Analysis of the grounding system for a mobile communication site placed on HV power line mast

I Bîrsan¹, C Munteanu², M Horgoș¹ and T Ilut³

¹Technical University of Cluj-Napoca, North University Centre of Baia Mare, Electrical Engineering, Electronics and Computers Department, Baia Mare, Romania
²Technical University of Cluj-Napoca, Department of Electrotechnics and Measurements, Baia Mare, Romania
³SC FDEE Electrica Distributie Transilvania Nord SA, Baia Mare, Romania

E-mail: ciprian.ionut87@yahoo.com

Abstract. This paper aims to analyze the potential distribution on the soil surface or potential variation on the main directions inside computing mobile site. I want to study a system made the earth a mobile communications site, antennas operator and the system of which the earth is placed on a High Voltage Power Line Mast (LEA 110 KV). I made direct measurements and I use a 3D software for analyze the results and simulating some possible solutions.

1. Introduction
Earthing installations consists of electrodes buried in the ground, tied together with wire grounding, connecting both between these electrodes, and between them and electrical installations. The role of these facilities is to direct to the soil, safe, dangerous currents owe atmospheric discharges or fault currents occurring as a result of damage to electrical equipment installation elements [1], [2]. The main components of earthing systems are natural and artificial sockets earthing conductors, wide flats that make the connection between the land and equipment and earthing conductors, installations, swinging for plant protection [3], [4].

2. Checking Calculations Based on the Normative
This paper aims to study a system made the earth a mobile communications site. Antennas operator and the system of which the earth is placed on a High Voltage Power Line Mast (LEA 110 KV).
Checking earthing designed in terms of fulfilling the rules of touch and step voltages is based on two documents:
- Normative design and execution of installations earthing indicative 1RE - Ip 30/2004;
- Recommendation ITU K.57 CIGRE entitled "Protection Measures for Radio Base Stations sited on Power Line Towers" released in October 2003 in Geneva [5-7].
According to straightening design 1RE - Ip 30/2004, the permissible values of step and touch voltages, where columns LEA are:
- For LEA pillars outside the cities, not standardize;
- For LEA pillars with devices, regardless of location, to network, to achieve the maximum voltage (U_a) or high voltage step (U_step) is 250V;
Conditions sizing for columns LEA with devices in relation with projected value of earthing installation intake are given according 1RE - Ip Recommendation K.57 CIGRE 30/2004 respectively, the relations:

$$R_p I_p \frac{k_a}{\alpha_a} k_{CIGRE} \leq U_a$$

(1)

$$R_p I_p \frac{k_{step}}{\alpha_{step}} k_{CIGRE} \leq U_{step}$$

where we have:

- $R_p$ is designed earthing resistance of 1Ω value.
- $I_p$ is the total failure of the current passing through the earth connection of the column; according to studies of CIGRE Recommendation for earthing 1Ω value, maximum 20 % of the total fault current closes the outlet of the column earth; thus taking into account the worst case, the fault current is maximal, in the station busbars 22kA result value $I_p = 4400$;
- Dispersion coefficients are chosen in the worst case, the value $k_a = k_{step} = 1$;
- Coefficients of the containment site to concrete platform are under the guidance of design, $\alpha_a = 3$ respectively $\alpha_{step} = 9$;
- Coefficient value reduction step and touch voltage, earthing using the double ring configuration is, according to studies of CIGRE Recommendation K.57 (Figure 1) $k_{CIGRE} = 0.15$.

In these conditions, the maximum touch and step voltages are:

$$U_a = 220V$$

$$U_{step} = 73.3V$$

(2)

These values are within the limits imposed by the rule admitted.

3. Numerical Calculation Using 3D Modelling For Earthing Systems

Three-dimensional numerical modeling earthing design was done using a commercial software package. By implementing Earth geometry intake at scale, the project may cause potential distribution at the soil surface and in any other section through three-dimensional geometry of the intake of Earth.
Thus, by three-dimensional numerical modeling can determine the potential variation in the soil surface within the site area mobile, can determine the maximum voltage values of the step and touch, in any location within the site [8].

**Figure 2.** Three-dimensional geometry earther

**Figure 3.** Variation of surface potential

**Figure 4.** The main directions of the representation of the potential distribution

**Figure 5.** Distribution of potential in the Ox axis

**Figure 6.** Distribution of potential in the 0Y - axis section

**Figure 7.** Potential along the Ox-axis
Dimensional geometry of the earthing, according to the draft proposed execution is represented in Figure 2 is specified as earth resistivity in numerical calculations it was assumed value of 100 Ohm meter.

In numerical analysis of electromagnetic field, is aimed primarily at the surface potential distribution soil, potential variation on the main directions that calculation inside mobile site. Thus, Figure 3 shows the surface potential variation in size relative to the unit of potential defect by setting ground (alleged interconnected through 110 kV pole -which strip out of the ground - light green).

In order to determine more specific potential distribution on the soil surface inside the mobile site were established four main directions of representation, indicated in Figure 4 by pink lines. Thus considered 0x axis direction in Figure 5 median direction that crosses the site and passing through the column 0x direction specified above. One diagonal directions (main diagonal) Figure 9 and diagonal 2 (secondary diagonal) Figure 10 diagonal direction of the square surface site.

After analyzing, the plot of Figure 4-6 shows the following:
- Potential distribution along the direction 0Y is symmetrical in relation to the position of the center of the site;
- Absolute maximum potential difference, along the four directions of calculation corresponding to Figure 7 (0x axis) as reported value 0.96 - 0.91 = 0.05 units;

![Figure 8. Potential along the axis Oy](image1)

![Figure 9. Potential along the main diagonal](image2)

![Figure 10. Potential along the diagonal site](image3)

![Figure 11. Distribution of potential in the plane z = -0.8 m](image4)
Distributions of potential along the diagonals of the square site are virtually identical; Considering the worst case, given the representation 0x axis (Figure 7), the maximum potential variation in the absolute value of the growth potential of 4400V, corresponds to a potential difference of 220V absolute maximum value of voltage which is below the maximum allowed on regulations in force, 250 V (step and touch voltage) value that is in full compliance with the maximum voltage to achieve estimated.

The potential variation following chart in Figure 7, it can be concluded that the area in the vicinity of 110 kV column (starting at abscissa x = 0 to positive) is the potential variation pronounced (largest potential gradient); calculating voltage step in this area (for a distance of x = 0.8 m) reveals a potential difference of up to 0.02 units reported what if 4400V overvoltage fault mean value of the 88V voltage step, far below regulatory limit of (250V).

**Figure 12.** Distribution of potential in the plane z = -1.2 m  
**Figure 13.** Distribution of potential in the plane z = -2.2 m

### 4. Conclusion

In conclusion, the analysis carried out, it can be said that ground socket designed to accept a diagram that makes potential resistive touch and step voltages as directed. The statement above is further justified by the potential distribution representations in different sections within the soil resulting in numerical analysis of 3D field, and presented in Figures 11-13.

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