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Evaluation of Several Grounding Approaches in the Distribution Network

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***Abstract:** Distribution line grounding systems are mostly installed to lower touch and step potentials and lightning-induced outages. Reliability may suffer when the grounding system malfunctions, and operations and maintenance funds may be diverted to investigate and rectify the issues at a higher cost to the utility. Grounding systems present several difficulties. The variety of building materials and soil types makes corrosion a highly complex problem. The two most common ground electrode configurations are vertically driven ground rods and horizontally positioned counterpoise. Frequently, topography, soil conditions, or rights-of-way access determine which is used. Furthermore, theft and rising construction costs, driven by utility requirements, have created a new challenge: the need for alternative grounding materials. This technical update identifies factors that could impact the service life of a grounding system and help utilities estimate the service life. Site visit will be used to measure the ground resistance and propose alternative grounding materials.*

***Keywords:** Ground System, Ground Material, Outages, Reliability, Lighting.*

Abbreviations:
TDR: Time-Domain Reflectometry

I. INTRODUCTION

Safe distribution management, operation, and maintenance are a significant priority for utilities. System refers to the distribution grounding area. The electric supply system's grounding provides a means to safely discharge electrical current (from transients or faults, particularly lightning transients) into the ground, ensuring that the potential does not exceed the equipment's capabilities and does not expose employees to hazardous voltages [1].

II. ISSUES AND CONCERNS [1]

However, there are three primary issues with the methods currently employed for grounding. Security in UG systems: (a) no research measures the advantages and level of security of the job site, (b) using these techniques on the current underground distribution circuits system presents difficulties because there is limited access to cable neutrals and conductors before the start-up of labour and prevents these techniques from being applied Correctly, and (c) current procedures do not have proof that the application of approaches in every instance, the methods are accurate based on measurement or other verification methods.

We offer extra remarks about the issues above.

Concern (a): Several current industry standards were created using research on streamlined models. There have been few thorough studies, and the industry requires more comprehensive research. These studies ought to consider the possibility that today's challenges may be more intricate than previously.

Concern (b): There is a genuine concern about the various protection techniques' practical applicability. Worry, as employees might encounter circumstances at work. Setting up the workspace requires access to conductors and cable neutrals as close to the work site as possible.

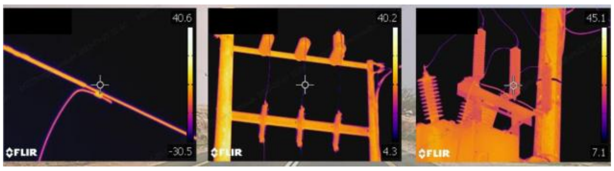
Concern (c): Methods for testing and preparing the work site should be established. It is necessary to create testing protocols to evaluate the prepared worksite's safety, and they ought to be definitive. There are restrictions on reaching this objective.

III. METHODOLOGY

Focused on recording the condition and design of the structures during visits to three feeders in southern Saudi Arabia's high lightning areas.

i. Overall condition (Generally – Structures in Good Condition) as shown in Fig. 1.
ii. Infrared inspection (No Heating Issues Found) as shown in the figure. 2.
iii. Ground resistance (Missing Ground Leads & High Ground Resistance Measurements) as shown in fig. 3&4.

[Fig.1: Structures in Good Condition]



[Fig.2: No Heating Issues Found]

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[Fig.3: Missing Ground Leads]

[Fig.4: High Ground Resistance Measurements]

IV. SUMMARY AND FINDINGS

Lightning damage appears attributable primarily to grounding Issues

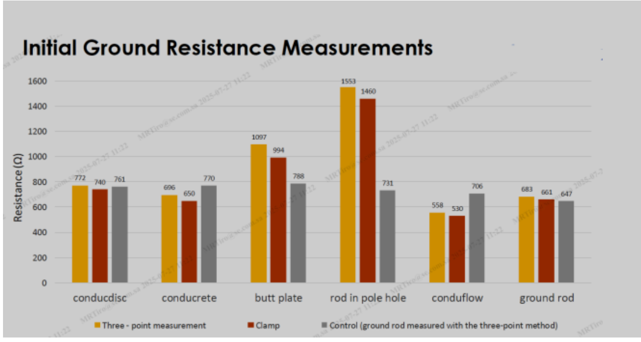
- Improving ground resistance can be done by testing ground resistance and enhancing ground materials, as shown in fig. 5.

