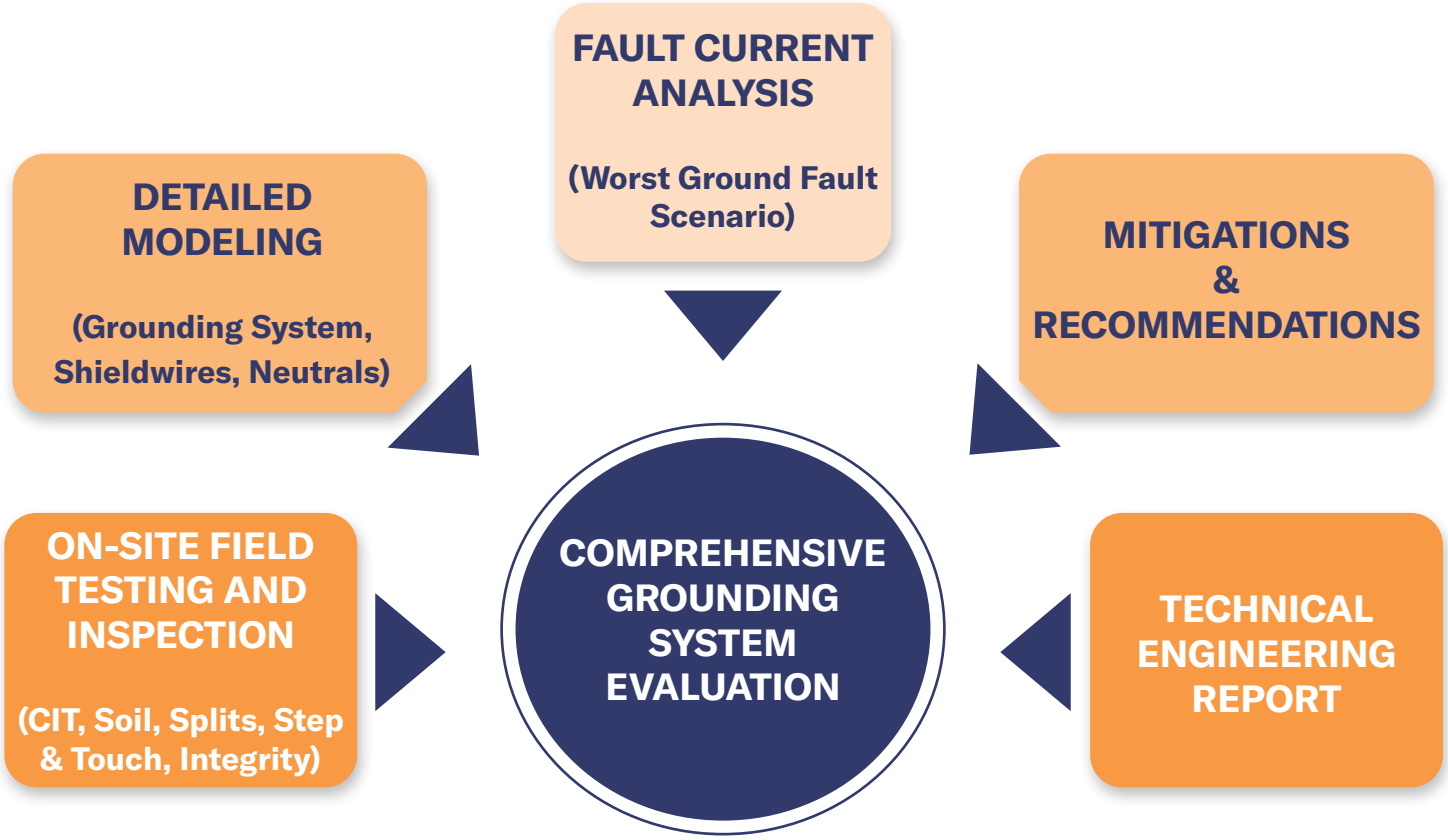
KINECTRICS

Grounding Services

Comprehensive Grounding System Evaluation

Overview

Kinectrics' grounding services focus on performing a comprehensive safety performance evaluation of the grounding system. These evaluations include on site measurements to assess the performance of exiting installed grounding systems during scaled fault conditions and checking the integrity of ground conductors. This is followed by creating a detailed ground grid model to validate the on-site measurements and conclude a validated ground grid model for studying any future ground grid upgrades.



Kinectrics has carried out grounding condition evaluations at more than 300 substations and electrical installations in the past 25 years. These evaluations take advantage of measuring instrumentation that support near 60-Hz impedance testing, obtained using a signal generator, an amplifier, and frequency selective measurements. Kinectrics performs integrity testing (DC continuity tests) to evaluate the integrity of all above grade bonds as well as buried ground conductors. The grounding system model for validation of field testing results is created by the most advanced commercially available grounding software which enables accounting for multi layer soil structures, proximity to other grounding electrodes, and capacitive, inductive, and galvanic coupling effects.

Kinectrics has contributed to a number of utility grounding standards. Kinectrics grounding subject matter experts are also actively involved in many IEEE working groups such Std 80 "IEEE Guide for Safety in AC Substation Grounding" and Std 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System".

Kinectrics Core Ground Grid Services:

1. Soil Resistivity Testing:

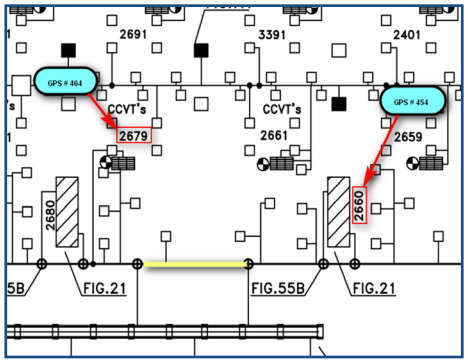
- Equipped with powerful instruments, suitable for areas with high resistivity soil
- Capable of performing long soil surveys (up to 1,000 ft spacing)
- Soil model interpretation by certified and experienced users

2. Integrity Testing:

- Ensuring the integrity of all underground ground conductors
- Checking the integrity of the station fence
- Identifying equipment with broken bonds to the grounding system
- Reporting missing/stolen ground conductors and underrated ground connectors

Integrity Testing proved the Pedestal was not bonded to the grid.

Integrity Testing proved the buried ground conductor (yellow line) between Breaker 2679 & Breaker 2660 was compromised.

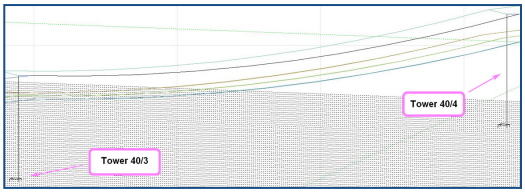


3. Ground Impedance Measurements (Current Injection Testing):

- Performing off-frequency Current Injection Tests (CIT) to simulate fault conditions
- Measure interconnected grounding impedance
- Measure current split factor
- Measure step and touch potentials
- Measure station rock resistivity
- Capability to use a de-energized phase conductor for high power injection
- Estimate the ground potentials rise (GPR) and zone of influence (ZOI)
- Ability to perform the injection tests while the station is energized
- Technical reporting includes a detailed ground grid model in a multi layer soil structure, engineering analysis to validate the current injection test results while accounting for all overhead shield wires & cable neutrals

4. Special Studies:

- Induction studies for HV cable installations
- Transient
- Pipeline coordination
- Electric and magnetic field (EMF) coordination & measurements
- Stray voltage measurements



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