

Operating Extruded Distribution Cable Systems at Elevating Temperatures

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ABSTRACT

ICEA, UL, and AEIC cable standards and specifications for EPR and TRXLPE insulated cables allow for operating cable conductors at highly elevated temperatures. The associated industry cable and accessory qualification test program requirements, however, do not evaluate the performance of the system components at these elevated temperatures. Therefore, the consequences of operating an extruded cable system at highly elevated temperatures are not fully understood by operators of these systems.

This paper describes the studies undertaken to review and summarize current industry requirements for evaluating the performance of cable systems operating at and above the generally accepted normal operating conductor temperature of 90 Deg. C. It identifies gaps between industry evaluation requirements and actual operating temperature conditions. Furthermore, it provides guidance so that users could determine the appropriate level of testing required for the accessories, cables, connectors; should users wish to operate at elevated temperatures.

KEYWORDS

Reliability, MV, Extruded Cable Systems, Elevated Temperature

INTRODUCTION

Operating temperatures for underground extruded power cables commonly installed across North America are specified in standards prepared by the Insulated Cable Engineers Association (ICEA) or Underwriters Laboratories (UL). These standards rate medium voltage cables made with polymeric insulations i.e. water tree retardant cross-linked polyethylene (WTRXLPE) or ethylene propylene rubber (EPR) at conductor temperatures up to 140 °C under emergency operating conditions. The implication is that complete cable systems have the same ratings and that the relevant standards require test programs that verify reliable operation at these temperatures.

It is instructive to note that utilities are not reporting significant failures due to elevated temperature operation and there is a good reason for this. While utilities purchase cables rated at a conductor temperature of 90/130 °C or 105/140 °C, survey responses clearly show that the most common maximum conductor operating temperature is between 45 °C and 60 °C for URD cable systems and between 75 °C and 90 °C for feeder cable systems. The design principles for Utilities is based on the premise that their cable systems will operate reliably at the rated emergency temperature even though they rarely operate

them at these temperatures. The concern is that if they ever chose to operate them at their rated temperature, there is evidence that such operation will degrade the cable system, with a subsequent reduction in reliability that is impossible to predict. Additionally recent service experience above 70 C has resulted in service failures leading a number of utilities to question the ability of a complete cable system to operate at elevated temperatures. A number of laboratory studies supports this concern.

To better understand the topic, a project was undertaken to provide an overview of high temperature operation issues for extruded underground distribution cable systems.

APPROACH

To prepare the overview, a number of sources of information were consulted, including:

- a) Operating temperatures specified in relevant cable and cable accessory standards
- b) Utility and manufacturer expectations of the cable system operating temperature
- c) Tests outlined in relevant standards to verify elevated temperature operation
- d) Extruded cable material properties as a function of temperature
- e) Risks associated with elevated temperature operation
- f) Potential options for mitigating the risk of high temperature operation.

Permitted temperatures and the temperatures experienced by devices during testing were extracted from the relevant standards / specifications - detailed at the end of the paper.

RESULTS

Operating Temperatures – what is allowed and what is tested

Performance requirements for extruded distribution cable systems are not covered by one standard; cable conductor operating temperature ratings are specified in ICEA and UL standards, with ratings for cable accessories (splices, terminations and separable connectors) being covered in separate component standards published by IEEE. The IEEE standard for cable joints (splices) also references an ANSI standard for evaluating the connectors used to join cable conductors inside joint housings. Cable specifications prepared by AEIC were reviewed because they provide supplemental test requirements to the ICEA documents. A summary of the temperature ratings outlined in relevant extruded distribution cable standards appears in Table 1.