Power and Energy Series 58

Lightning Protection

Edited by Vernon Cooray

LIGHTNING PROTECTION OF LOW-VOLTAGE NETWORKS

Alexandre Piantini

Lightning causes various power quality problems and usually has a considerable impact on the number of equipment damages and failures, voltage sags, and unscheduled power supply interruptions experienced by LV customers. Owing to the widespread use and growing dependency on the continuous operation of sensitive electronic equipment, there has been an increasing awareness of the importance of mitigating such effects.

In this chapter, the major mechanisms by which overvoltages stem from lightning were discussed. Particular emphasis was given to the voltages induced on overhead LV networks by nearby strokes and to those transferred from the MY system, which are the most important on account of their magnitudes and frequencies of occurrence. Simple but effective models were used to represent the high-frequency behaviour of typical distribution transformers and LV power installations.

Surge magnitudes and waveforms depend considerably on many line and lightning parameters, which may combine in an infinite variety of ways. Therefore, a sensitivity analysis was carried out and a typical LV distribution network, which may be considered representative of rural lines, was taken as reference. The basic characteristics of the overvoltages, as well as their dependence upon the network configuration and the most important stroke parameters, were assessed. The analysis revealed that secondary systems are in general more susceptible to subsequent strokes, although severe surges can also be produced by the first.

Phase-to-ground voltages induced by nearby strokes can reach some tens of kilovolts at various points along the network, especially if the stroke location is not in front of a neutral earthing point. Lower magnitudes are observed at the transformer and customers' entrances, but the value of 10 kV may often be exceeded in the case of strikes closer than ",50 m. Phase-to-neutral voltages of some kilovolts are common if surge protective devices are not applied. In the case of direct strikes to the MY line, short duration pulses of several tens of kilovolts are transferred to the secondary circuit.

In regions of high lightning activity, surges originating in the LV side can be responsible for a great number of transformer failures or damage, even if arresters are placed close to the primary terminals. The application of arresters on transformer secondaries can significantly reduce lightning damage rates of exposed transformers, but it does not prevent overvoltages from arising at the service entrances.

Similarly, the application of secondary arresters to a power installation can effectively reduce the local overvoltages to acceptable limits, but in some circumstances this may result in higher voltage stresses at unprotected premises. Therefore, unless they are applied at every service entrance, exposed sensitive electronic equipment can be damaged. In fact, voltage oscillations caused by reflections at various points within the installation can give rise to internal overvoltages with higher magnitudes than that limited by the arresters placed at the service entrance. Therefore, local protection is required for such susceptible loads.