ABSTRACT

The main objective of grounding system of substation is to provide a low resistance path for the discharge of heavy fault current. This further helps by providing safety to working personnel and costly installed equipments and machinery in the substation. It is essential to curb the flow of heavy fault current which may result in rise of potential in the substation area and with respect to remote ground. Also it is necessary to control the ground potential rise, and touch and step voltages within the permissible limit.

The numbers of GIS substations are increasing due to scarcity of space especially in metropolitan cities. Also the level of fault level of substations is increasing with the growth of power system. There is need to provide low resistance path for the discharge of short circuit fault current to ensure safety to working personnel and costly installed equipments in the substation. This in turn helps to keep the ground potential rise, and touch and step voltages within the permissible limit.

It is pertinent to mention here that an accurate soil model is required to design grounding system of the substation that ensures that the resistance of the grounding grid through the earth is sufficiently low. Soil resistivity data is of fundamental importance in performing grounding system analyses. Reliable data is required to achieve good correlation between design and measured grounding system performance. Soil model is derived from the accurate soil resistivity measurement structure at the proposed grid location.

The prevailing practice of most utilities is to install a grid of horizontal, ground electrodes (buried bare MS conductors) supplemented by a number of vertical ground rods connected to the grid, and by a number of equipment grounding mats. The grounding grid provides a common ground for the electrical equipment and for all metallic structures at the station. It also limits the surface potential gradient. Currently the IEEE 80-2000 (2013) standard for

substations grounding is used for the determination of the grounding parameters (namely step, touch and ground potential rise) using a uniform soil model unless the Sunde graphical method is used.

The goal of the thesis is to improve upon the current restrictions for the grounding grid design, while minimizing the material (i.e., MS conductors) and installation costs of a grid. Other objectives of thesis are to get a relatively accurate soil resistivity structure model with two different layers of soil instead of uniform soil model & map the different parameters that will influence the performance of the grounding system & to compute the effect of each parameter on the design. Further there is to need to develop a software program for designing of grounding system for two layer soil resistivity model of GIS substation and estimate the surface potential on different parts of substation and division of fault current in the grounding mat using the scale model. Also, empirical formulas for designing ~~of~~ grounding system with two layer soil model are required.

The first part of the research examined previous work through a combination of literature review, mathematical computation, and field measurements to validate the theoretical aspects of grid design. The thesis introduces an optimized uniform and two-layer soil with fast accurate calculations directly from soil measurements without the use of graphical methods or the use of complex image theory. Next, on the basics of various influential parameters a computer program named **RPDGS** with the help of MATLAB GUI has been developed for designing grounding system of GIS with uniform and two layer soil model.

This thesis further presents a parametric analysis for designing grounding system of GIS substation with uniform layer soil and two layer soil model with the help of MATLAB GUI and SES software Auto Grid Pro. Some case studies are presented to validate the computer program and empirical formulas are developed for designing grounding system.

The final part of the thesis demonstrates how it is possible to optimize the configuration of the grounding grid itself, minimizing costs of the installation.

This thesis in short presents an accurate method cum procedure for two layer soil resistivity modeling & designing the grounding system of gas-insulated substation (GIS) and air insulted substation (AIS) using developed empirical formulas.