Lightning Protection of Low-Voltage
Networks Procedures

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The following conclusions have been drawn from the findings discussed in the TB:

- cloud discharges give rise to bipolar pulses with very fast rise times and should be taken into account in the evaluation of the interference problems caused by LEMP. A typical lightning flash within a distance of a few kilometers may induce voltage pulses of some hundreds of volts peak-to-peak;
- due mainly to the shielding provided by nearby trees and structures, LV networks are in general not that prone to direct strikes, but in some rural and semi-urban areas exposed lines longer than 1000 m do exist. In case of direct strikes, the resulting overvoltages lead to multiple flashovers and unprotected connected equipment can be damaged;
- a direct strike to an end-user building causes an earth potential rise that may lead to the operation of SPDs or to flashovers between the structure and the line conductors. In both situations a portion of the stroke current is injected into the power line, producing overvoltages that propagate along the network;
- voltages induced by nearby lightning have a high frequency of occurrence and often reach large magnitudes. The severity of the surges depends on many parameters. Secondary systems are in general more susceptible to subsequent strokes, but severe surges can also be produced by the first stroke. Phase-to-ground induced voltage magnitudes can reach some tens of kilovolts in various points along the network. Phase-to-neutral voltages of some kilovolts are common if surge protective devices are not used. If the strike point is close to the line, an appreciable fraction of the total current may enter the system from the neutral earth connections;

- in the case of direct strikes to the MV network, short duration pulses of several tens of kilovolts may be transferred to the secondary circuit. The overvoltages are characterised by oscillations caused by the various reflections that occur throughout the LV network and are strongly affected by the spacing between adjacent earthing points and flashovers across MV and LV insulators. The presence of SPDs at various places of the LV line does not prevent high voltages from arising at unprotected points;
- the estimation of voltages transferred from the MV to the LV side requires the use of an adequate high-frequency transformer model. As shown in the TB, the transferred voltages estimated using the p-capacitance model tend to be substantially higher than those obtained using more accurate models. Attenuation of the overvoltage along the secondary network can be observed only for stroke locations distant from the LV portions of the system;
- in regions of high lightning activity, surges originating in the LV side can be responsible for a great number of transformer failures or damages, even if surge arresters are placed close to the primary terminals. The mechanism is explained in the TB. Although the application of LV arresters can significantly reduce the lightning damage rates of exposed transformers, it does not prevent overvoltages from arising at service entrances;
- use and location of SPDs for buildings and structures with and without lightning protection systems are illustrated and discussed in the TB. The application of SPDs 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 equipment can be damaged. Additionally, voltage oscillations caused by reflections at various points within the installation can give rise to internal overvoltages with higher magnitudes than those limited by the SPDs placed at the service entrance;
- overvoltage protection in wind power, photovoltaic, and d.c. traction systems requires special consideration. Stresses from lightning surges can be very different depending on the system studied and each case requires specific considerations. The TB provides guidance and examples showing possible solutions for overvoltage protection of these systems.