Behavior of Low Voltage Surge Protective Devices in Fast Transient and Repetitive Current Impulse Environment

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Chaminda Mahesh Edirisinghe

Faculty of Science,

University of Colombo

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Abstract

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Electrical energy is proving to be a more and more important need in the modern society. A spectrum of the electrical devices has spread and today the trend is still toward smaller devices, which are more sensitive to the disturbances over the electrical network and disrupted power supply. The issue of surge protection in low voltage systems is of increasing importance due to the vulnerability of modern electrical devices in a transient environment. It is essential to investigate response of surge protection devices to fast transients and its performance under repetitive current impulse environment for an effective design of a protection system. Study of lightning generated HF radiations is another key issue for proper insulation coordination at the distribution level in accordance with the need & sensitivity of the protected equipments in modern world.

Investigating the HFs radiated by lightning, it was found that about 87% of negative ground flashes, HF radiations at 3 MHz, 5 MHz, and 10 MHz are stronger at the onset of the return stroke. For 13% of flashes it was strongest radiation at the leader phase. It was observed that the leader like pulses appeared at leader phase and after the return stroke act as a strong source for HF radiations. Out of the 526 pulses analyzed, 298 were found to be due to positive field change pulses and 228 due to negative field change pulses. The average rise time of those pulses was 0.127 μs and the peak amplitude was in the range of 0.65-2.19 V/m.

The studies to investigate the behavior of surge protective components revealed that, clamping voltages of tested surge protective components due to fast transients were considerably greater than that measured with the standard 8/20 μs current impulses. It was found that the varistor models need to be improved in order to have a better agreement for fast transient environment. It was observed that if the varistors do not fail physically or if there is no relaxation time period in between, maximum clamping voltage will not increase further but it will asymptotically approach to a certain value depending on the individual characteristics of the varistor under a repetitive current impulse environment. Further more, most of the physical damages (90%) were observed at the surface coating of the varistors. Surface flashovers could be the main reason for this type of damages. Dielectric behaviour of the varistor surface coating & the electrode contact system, and manufacturing defects of the varistor surface coating could be a major influence on withstand capability under the repetitive impulses. It was observed that the surface flashovers may occur and varistors may be physically damaged before reaching the clamping voltage failure mode.