[Fig.5: Test Ground Resistance-Enhancing Materials]

- Finding alternative approaches for protection by comparing with standard grounding methods, as shown in fig. 6.

[Fig.6: Compare with Standard Grounding Methods]

- Comparing Grounding Approaches as shown in fig.7.



[Fig.7: Comparing Grounding Approaches]

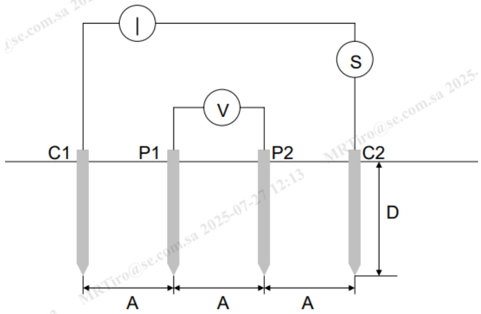
- Resistivity of Common Soils: - Soil resistivity varies considerably by soil type. Typical resistivity ranges are shown for several common soil types in Table 1 [2].

Table I: Typical Values of Low-Frequency Resistivity for Common Soils

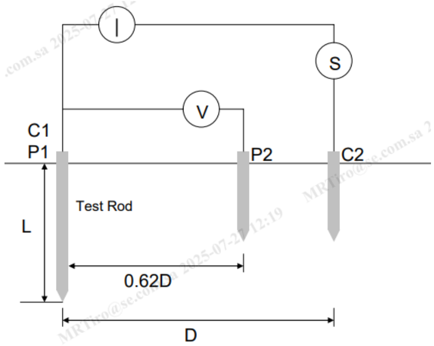
Type of Soil	Resistivity Range(-m)	Average Resistivity(-m)
Loams, Garden Soils, etc.	5-50	30
Clays	2-200	40
Sands and Gravel	60-100	80
Clay, Sand, Gravel Mixture	40-250	100
Slate, Shale, Sandstone, etc.	10-500	250
Crystalline Rocks	200-10,000	2,000

- Soil Resistivity Measurements [2]

iv. Direct galvanic measurements – measurements made via an electrode array such as the Wenner, Schlumberger, or Lee array, as shown in fig. 8&9.



[Fig.8: Wenner Four-Pin Method for Measuring Soil Resistivity]



[Fig.9: Three-Pin Method for Measuring Soil Resistivity]

v. Resistivity measurements of soil core samples – core samples are often taken for civil engineering and geotechnical work. Resistivity measurements can be made on the core samples, often with time-domain reflectometry (TDR) [3].

vi. Passive electromagnetic methods – these methods use analysis of the attenuation of electromagnetic signals to make high-frequency soil resistivity measurements. Radio wave attenuation and lightning system observations are two more common electromagnetic soil resistivity measurement techniques [4].

vii. Active induction methods – these methods use low-frequency sine wave frequencies to characterise soil resistivity.

V. CONCLUSION & RECOMMENDATIONS

There is a multi-way approach that can be applied to improve the ground system, and we can conclude that the best way to measure the grounding resistance is an essential factor. Additionally, there are various methods of grounding execution and ground material selection that best suit the nature of the soil, which is another critical factor. Furthermore, we still need to find the guidelines to match these factors with the territory specifications.

We can recommend the following two points: -

- There are a lot of advantages of using long ground rods to measure soil resistance, as it is:
  i. More likely to reach the water table.
  ii. Intercept multiple soil layers.
  iii. Reach moisture-stable layers.
- To improve the ground resistance, we need to test ground resistance using the right approach and enhance the ground materials as per the site's needs.

DECLARATION STATEMENT

I must verify the accuracy of the following information as the article's author.

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- **Funding Support:** This article has not been funded by any organizations or agencies. This independence ensures that the research is conducted with objectivity and without any external influence.
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- **Author's Contributions:** The authorship of this article is contributed solely by the author.

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