

Schedule B for Scope of work.

Sub:- Work of Health Analysis of grounding system & soil resistivity measurement at various substations under EHV O&M Division-I, Pune.

Scope of Earthing Audit Works to be carried out has been detailed as:

1.1 Soil Resistivity test 2/4 Direction:

Scope of Works: Reading shall be taken up to 25 meters spacing between the spikes subject to physical site condition & space availability, in as required directions from location center.

Methodology to be followed: Wenner four-point method

Meters to be used: Variable voltage and variable frequency meters (Megger DET4TC2/Kyoritsu) or its equivalent.

Deliverables: Audit Report should consist of

- i) Soil resistivity table.
- ii) Trend graph for average soil resistivity versus probe spacing.
- iii) Interference on nature & type of soil
- iv) Executive summary

1.2 Earth Electrode Resistance Test:

Scope of Works: Individual earth electrode resistance measurement should be done after ensuring suitable earth bypass arrangement, by using Stake-less method where it is not possible to disconnect the electrode from the earth grid. Fall of Potential method can also be used where it is possible to disconnect the electrode from the earth grid.

Methodology to be followed: Fall of potential or Stake-less method. Measured resistance value has to be compared with calculated value to assess the condition and health of individual earth electrode

Standards to be followed: IEEE 81 / IS 3043

Meters to be used: Variable voltage and variable frequency meters (Megger DET4TC2/Kyoritsu) along with I and V clamps or its equivalents.

Deliverables: Audit Report should consist of

- i) Earth electrode resistance table.
- ii) Comparison of measured resistance with calculated resistance.
- iii) Earth grid resistance.
- iv) Observation on health and condition earth electrode.
- v) Recommendation.
- vi) Executive summary.

1.3 Riser Integrity Test:

Scope of Works: Integrity of riser earth connection between electrical equipment and earth grid/earth electrode has to be determined in report.

Methodology to be followed: Low magnitude current injection at off grid frequency using current division method.

Standards to be followed: IEEE 81

Meters to be used: Current injection kit with variable frequency option and Fluke flexible clamp meter 376 / Equivalent.

Deliverables: Audit Report should consist of

- i) Measured current division between conductor towards electrical equipment and conductor towards earth grid/electrode.
- ii) Pin point open/defective risers.
- iii) Observation on health and condition of riser.
- iv) Recommendation.
- v) Executive Summary.

1.4 Grid Integrity Test:

Scope of Works: Integrity of earth grid conductor in substations and plant area has to be determined.

Methodology to be followed: Grid conductor impedance should be measured between two selected points within the earth grid. Measured impedance values are to be compared with calculated impedance. This Test has to be repeated to cover the entire earth grid area subject to feasibility and actual site conditions.

Standards to be followed: IEEE 81

Meters to be used: Earth grid impedance measurement kit - DLRO / Equivalent.

Deliverables: Audit Report should consist of

- i) Table of measured earth grid impedance between two selected points in earth grid conductor and calculated earth grid impedance.
- ii) Measured current division between conductor towards electrical equipment and conductor towards earth grid / electrode.
- iii) Pin point open / defective section of the earth grid.
- iv) Observation on health and condition of the earth grid.
- v) Recommendation.
- vi) Executive summary

1.5 Touch & Step potential Test:

Scope of Works: Measure Touch and Step Potentials at 10 locations within the substation area by extrapolation technique.

Methodology to be followed: Low magnitude off grid frequency current at low voltage has to be injected from a remote location. Touch and step potentials should be measured at 10 locations using a tuned voltmeter. Measured potentials has to be linearly extrapolated for the actual fault current at the substation. This value has to be compared with threshold potentials obtained in software simulation for safety.

Standards to be followed: IEEE 81

Meters to be used: Off grid frequency current injection kit and tuned voltmeter - Mitton / equivalent.

Deliverables: Audit Report should consist of

- i) Table of measured touch and step potentials in milli Volts.
- ii) Table of extrapolated touch and step potentials for the actual fault current.
- iii) Comparison of extrapolated touch and step potentials with threshold potentials obtained in software simulation.
- iv) Observation.
- v) Recommendation.
- vi) Executive summary.

