Contribution ID: **24** Type: **Oral**

Characterization of the breakdown voltage of vacuum interrupters by different procedures

Tuesday 9 March 2021 17:15 (30 minutes)

This work compares three different procedures for the application of the Lightning Impulse Voltage Waveform (LIVW) with 1.2/50 μs front/half value times: Up & Down (UD), Always Breakdown (AwBD) and Multilevel (ML) to obtain the voltage breakdown distribution for Vacuum Interrupters (VIs).
The voltage pulses were applied to several VIs for medium voltage application with both fixed and floating shield with gap lengths ranging from 4mm to 15mm. The repeatability of the results for a given procedure was investigated and the results compared.
The AwBD procedure, where the peak voltage of each pulse is set and kept at the same arbitrary high level to collect a breakdown for each pulse, was thoroughly investigated. This procedure is effective to collect data on many breakdowns very quickly, due to both the speed of the voltage conditioning phase and because breakdown data are collected for each pulse. Furthermore, the memory effect due to the status of the previous pulse (BD or withstand pulse) is reset due to the random distribution of surface microprotrusions produced by the arcing occurrence at each pulse. In contrast, for the ML procedure the status of the ith-pulse depends on the status of the (i-1)th-pulse. On the other hand, the AwBD procedure showed a dependency of the breakdown voltage distribution curves on the set peak voltage applied. This phenomenon has been investigated and might be explained by a delay time between the breakdown onset and the voltage collapse on the rising front of the pulse, where the slope (dV/dt) of the LIVW depends on the chosen set peak voltage. However, the results suggested that after having identified the proper delay time, the results can be corrected providing a similar breakdown voltage distribution independent on the set voltage and close to that obtained with the UD procedure.

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Session Classification: Experiments & Diagnostics