

Earthing System Management Plan

by Safearth Consulting

Overview of ESMP

Owners of HV assets hold a responsibility for their safe and effective operation from the first day of service through to end of life. While test and maintenance requirements for HV equipment are typically well understood, earthing systems often remain a mysterious unknown. Many high voltage asset owners will engage a consultant or technician to 'test' their earthing system - but what should an earthing 'test' look like? There are actually a range of investigations that can be performed and depending on what the objective is, a particular test could be perfectly appropriate or alternatively, completely uninformative or perhaps even misleading. Consequently, there is a real risk that poor test information can misguide decision making on safety compliance and earthing maintenance activities.

For HV asset owners to make good decisions, it is imperative that they have: (i) a **plan** for routine tests and inspections of the earthing systems, and (ii) an **understanding** of the purpose of each test, and of how it contributes to the effective management of the risks associated with the asset.

The first need is met in the provision of a Safearth Earthing System Management Plan (ESMP), which forms an asset management document that outlines the objectives and requirements for earthing system testing and maintenance. The second need is met in the provision of theoretical and site-specific practical training in earthing risk and management.

Stage 1: Development of ESMP

After an initial conversation to discuss objectives, the first step is a desk audit to gather site-specific information. This is followed by a site visit, typically between 1 and 3 days, to identify and review relevant earthing systems, and to meet with site electrical staff to discuss past testing, understand existing issues, previous incidents etc.

During the site visit, data will be gathered to develop the ESMP documentation, which will:

- outline the earthing system objectives for each type of asset;
- outline the requirements for safety and functional operation of the respective earthing systems according to Australian Standards, Mines Regulations and industry best practice;
- identify the critical earthing system elements at each asset;
- provide a description and recommended schedule for inspection and testing at each asset, including initial baseline tests and routine tests;



The scope of the ESMP is dependent on the site requirements, but could cover substations, powerlines, cables, as well as lightning protection for buildings and structures.

In most cases, the ESMP will require initial baseline testing, which typically includes visual inspection and continuity testing across the site, and injection testing (including EPR and voltage hazards measurement) at main substations. This testing usually forms part of Stage 2 below.

Stage 2: Baseline Testing

All earthing testing generally fits into one of two categories: performance testing or condition testing. Performance testing is generally more complex, and involves testing the operation of the earthing system, usually by simulating a fault through an injection test, and taking measurements of associated hazards including touch voltage and step voltage. Condition testing verifies that the various elements of the earthing are intact and in good condition.

Of course, condition of the earthing system will directly affect performance, and so if the right condition testing is carried out and indicates nothing has changed, then it is reasonable to conclude that the performance remains unchanged, and performance testing may not be required. The assumption of course is that the original performance is satisfactory.



Baseline testing includes both performance and condition tests, with two objectives: (1) it ensures the initial performance of the earthing system is satisfactory, and (2) it provides an initial set of condition test data, to which future condition tests will be compared in order to determine change. In some cases, a site may already have recent and satisfactory performance test results, in which case only the baseline condition tests may be required.

Baseline testing could take several days, depending on the size of the site. The value is achieved in the fact that the need for future ongoing performance testing is dramatically reduced, and the likelihood of identifying change or deterioration in the earthing system condition is dramatically increased. This means faster identification of hazards and a lower lifetime maintenance cost.

Typical baseline testing includes:

- Visual inspection, to assess initial condition
- DC continuity testing, to ensure adequate bonding/separation
- Loop impedance testing, to measure indicative values for future comparison
- Current injection testing, to measure EPR, earth grid resistance, earthing system impedance, fault current paths, voltage hazards under simulated fault conditions.

Some assets may not require every test, but this would be identified in the ESMP.

Following the site visit, a detailed written report would be prepared including our findings at each location tested and comparison to safety requirements, and any further recommendations for improvement.

In some cases, where major remedial changes are required, some baseline testing may need to be repeated after remediation.

After the baseline testing is complete, some final changes will be made to the ESMP test plan. The baseline results will be included and form a critical part of the ESMP, as all future test results will be compared to them.

Stage 2A: Training

It is important that asset owners have a sound understanding of earthing theory and practice, so they can appreciate how their systems work and how they need to be maintained, for which Safearth can provide training. Where sites are keen to do some of their own testing, Safearth can provide training for site personnel. The training is typically carried out in conjunction with the baseline testing, adding 1 or 2 days to the site visit.



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