried out. (SM-EI Rule 3.710 provides safety advice where contact could occur).

(h) Effect of Tension on Conductor Sag

When a conductor is under significant tension, relatively small horizontal displacements can cause a significant change to the conductor sag, and this must be taken into consideration when work such as transferring conductors from an old to a new pole is taking place. Care must be taken to ensure there are no hazards from changes to the conductor sag in any span between the strain structures.

(i) Training

The Arahura accident has highlighted that field staff are not sufficiently familiar with the principles of earthing and creating equipotential zones, and that relevant training must be provided. There have been a number of relevant seminars, but more are required to achieve the desired results.

It is recognised that a number of employers and asset owners are facilitating training for their staff and contractors, and this is strongly encouraged. Training providers are also reviewing their course material for earthing.

The EEA will also be facilitating a workshop on temporary earthing in November 2005.

(j) Further Research

On the topic of temporary earthing and the creation of equipotential zones, there is further research work to be done in order to better understand the practicable means of creating equipotential zones, particularly where wooden (and unearthed concrete) poles are involved. The EEA has established a workstream through the SSPG to ensure that it obtains relevant information on the research topics, and that the information is documented for industry use.

Key topics of this workstream are:

- The conductivity characteristics of poles used in NZ.
- The effect of pole steps on pole conductivity for the typical range of poles to which they are fitted in NZ.
- The recommended practices for creating equipotential zones for typical working positions on poles, particularly those without pole steps.
- Development of recommendations for entering and leaving equipotential zones.
- Further research on international practices.
- Development of training material.
- Documentation of guidance through key publications, eg. SM-EI and the Technical Guide for Earthing.

Safety Strategy & Policy Group
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