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Diagnostic of field aged cables and accessories by time-domain dielectric spectroscopy (TDDS)

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Time-Domain Dielectric Spectroscopy (TDDS) was used as a diagnostic tool to assess the degradation state of field-aged extruded cables retrieved from the underground network. Field-aged, artificially aged and unaged cable accessories were also characterized with respect to their dielectric response in order to account for their effect on real line diagnostic. The design of this high voltage time-domain spectrometer allows the measurement of the dielectric response up to 25 kV for equivalent frequencies below 10^{-1} Hz. In addition to TDDS measurements, high voltage Frequency-Domain Dielectric Spectroscopy (FDDS) was performed for the sake of comparison. This diagnostic equipment has a voltage limit of 30 kV and a maximum frequency bandwidth ranging between 10^{-3} and 10^{3} Hz. Both types of dielectric measurements are compared in the frequency domain since time results were converted into equivalent frequencies by using the Hamon approximation. The cables were 28 kV rated and manufactured between 15 and 25 years ago. Each cable was characterized with respect of water content and water tree density. AC breakdown strength measurements were also performed in order to characterize the state of degradation. Cable accessories consisted in 25 kV rated joints and terminations.

The dielectric response is presented for dry and wet cables with and without water trees. It is compared to their residual breakdown strength and water tree density measurements. The variability of the dielectric response of cable accessories with respect to parameters like aging and thermal cycling is discussed. A real line simulation including the dielectric response of cable accessories is also presented. The applicability of the TDDS diagnostic method on real lines is then discussed with respect to this simulation.