Title: Power System Grounding

Objectives: Students will get practical knowledge about the grounding system of substation, transmission tower and induced voltage nearby object of the transmission.

Prerequisite: Bachelor degree in Electrical Engineering

Contact hours: 3 hours per week

Lab/Simulation: 3 labs and simulation

Topics

Grounding system: Ground resistance and characteristics, purpose of ground resistance, ground current, ground electrode resistance, grounded, gradient control mat and wire, allowable body current and voltage, allowable potential difference, influence of resistivity of surface soil on body safety, grounding grid, ground potential rise, ground resistance, step and touch potentials, remote earth

Soil resistivity: Geological information and soil samples, electrical properly and permittivity of soil, factors affecting soil resistivity, frequency characteristics of soil resistivity, current density in the earth, current field at the interface of the layered soil, current field creation, field current in non-uniform soil,

Soil resistivity measurement: Soil structure, measurement methods, sampling analysis method, electrical sounding method, two-probe method, three-probe method, four-probe method, equal spacing or Wenner method, unequal spacing Schlumberger-palmer method, interpretation of the measurement**.**

Ground Fault Current: Types of ground fault current, zero sequence fault current, fault current division factor, determination of decrement factor.

Substation Grounding system: Function, objectives, design procedure, calculation of ground resistance,

Ground resistance measurement: Fall-of-potential or three-pole method, clamp-on or probless method, measurement of step and touch potentials

Transmission and Distribution tower grounding: Tower grounding device, requirement of transmission tower grounding, seasonal factors, basic structure, concrete encased grounding, tower grounding resistance with different structure,

Induced voltage on Pipeline: Transmission lines, pipeline, electrostatic, electromagnetic and Resistive couplings, Carson's equation, induced voltage with single circuit with and without earth wire, double circuit with earth wire, mitigation.

Learning Outcomes

- Establish an understanding of grounding system related parameters.
- Demonstrate an understanding the soil properties, electrical property, earth current density, field current in uniform and non-uniform soil.
- Establish a practical idea about the measurement of the soil resistivity under different weather conditions.
- Establish an idea about the measurement of the ground resistance of the substation, transmission and distribution towers.
- Demonstrate an understanding about the calculation of pipeline induced voltage at the same corridor of the transmission lines.
- Use of commercial equipment and software for the measurement of soil resistivity, ground resistance and pipeline induced voltage.

Assessment

Final exam: 60%

Lab/Simulation and presentation: 40%

Textbook

Jinliang He, Rong Zeng, Bo Zhang, "Methodology and Technology for Power System Grounding", IEEE and John Wiley & Sons Inc., 2013

References

ANSI/IEEE (1983) Standard 81-1983. IEEE guide for measuring earth resistivity, ground impedance, and earth potentials of a ground system.

ANSI/IEEE (2000) Standard 80-2000. IEEE guide for safety of AC substation groundings.

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