A technique for online monitoring of substation ground grid conditions
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Why to monitor?
It is well known setting up grounding grid is a very important measure to limit step/touch voltage in permissible range and ensure the safety of human and devices in a power station. In practice, the grounding grid performance may vary with time due to many reasons. Therefore, it is highly desirable to evaluate the performance of grounding grid effectively and expeditiously. We propose an online technique which enables monitoring of substation grounding conditions in a continuous way. Simulation results are also given for verification.

How to measure Vt and Vs?
According to IEEE standard, touch and step voltages can be measured using the approaches shown above. Two metallic plates can be used to represent the "foot" of human bodies. This is a very cost-efficient way of monitoring since there is no need to place a current probe very far away and also no need to locate a remote earth point compared to traditional methods. The sensors can wirelessly transfer measuring data simultaneously to a substation hub for comprehensive assessment.

Drawbacks of Traditional offline method
1. Traditional Non-online method is Fall-of-Potential method shown as the figure below. A certain level current is injected into the grounding grid and in the meanwhile, grounding potential rise is acquired using a potential probe between grid and remote earth.
2. Current probe has to be located very far away from the substation to ensure a large enough current loop. This defect increases the labor and expense obviously and makes these methods not very convenient.

Proposed Online Technique

1. The proposed technique can be divided to local/remote approaches according to different signal injection schemes. Then sensors deployed as a sensor network on substation surface will continuously collect touch/step voltages. The data will be sent to a specific software for safety assessment according to history or standard comparison.

Schemes

<table>
<thead>
<tr>
<th>Scheme</th>
<th>The Remote Source Scheme</th>
<th>The Local Source Scheme</th>
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<tbody>
<tr>
<td>Pro</td>
<td>1. All generated current injected into the under-test grounding grid. 2. The voltage level of step-down transformer can be reduced as it works in low voltage side of substations.</td>
<td>1. It is convenient to maintain the device as located in substation. 2. The device is little affected by the weather and climate change. 3. No extra cable is needed.</td>
</tr>
<tr>
<td>Con</td>
<td>1. An extra cable is needed for current loop. 2. It is located far away from the substation, which increase the cost of maintenance.</td>
<td>1. The voltage level of step-down transformer is high. 2. The cost for the power electronics or circuit breakers is high.</td>
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Impact of Vs/Vt classified under different climates.

Safety Assessment
Evaluation can be made through observing variations of Vs/Vt classified under different climates.

Conclusions
Grounding grid is needed to ensure the safety of human and devices in substations. The performance of the grid is determined by soil characteristics, structure of grounding grid and the fault current loop. The grid’s performance vary due to many factors, such as the change of soil conductivity, corrosion of grounding rods, and theft of grounding conductors. This project has studied an online grounding grid monitoring system.

1. The proposed online monitoring method intends to overcome the problems faced by the offline methods. 2. The proposed method further involves the use of touch/step voltages as the indicators of grid condition. 3. The proposed method uses comparative analysis to determine the condition of a grid.