B.9.4.

Comparative evaluation by laboratory aging of 15 kV TR-XLPE & EP cables

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ABSTRACT: This paper provides data on three commercial tree retardant cross-linked polyethylene (TR-XLPE), one cross-linked polyethylene (XLPE) and one ethylene propylene rubber (EP) insulated 15 kV distribution cables. All the TR-XLPE cables have "extra-clean" insulation. One of the TR-XLPE and the XLPE cable have "super-smooth" conductor shields. AC and impulse voltage breakdown data are presented on cables aged immersed in room temperature water up to 24 months. The ac breakdown stress of two TR-XLPE cables is high, but that of the third cable is lower. The ac breakdown strength of the XLPE cable is slightly higher than that of the TR-XLPE cables and that of the EP cable is lower. The impulse voltage breakdown stresses of the TR-XLPE and XLPE cables are initially higher than the EP cable. During aging all cables decrease in impulse breakdown strength. The excellent performance of the XLPE cable indicates evaluations, over a longer time, are required. The other characteristics were generally satisfactory; except for the XLPE insulated cable where the bond strength of the insulation shield is marginally lower and for the EP insulated cable where the dissipation factor is increasing with time of aging.

Keywords: Cable, 15 kV, Super-smooth shields, Extra-clean insulation, Laboratory aging, TR-XLPE, XLPE and EP

I. INTRODUCTION

Since the mid 1980's, new or modified types of XLPE, TR-XLPE and EP cables have become commercially available. Included in this group are cables having "super-clean" insulations, conductor and insulation shields [1]. In addition, "super-smooth" conductor shields have become commercially available [2]. These compounds have been incorporated in new cables intended to have increased service life. "Super-smooth" and "extra-clean" are USA marketing terms. "Super-smooth" refers to a second generation of conductor shields that provide an improvement concerning the smoothness of the shield interface. "Extra-clean" insulation refers to insulation materials meeting a tighter specification for contamination than conventional or standard materials. For example, Dow Chemical defines "extra-clean" materials as those having up to two contaminants smaller or equal to 250 micrometers per kg of material. "Extra-clean" semiconductive shields refer to materials that have reduced levels of sulfur and ash than conventionally used materials, typically described as having an order of magnitude less.

In 1999 Reliant Energy in collaboration with the Electric Power Research Institute (EPRI) initiated a project to identify new cables with suitable quality characteristics for their system. Seven TR-XLPE cable designs were made available for the project. In addition, one cable insulated with cross-linked polyethylene (XLPE) and one insulated with ethylene propylene rubber (EP) were included for comparison purposes. It was planned to age the cables at Cable Technology Laboratories (CTL) for 48 months, conducting periodic evaluations.

The present paper deals with the characteristics of five of these cables during the first 24 months of accelerated aging in the laboratory. It is planned to continue the aging for another 24 months. The cables were selected based on the fact that three had TR-XLPE insulations made by three different manufacturers, using different additives. The characteristics of these cables are compared with those of similar size cables insulated with XLPE and EP compounds. One of the TR-XLPE and the XLPE cable had "super-smooth" conductor shields. AC and impulse voltage breakdown data and other important characteristic data are provided in the paper. Data on the other cables in the project will be published elsewhere [3].

A number of articles on experiences with TR-XLPE insulated cables during laboratory aging and testing have been published [4, 5, 6]. The present paper permits a comparison of three current (made in 1999) TR-XLPE insulated cables with one XLPE and one EP insulated cable.

II. CABLES USED IN STUDY

Commercially available 15 kV cables, made with three different types of TR-XLPE insulation, one type of XLPE and one type of EP insulation, were selected for this program. Table No. 1 describes their general construction and compounds. All cables have strand-blocked conductors. No jacket was placed over the neutral wires in order to maximize water ingress into the cable during laboratory aging. Cables A, B, C and D were manufactured to meet requirements of the AEIC Specification CS5-94 [7]. Cable E (the EP insulated cable) was manufactured to meet requirements of the