High and Low Voltage Earthing Design Services

Liberty Consulting Services (LCS) uses the industry leading software package CDEGS (Current Distribution, Electromagnetic Fields, Grounding and Soil Structure Analysis) by SES Technologies, to model soil resistivity field test results and perform earth grid design calculations for high voltage substations, switchyards and power generating plants to effectively handle fault currents while limiting step and touch potentials to safe levels.

Why focus so much attention on earthing design?

Recent trends in electrical earthing design have shown that “low” earth grid resistance is NOT a guarantee of safety. This is reflected in the withdrawal of the “less than one Ohm” requirement from various Australian Standards.

Fault level increases, reduced substation sizes, higher building density, voltage rises, and therefore more interaction between power systems and consumer facilities, means that there is now more than ever an increased reliance on earthing designs to eliminate touch and transfer voltage hazards in the event of an earth fault condition.

The increasing ownership of HV assets by private customers, the widespread use of conductive structures in earthing systems, and the legacy of older, non-compliant earthing being added to, all mean that it is crucial that an experienced, qualified earthing designer is engaged for your project.

Relevant Earthing Related Standards & Codes

- AS/NZS 3000 Electrical installations (Australian & New Zealand Wiring Rules: Section 5)
- ENA EG-1 Substation Earthing Guide
- AS/NZS 2067 Substations and high voltage installations exceeding 1 kV a.c. (Section 8)
- AS/NZS 60479.1 Effects of current on human beings and livestock, Part 1: General aspects
- AS/NZS 7000 Overhead line design – Detailed procedures (Section 10 & Appendices E & U)
- AS/NZS 3007 Electrical equipment in mines and quarries – Surface installations and associated processing plant (Appendix F)
- AS/NZS 4853 Electrical hazards on metallic pipelines
- ENA C(b)1 Guidelines for design and maintenance of overhead distribution and transmission lines
- AS/NZS 1768 Lightning protection
HV earth grid system design approach

The earth grid design approach adopted by LCS follows the well-known step by step process detailed in ENA EG-1, in conjunction with the risk management process described in ENA EG-0.

The crucial first step in any design process is to collect relevant site data, including the earth grid system geometry, earth fault current levels of all possible fault scenarios, the maximum duration of these fault conditions, and most importantly soil resistivity measurements covering the proposed earth system area, in enough detail and with adequately powered test equipment, to satisfy design requirements.

The impact of multilayer soil profiles on earth design results shows that conservative (expensive) or non-conservative (unsafe) designs result without adequate multi-layer soil inputs to the design process.

Tolerable step and touch voltage limits based on protection operating times need to be determined, in accordance with the latest Standards. An iterative grid design process is often required, using adequately sized earth electrodes and conductors.

Distribution of fault current between the buried grid system and return current paths is able to be determined using CDEGS software. This ensures earth grids are designed to optimise the amount of buried earthing conductors by considering:

- Combination of horizontal conductor and vertical electrodes depending on soil profile;
- Alternative fault current paths;
- Adjacent earth systems; and
- Structural rebar in concrete foundations.

Deterministic vs probabilistic design approach

The traditional “deterministic” approach determines when hazardous step & touch (transfer) voltages exist, when compared to acceptable limits of body currents in accordance with ENA EG-1 and AS2067.

The “probabilistic” approach calculates the probabilities of exposure to a hazard (e.g. unsafe touch potential) occurring, and the likelihood of that hazard event occurring when an individual or group of individuals (societal risk) is present. ENA EG-0 and the latest AS2067 outlines a combination of these two approaches so that safe earthing systems are designed, with regard to both safety and cost.

Final testing of completed HV earth grid system

Once the earth grid has been installed, its impedance, as well as step and touch (transfer) voltage levels need to be confirmed, using acceptable test methods. The use of low current, off frequency current injection test equipment with tuned voltmeters, is the minimum acceptable standard for performing fall of potential earth potential rise (EPR) testing.

EPR mitigation methods - If EPR and touch voltages exceed safe limits, mitigation methods are able to be employed.