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Developing a reliability model for an 88 kV XLPE cable termination

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Abstract

Whereas there are life models for cable systems, the focus has been on cables and not on accessories. Literature shows that cable accessories are the problematic area in cable systems. There is therefore a need to develop cable accessory reliability models which can be used for informed asset management decision. This research work has conceived a reliability model for cable terminations using a case study municipal substation which has been experiencing failure of 88 kV XLPE power cable terminations. In the literature, there is an electrothermal model developed for cable systems. In the present work the existing model was adopted and extended. This study involved identifying the modes of degradation by forensic investigation of the failed terminations. For each mode of degradation, a corresponding mathematical model of the stress life factor was developed. Using the Weakest Link Principle, the product of reliabilities due to each degradation mechanism computes the overall reliability of the termination system. The results indicate that electrothermal stress hardly reduces the reliability of the termination from the time of installation to 40 years in service. However, thermomechanical stress causes a reliability of less than 10% after 18 years and galvanic degradation reduces the termination reliability to less than 10% after 24 years in service. Each new cable termination design should have a corresponding reliability model. The latter entails conducting laboratory aging tests which give the parameters required in developing the stress life factors. For existing terminations, root-cause analysis of failure can lead to determination of the stress factor parameters. The model developed in the present research work can be used in real-time asset management decisions by processing the real time operating conditions.