1.6 Effect of Corrosion Test:

Scope of Works: Determining the metal loss due to corrosion in main mat and risers and earth pits based on which the adequacy of size of conductor installed for the prevailing fault current/the residual life of the earth system is determined. It is done at random location of the substations. earthing system corrosion assessment activity at severe locations selected based on IEEE and NACE guidelines and assessment shall be carried out under the guidance of NACE certified CP-Level III Engineer.

Standards to be followed: IEEE 81/ CBIP manual

339 Meters to be used: Standard Vernier Calipers.

Deliverables: Audit Report should consist of

- i) Measured dimension of earth strip/ grid conductor.
- ii) Comparison of measured dimension with original earth strip/ grid conductor dimension.
- iii) Observation on health & condition of earth strip/ grid conductor.
- iv) Recommendation
- v) Executive summary

1.7 Software simulation & design Adequacy:

Scope of Works: Computer software modeling and simulation of earth grid for safety using CDEGS Software/or its equivalent IEEE software's.

Methodology to be followed: Uniform/Two/Multilayer soil modeling should be chosen based on least RMS error. Earth electrodes and earth grid in the substation has to be model with present condition. Injection of fault current in the modeled grid has to be done to determined safe touch and step potentials for safety of the earth grid.

Standards to be followed: IEEE 80/ IEEE

81 Meters to be used: CDEGS

/Equivalent/suitable.

Deliverables: Software Simulation Report should consist of

- i) Input data provided by customer
- ii) Soil modeling software screen shot.
- iii) Touch & step potential software screen shot with threshold & actual attained values.
- iv) Adequacy of existing Earthing Grid for present Fault Current Level & also for future expansions.
- v) Stitching treatment with implementable solution comprising Earthing designs & BOQ if the sub-station is unsafe.

1.8 Submission of Evaluation Report:

The Executing agency shall after carrying out the detailed study of the existing earthing systems shall submit the comprehensive report with the help of requisite software's regarding adequacy of the existing earthing system & called up to which it is adequate/safe.

Also, submit the prepared modification/additions to the existing earthing system **to meet the fault level of 50 kA** along with requisite estimate & bills of materials supported by all self-explanatory drawings for each substation separately.

The agency shall also submit their suggestions/recommendation for improvement or strengthening of the earthing systems.

1.9 Other Details:

- a) Bidder should provide valid license copy for the CDEGS software or equivalent to be used for earthing adequacy along with the bid. Bidder should possess sufficient experience and expertise in using the software.

- b) Field audit should start with a kick off meeting at the site office with concerned MSETCL engineers.
- c) Audit methodology and schedule should be discussed and finalized with concerned MSETCL engineers.
- d) Audit team should conduct various tests and measurements as defined in scope of work.
- e) Audit team should wear appropriate PPE to ensure utmost safety while working in the field.
- f) Vendor/Service Provider should use meters and test equipment of reputed make such as Megger / Fluke with Current injection capability at variable voltage and variable frequency as recommended in IEEE 81-2012.
- g) Copies of valid calibration reports for all the meters and test equipment should be carried to the Site by the audit team and the same should be shown to concerned MSETCL engineers.
- h) All data and drawings required for the successful completion of the audit should be collected by the audit team from concerned MSETCL engineers.
- i) Preliminary/Draft report should be submitted within 15 days of completion of field audit.
- j) Audit Report should consist of:
 - i. Executive Summary
 - ii. Test & measurement results, collected data and drawings in appropriate chapters.
 - iii. Health Condition and status of existing earthing and systems.
 - iv. Observations of all anomalies and defects at site.
 - v. Implementable Mitigation measures and recommendation for all the anomalies and defects in the existing system.
 - vi. Conclusion.
- k) Vendor/Service Provider should arrange a report discussion cum presentation meeting within 10 days of submission of draft report to clarify all the queries of MSETCL through virtual meeting platforms.
- l) Final report in one soft copy and two hard copies should be submitted by the vendor within 15 days of report discussion.
- m) Audit and report engineer should be certified by third party agencies like National Safety Council.
- n) The all above activities are part of the stipulated time period of the contract.
- o) The bidder shall visit the site of work to see himself the conditions of workplace, labour rates and all other materials required to carry out the work in order to complete in all scope.

Sd/-
Superintending Engineer
EHV (O&M) Circle, Pune.