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Evaluation of tree retardant XLPE (TR-XLPE) and EPR insulated 35 kV cables after 17 years of field service

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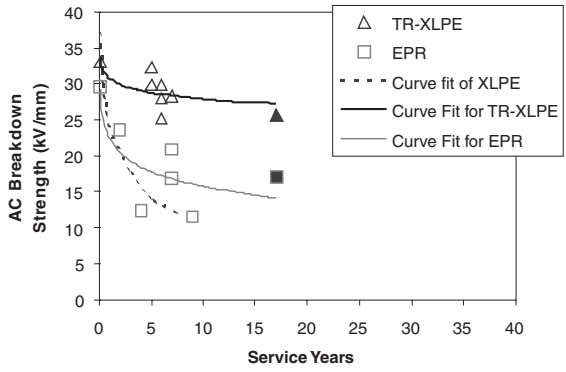
Cables insulated with TR-XLPE and EPR were evaluated after 17 years of field service at the Galleria Mall near Birmingham, Alabama, USA. The 35 kV cables used in the study are of similar construction, using a 1/0 AWG (53 mm^2) conductor and 345 mils (8.5 mm) of insulation, and were a part of two separate 200 amp circuits with a load of 20 mVA. The average operating stress for the cables was 58 V/mil (2.3 kV/mm). Neither of the cables experienced any failures during the 17 years of service.

Cable samples of each material type were removed from service and analyzed for water tree density, as well as ac breakdown and impulse breakdown strength. Water tree lengths and densities in both types were found to be low, although longer trees were seen within the EPR insulation. The tree-retardant additive concentration in the TR-XLPE cables was found to be uniform across the insulation thickness, at the level expected for an unaged cable, which indicates that the additive is non-migratory.

Both the AC breakdown strength and Impulse breakdown strength of the TR-XLPE cables were found to be higher than that of the EPR cables. A comparison of the breakdown data to previously published breakdown data for similar constructions of EPR, XLPE, and TR-XLPE insulated 35 kV cables after 7-9 years of service, indicates that both EPR and TR-XLPE exhibit good relative stability of AC and Impulse breakdown strength after 17 years of field service. These results support data from accelerated aging tests of XLPE, TR-XLPE and EPR cables.



AC Breakdown Strength versus time in service for TR-XLPE and EPR insulated 35 kV cables. Open symbols and XLPE curve are from published results by Katz & Walker, 1995 and 1998.

Step-wise AC Breakdown tests over a range of time steps have been used in other work to extrapolate the declining breakdown strength to a limiting multiple of the operating stress, and thereby generate an estimate of "remaining life." An attempt was made to employ a similar "voltage-time" (V-t) analysis with the use of 30-second and 12-hour time step AC Breakdowns, in addition to the impulse and standard 5-minute AC Breakdowns. Although

the V-t extrapolation was not possible due to the similarity in breakdown values between the 30-second, 5-minute, and 12-hour time steps within this study, the results support a long-life expectancy for cables insulated with either TR-XLPE or EPR.

Results of the test program indicate a long-life expectancy for both the EPR and TR-XLPE insulated cables. The AC and Impulse breakdown strength after 17 years of service are consistently higher for the TR-XLPE cable.