MATHEMATICAL MODEL OF THE PROTECTION ZONE OF DOUBLE AIR-TERMINATION ROD (ATR)

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As in the case of protection zone (PZ) constructing for a single ATR, the task of obtaining a double ATR is a special case. The geometric model is a problem of finding the coordinates of the protection surface when the sphere simultaneously touches two ATRs. Moreover, the touching of the sphere occurs symmetrically with respect to a straight line passing through the coordinates of ATRs centers.

This task can be reduced to the following. Let it be necessary to find a pair of intersection points of two circles formed by the projection of the sphere center on the soil plane during the ATR breaking-in with a sphere of a certain radius corresponding to the accepted level of lightning protection. That is, it is necessary to solve the problem of finding the points located at a known distance from a straight line. It is clear that there are two such points (A_1 and A_2), and they are located symmetrically.

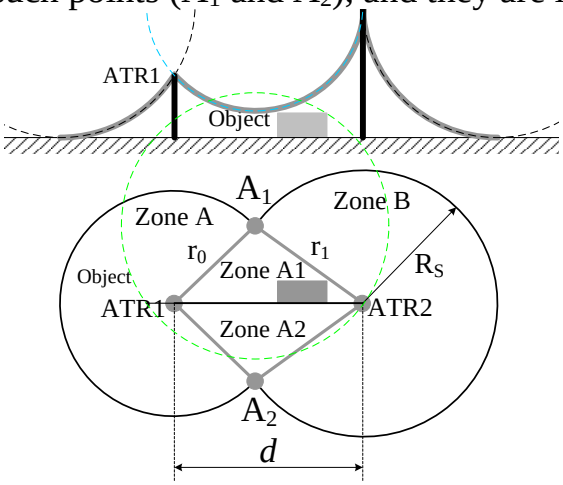

Figure 1 – PZ of double ATR

Since the straight line passing through the points A_1 and A_2 is orthogonal to the straight line passing through the points ATR1 and ATR2, the coordinates of A_1 and A_2 can be found as follows:

$$x_3 = x_2 \pm h(y_1 - y_0)/d\,,\ y_3 = y_2 \mp h(x_1 - x_0)/d\,,\ z_3 = R_S\,. \qquad (1)$$

Let the coordinates x_i, y_i of a certain point in the Cartesian coordinate system be given, find the coordinate z_i of this point belonging to the PZ surface. According to the geometric model, if a point belongs to the region A or the region B, then the coordinate z_i is determined by the expressions (1).

If the point belongs to the zone A_1 or A_2, then the coordinate z_i is defined as follows:

$$z_i = R_S - \sqrt{R_S^2 - (x_i - x_3)^2 - (y_i - y_3)^2}\,. \qquad (2)$$

Thus, in contrast to the results given in [1], the solution was obtained for calculating the PZ for the system of two ATR of arbitrary height (see Fig. 1).

Reference:

1. Nit Petcharaks. Lightning protection zone in substation using mast. KKU Engineering Journal, 2013; № 40(1), pp. 11-20.