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Operating experience, calculation and modernization of lightning protection EHV overhead lines with sections without ground wire

Improvement of the protection of overhead lines and substation equipment against lightning and other transient phenomena

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In Russia for the line route located in areas with intensive icing the problem of lightning protection of EHV overhead lines occurs. It is not always possible by using zonation map for ice to identify the local "problem" sections of EHV OH lines routes subjected to heavy icing, often in combination with strong winds. As a result in autumn and winter seasons the sagging, damage and breakage of ground wires are resulting in HV lines outage and interruptions of power supply. After several years of unsuccessful operation the ground wires on "problem" sections are dismantled to ensure reliability of electricity supply in the autumn and winter seasons. Lightning proofness, of course, is reduced. However, the overall reliability of the power supply expected to be increased, since lightning outages are usually accompanied by a successful automatic reclosing (AR).

The operation without the ground wire regardless of the intensity of lightning activity and class of OH line rated voltage is allowed by Russian regulatory document (Electrical Code) in such cases. The operating experience over a five year period of OH line 500 kV "Rostov nuclear power plant - Budennovsk" with overall length of 432 km, with two sections without ground wire with a total length of 136 km (31.5 % of the length of the route) was analyzed. The analysis revealed that when refusing to use the ground wire, lightning protection system using modern protective devices - non-linear surge arrester is needed to ensure the reliability of electricity supply during thunderstorm season. Considered OH line had an average of 6.2 lightning outage per year. When ground wire is installed along the entire line length the quantity of lightning outage per year reduced to 0.3 per year, i.e. 20 times less.

Application of the EHV breakers, switching the individual phases, allowed to receive the distribution of the number of lightning strikes in phases with use of registration data of short circuit points in sections without ground wire. It was found that this distribution is substantially different from the distribution obtained by using methods based on the principle of equidistance (e.g., electro-geometric). For this distribution the proportion of lightning discharges affecting middle wire due to influence the operating voltage to the orientation of

the lightning leader was increased. This conclusion, obtained from the analysis of operating experience, is extremely important for the development of systems of lightning protection of overhead lines without using a ground wire but with use of surge arresters. The obtained results can be used for rational arrangement of surge arresters on the support and along the line route.

Savings of expensive devices of lightning protection systems without ground wire can be achieved by introduction of the special supports characterized by enhanced outer wires suspension height over middle wire. The specific arrangements of wires (triangle) is proposed. Their effectiveness in terms of lightning protection is estimated using the electro-statistical methodology, which allows to take into account the effect of the operating voltage on the distribution of lightning strikes on the wire. This distribution is calculated using a probabilistic assessment of the two conditions: first, conditions for development of counter leader from the object, second, conditions for creation of electric field intensity in the gap between lightning leader and object which is sufficient for transition of lightning discharge in the through stage.