List of the topics of the proposed lectures

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1. Effects of Electrical Currents passing through the human body and Bonding Requirements in Buildings

- Equipotential Bonding connections;
- Physiological Effects of AC Currents;
- Human Body Impedance & its Resistance-to- Ground;
- Electrical Resistance of Shoes;
- Numerical simulation of heart-current factors and electrical models of the human body;
- Thermal shock;
- Extraneous-Conductive-Parts & Bonding Criteria for “dead” metal parts in buildings.

Abstract: this lecture presents the crucial role that electrical bonding plays in maintaining the same potential between metal parts in buildings; potential differences, in fact, may induce lethal currents through the human body. The partnership between bonding conductors and protective devices (e.g. overcurrent, GFCIs) maintains the electrical safety of installations. However, issues may arise due to undue bonding connections, which will be examined during the lecture. Objective bonding criteria based on the effects of currents passing through the human body will be examined, in light of grounding methodologies, and related safety criteria per IEC and IEEE standards.

2. An Effective Semi-Analytical Method for Simulating Grounding Grids

- Cylindrical electrode embeded in conductive medium;
- Grounding Grids;
- Determination of the matrix of the resistances;
- Consistency of the semi-analytical method with respect to the discretization of the grounding system;
- a comparison of the efficiency of the semi-analytical with the finite element method
- Applications of the Semi-Analytical method to common grid configurations.
- Distribution of ground-currents and ground-potentials

Abstract: The analytical study of grounding systems is only possible for basic electrodes, such as hemispherical and spherical electrodes, rods and horizontal wires. However, it is normal practice to employ more complex earthing systems, such as

grounding grids integrated with rods, in order to obtain lower resistances-to-ground and improve the electrical safety of substations.
This lecture introduces a semi-analytical method consisting of an analytical approach integrated with a numerical solution, to study grounding grids of complex geometry and their effects on non-stratified soils. This method allows the determination of all the quantities of interest for the design and the analysis of grounding systems: ground-resistance, ground potentials and the distribution of the ground-fault current along the grid's components (i.e. horizontal wires and rods). The model is based on the assumption that conductors forming grids have radii very small if compared to their lengths and that the wires can be considered equipotential cylindrical elements.
A verification of the proposed algorithm through a finite element method (FEM) has also been carried out to confirm the validity of the results. Example calculations of the ground resistance of grids are included in the lecture.

3. Latent Touch Voltages in NEC Based Low-Voltage Installations

- *National Electrical Code* grounding requirements at service entrances;
- Transferred fault potentials to healthy equipment under ground-fault conditions;
- calculations of fault-loop impedance;
- calculations of touch voltages in buildings;
- supplementary equipotential bonding connections;

Abstract – In the U.S. National Electrical Code based low-voltage installations, ground-faults do not involve the actual earth, but fault currents return to the source via equipment grounding conductors; such conductors are employed to provide a clear path (i.e. low impedance) toward the source,
In this lecture, it will substantiated that under ground-fault conditions even healthy equipment, sharing the same equipment grounding conductor with the faulty equipment, becomes energized; in addition, also metalwork in the building acquires electrical potentials.
It will also be discussed that the common use of extension cords, as the typical solution to the socket shortage, may worsen this problem.
The presence of non-zero potential differences between equipment, metal enclosures and metal parts of buildings may constitute a hazard particularly in special locations, such as bathrooms with showers or bathtubs. In such areas, in fact, the resistance-to-ground of persons may be greatly reduced by moisture, water or the absence of clothing.
This lecture illustrates the advantages of supplementary equipotential bonding connections in such locations, as well as of the use of a general *Ground Fault Circuit Interrupter* in buildings, not contemplated in the NEC, as a possible solution in the reduction of touch voltage issues.