CASE STUDY
EARTHING SYSTEM CONDITION ASSESSMENT

ERM
PART OF THE LSTC GROUP

PROJECT BRIEF

This site is a 400kV substation with two L2 double-circuit overhead lines and four 400/132kV transformers that feed an adjacent 132kV substation. The existing perimeter fence and security system were to be upgraded as part of the security upgrade works. ERM was engaged to provide an earthing design for the new fence and security systems and ensure the site earthing system was in good condition prior to work commencement.

CHALLENGES

Earthing condition assessments on live high voltage sites can be challenging. The factors below were important in successfully completing the project:

- Detailed analysis of dated earthing drawings to determine the existing earthing system layout and specification and a programme of tests to give a full condition assessment.
- Carrying out several weeks of testing in a live substation environment.
- Impressed voltage management.
- Combining on-site tests with CDEGS calculations to verify the test and measurement results, provide calculated potential hazard analysis and the new fence earthing design.
- Obtaining accurate records of buried services (pipelines and cables) and overhead transmission lines and finding off-site test routes that would avoid them.
- Managing contractor and public access to test areas to maintain high levels of safety.
- Computer analysis of overall impedance measurement results to remove test lead coupling from raw results.
- Condensing a large amount of test data and computer simulation results into a concise report.

OUR APPROACH

ERM's expertise and experience of earthing condition surveys at large sites was instrumental in providing a detailed report on the condition of the earthing system and an earthing design for the new fence line. ERM was able to liaise effectively with the client, providing detailed methods statements and risk assessments and managing high levels of on-site safety. The survey required minimal client planning input. Where possible ERM will carry out further investigations to pinpoint the cause of any problems or issues found, to enable a swift and cost effective solution.

PROJECT OUTCOME / DELIVERABLES

- A detailed fence and associated security equipment earthing design was provided.
- A report was provided detailing earthing defects found with remedial action required. Risks were prioritised to draw attention to those requiring immediate attention.
- Safety maintained throughout the test. No environmental footprint left.
- Accurate earth impedance measurement result achieved, which confirmed the CDEGS model and validated the EPR calculations, earthing design and safety recommendations.
- Client requirements met with delivery of the report in a timely manner.
- Positive feedback received from client.

Email: info@erm.ltd

Telephone: +44 (0) 2920 850 444

Web: www.erm.ltd

Head Office

Britannia House

Caerphilly Business Park

Caerphilly

CF83 3GG

02920 850 444

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The below table summarises the assessment carried out to confirm earthing system integrity. On completion of the survey, a report and CAD drawing were provided. Detailing the investigation and remedial action / repairs for the earthing system and the fence earthing system.

Activity	Description of Test
Below-ground continuity	Continuity tests were carried out between the main earthing system (MES) and each item of plant or equipment
Above ground-continuity	Joint resistance tests were carried out to confirm the integrity of bi-metallic (copper to aluminium) and plant to MES earth bond joints. Conductor size, condition and configuration were also checked.
Main earthing system electrode testing	Rod group earth resistance measurements were undertaken to evaluate the integrity of the rod groups. Tests results were compared against calculated values.
High-frequency earth resistance testing and visual inspections	Earth resistance measurements are carried out, the results are compared against calculated values. Visual inspections are also undertaken to confirm the construction is in line with specification
Fence earthing system	Fence earth bond continuity and earth resistance measurements were carried out. Measurement results are compared to calculated values to verify below-ground integrity. Quantified risk assessment was used to assess transfer potential hazards between separately-earthed fence sections and MES-earthed plant or structures
Terminal tower testing	Continuity tests, visual inspections and tests to verify the below-ground bond integrity to the MES were undertaken.
LVAC supplies	A visual inspection of incoming LV supply cable was carried out to determine the need for cable gland isolation
Soil pH testing	Soil samples are taken at several locations, to determine if the soil pH is at a level that is hostile to copper
Soil resistivity measurements	Field tests conducted to determine the electrical properties of the soil
Earth Impedance Measurements	Earth impedance test taken to verify the as-installed earthing system impedance and verify against design calculations
Lightning protection survey and testing	Assessment of key buildings against BS EN 62305

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