Endurance of Medium Voltage Joints under Laboratory Wet Aging Environments

Thomas **PARKER**, JC **HERNANDEZ-MEJIA**, Caryn **RILEY;** GT-NEETRAC, USA, thomas.parker@neetrac.gatech.edu, jean.hernandez@neetrac.gatech.edu, caryn.riley@neetrac.gatech.edu

Nigel **HAMPTON**, UL Solutions, USA, nigel.hampton@UL.com

ABSTRACT

Traditionally, when Medium voltage (MV) power cable accessories (joints and terminations) are tested in a laboratory environment, they are assessed as stand-alone units. This is expected since the main goal of the laboratory testing is to assess the performance of the accessory design and not the long term interactions of the system. In this case, long term interactions (>100 days) between the cable and accessory are non-existent; understanding the interactions is important because they better relate to a more realistic performance of a power cable system installed in the field. Therefore, the work presented here examined the possibility of testing cable joints using a laboratory test method based on that used for cable qualification and comparing the results to those of cable alone. It also developed a method to perform a relative comparison of joint and cable interaction with relevance to field circuits.

KEYWORDS

Joint, Aging; AWTT, ACBD, HVTT, Laboratory Testing, Performance

INTRODUCTION

Medium voltage (MV) cable joints are an essential component of a power cable system since they are used to connect two or more cables together. These joints are designed to withstand high voltage levels, but over time, they will degrade, leading to several issues, including, overheating, faults and even fires in manholes.

There are several causes of cable joint degradation, including environmental factors, mechanical stresses, and electrical stresses. Environmental factors, such as moisture, temperature changes, and exposure to chemicals, can cause the insulation material to deteriorate over time. Mechanical stresses, such as vibration or movement of the cables, can also cause damage to the joint, leading to cracks, delaminations, or breaks in the insulation. Electrical stresses, such as overloading or short circuits, can cause the joint to heat up and degrade rapidly, leading to failure. Electrical stresses such as localized high stress (electric field) may be generated by poor workmanship issues and in fact play an important role in joint failures observed in the field.

In the traditional laboratory testing of power cable accessories, joints are evaluated as individual components, without considering their interaction with the cable itself. However, understanding these interactions is crucial for assessing the real-world performance of power cable systems in the field. Therefore, the work presented here is aimed to address this issue by testing cable joints in a manner similar to cable qualification tests and comparing the results to those of the cable alone.

The paper also presents a method to evaluate the relative impact of different joint designs on field cable segments.

Results showed that all joint designs exhibited a decrease in AC breakdown voltage with aging time, but at varying rates. Most joint designs aged faster than cable under the same qualification protocol. It is worth noting that the impact of poor workmanship on accessory life was not investigated, and thus the presented results represent best performance outcomes.

TEST PROGRAM

Samples

Five designs of joints were selected for the evaluation program to represent a diverse set of technologies typically used. The general sample descriptions are shown in Table 1. Six samples of each design were evaluated with no aging, 120 days of aging, and 180 days of aging (eighteen samples per design). Then samples were subjected to a high voltage time test (HVTT) to breakdown.

Table 1: Generic Joint Descriptions Tested

Joint Design	Joint Description	Conductor Connector Description
A	Cold Shrink (Silicone)	Compression
B	Heat Shrink (EPR)	Shear-bolt
C	Cold Shrink (EPR)	Shear-bolt
D§	Molded (EPDM)	Compression
E	Cold Shrink (Silicone)	Shear-bolt
§: Design D did not include jacket restoration		

The materials used to assemble the test samples (cable and joint kits) were purchased from suppliers of materials to electric utilities. Thus, these materials would have been installed and used on a utility system. Since the cable specified for the typical qualification/evaluation test program is 15 kV standard insulation wall thickness cable with a 1/0 AWG conductor, the cable and joints selected for this test program were standard 15 kV rated, 1/0 AWG conductor components.

The cable was a 15 kV rated cable with a 1/0 AWG water-blocked conductor, 175 mils of TRXLPE insulation, sixteen #14 AWG copper concentric neutrals, and a 45 mil LLDPE jacket. The joints were commonly used 15 kV rated joint designs purchased as a kit. Most, but not all, of the kits contained all required connectors. For those kits that did not include all needed connectors selected by the manufacturers of the joints, the connectors commonly used with those kits were purchased from the same supplier. Any jacket restoration materials supplied with the kits were installed on the joints. If a kit did not contain jacket restoration materials, none was added to the joint.

A total of ninety samples containing a single joint installed on jacketed cable were assembled for this work. Each test