



Contribution ID: 222

Type: Poster Presentation

Transient Voltage Distribution Characteristics of Ultrahigh-Voltage Transformer Windings under Impulses with Different Front Time

Tuesday 5 June 2018 13:30 (1h 30m)

Larger entrance capacitance of ultrahigh-voltage transformers makes it more difficult to generate standard lightning impulses (SLI) in the lightning impulse withstand voltage test (LIWVT), especially for the front time. In order to analyze the feasibility of substituting test impulses with longer front time for SLI in LIWVT, this paper experimentally studied the voltage distribution characteristics of the 1000kV transformer windings subjected to impulses with different front time. The transient voltages of the outmost turn of each disc under impulses with front time of 0.1 μ s, 1.2 μ s and 6 μ s, respectively, were measured with the capacitive voltage sensor. The results showed that, for the innershield-continuous low-voltage winding and the interleaved-continuous-innershield high-voltage winding, whose high voltage leads were respectively located at the top and middle, the maximum voltage distributions were almost independent of the front time; while for the innershield-continuous mid-voltage winding, whose high voltage lead was located at the bottom, the maximum voltage distribution changed as the front time varied. In addition, for all three kinds of windings, the front time had little effect on the frequency components of the transient voltages, but was proportional to the front time of the measured transient voltages, which could significantly influence the dielectric behavior of oil-paper insulation. It could be derived from the results that, from the perspective of the transient voltage distribution, longer front time of test impulse was only allowable for windings whose high voltage leads were not located at the bottom. Some discussions were also made on the effect of very fast transient overvoltage (VFTO) on transformer windings. The results in this paper have great referential values to the LIWVT of ultrahigh-voltage transformers and can be utilized to validate circuit models of transformer windings.

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Session Classification: Poster 2 - High Voltage Design and Power Modulator Components