**WG B2.56 – Ground Potential Rise at Overhead AC Transmission Line Structures During Power Frequency Faults**

As we know, transmission lines are often located close to areas of public access. Public and worker safety is always top priority in the operation of transmission overhead lines and effective grounding of each line structure is necessary to provide safety, proper protection operation and acceptable lightning performance. Working Group B2.56 has examined the issues related to ground potential rise (GPR) on overhead transmission lines during power frequency faults and has recently produced Technical Brochure 694 to:

* Raise awareness of potential safety risks associated with Ground (Earth) Potential Rise (GPR) for overhead lines;
* Promote a safe operating environment near line structures during power frequency faults and;
* Aid understanding of the strategic design approach associated with line grounding problems and available solutions for power frequency line faults.

Issues related to lightning performance are beyond the scope of this work. The TB is not intended to be a design standard. It is the accountability of the transmission line owner to ensure adequate provisions are made for public safety near any transmission line infrastructure. The Australian members on the working group were Charles Crew and Tim De Grauw and Australian Panel Convenor is John mcCormack.

Grounding of overhead lines is primarily for electrical safety and lightning performance. It is a means to avoid build-up of high ground potential rise (GPR) around the line structure base during line faults. Effective grounding for overhead transmission lines can be a challenge. This is particularly so with respect to designing for safety due to the multitude of assumptions on which to base the safety risk analysis.

**GPR risk evaluation**

When assessing GPR related to power frequency faults, the following key input factors should be considered:

1. **System Effects**
* Causes of line faults
* System response to a fault event (magnitude & distribution of fault currents)
* Influencing factors such as fault clearing time, dc offset, coupling effects
1. **Soil Effects**
* Soil is the most influential parameter on line grounding design
* Soil is a complex system consisting of solid, liquid and voids
* Conductivity of soil is strongly determined by variations in mineral composite, temperature and moisture content which creates an electrolyte
* Soil resistivity is a measure, which is highly dependent on local conditions and seasonal variation in the soil.

1. **Transfer Potential**

GPR risk evaluation needs to undertake a “Conductive coordination study”. That is to identify the possibility of transfer of fault voltage rise to or via adjacent infrastructure such as:

* Communication System Installations
* Underground Facilities eg metallic pipes, cables, corrosion protections, Equipment (storage tanks)
* Overhead Low Voltage Distribution Systems
* Equipment Neutral Grounding Systems
* Buildings, fences & other installation in the Vicinity of Line Structure.
1. **Human physiological responses to electrical shock**

* Perception current, let-go current;
* Currents for muscle contractions, as well as muscular contraction causing fractures of bones/vertebrae, muscular and tendon tears;
* Disturbances of the heart including fibrillation and transient cardiac arrest.

**Safety Risk Analysis**

Deterministicanalytical models are generally well established. However, probabilistic methods are becoming more useful to demonstrate that appropriate measures have been adopted to mitigate safety risk. Issues related to probabilistic methods are:

* Dependence on statistics on the causes of faults.
* Expectation of extremely low probability of coincident occurrence of human presence at or near a line structure during a fault.
* Lack of evidence of fatalities (they are practically unknown or unreported).
* Acceptance of safety limits using ‘As Low As Reasonably Practical’ principles (Studies of electrical hazard risks associated with GPR have resulted in a “risk-value” in the order of 10-6}.
* Regulation defining acceptable safety limits is a continuing challenge.

**Safety Standards & Practices**

Grounding/Earthing standards & practices are provided in IEEE, IEC & AS/NZS.

Studies have focussed on general public and not skilled utility workers familiar with the operation of electrical infrastructure.

Inputs from many jurisdictions and utilities have been limited (inclusive of USA, Western/Eastern Europe, Asia, Australia, etc.).