

## Electrical and physical characterisation of a 138 kV XLPE insulated cable with 12 years service life

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### ABSTRACT

*In the present study a length of a 138 kV crosslinked polyethylene (XLPE) insulated cable that has been in service for 12 years has been characterised with electrical, visual and physical testing. A description of the service conditions will be given. The electrical characterisation includes electrical tests such as PD testing, AC voltage withstand test, dissipation factor and lightning impulse testing. The physical characterisation includes measurements of the degree of crosslinking, tensile properties, degree of crystallinity and thermo-oxidative ageing studies. The obtained results are discussed and compared with requirements in the ICEA S-108-720-2012 standard.*

### KEYWORDS

XLPE, service aged, cable

### INTRODUCTION

In 1996 Commonwealth Edison (ComEd) an Exelon company based in Chicago, Illinois, U.S.A. began an unprecedented cable replacement program. The goal for phase I was to replace 33 circuit miles of 138 kV Low Pressure Fluid Filled (LPFF) cables with crosslinked polyethylene (XLPE). At that time XLPE cable technology was new not only to ComEd but also to the U.S. The concern has always been what the life expectancy of XLPE cables would be when compared to the long life that fluid filled systems have provided for decades. Due to a third-party dig-in as shown in Fig. 1, ComEd had the chance to remove and test the section of damaged cable that had been operating successfully for the prior 12 years.



Fig. 1: Damaged 138 kV XLPE cable.

Together, ComEd, Prysmian and Borealis took the opportunity to subject the section of the removed cable to a series of tests to determine if the cable showed any signs of ageing. The circuit is about 7 miles in length. It was

energized in 2001 and has a current rating of 920 A SN and 1,060 SE. The cable operated at about 80% of its capacity for the first five years and at about 60% of capacity thereafter.

A series of electrical and physical tests were performed at the Prysmian and Borealis laboratories. The findings/results of the testing will be described throughout this paper.

### EXPERIMENTAL

While it was not practical to recover the entire length of cable, a sample of approximately 100 m was carefully salvaged for a characterisation of the electrical and physical properties after the 12 years of service life. The testing protocols for the electrical and physical testing were developed to identify if any changes in cable performance during its service life have taken place. The electrical test protocol includes partial discharge (PD) testing, alternating current (AC) voltage test, dissipation factor measurements, lightning impulse (LI) testing and volume resistivity (VR) measurements of the semiconductive shield layers. The physical test protocol includes a visual inspection, analysis of the degree of crosslinking, mechanical (tensile) properties and the degree of crystallinity as well as a thermo-oxidative ageing study.

### Test object and material description

Fig. 2 shows a picture of the cable construction of the investigated 138 kV XLPE insulated cable.



Fig. 2: A picture of the 138 kV XLPE insulated cable construction.

### Electrical characterisation

As the cable had been produced and originally tested for use in the United States, the electrical testing method and criteria used were based on ICEA S-108-720-2012. These tests included both routine production testing and