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Actual application of on-site diagnostic method for water treed XLPE cable by harmonics in AC loss current

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Abstract: Water trees form one of the major factors in degrading the insulation characteristics of XLPE cables underground for years on end. There has emerged a great demand for diagnostic methods of XLPE cables aged by water trees. The authors' study has found that water trees exhibit non-linear voltage-current characteristics, triggering off harmonics in AC loss current. These findings led us to design and fabricate an on-site diagnostic system, where we set up a scheme of diagnosing the XLPE cable degradation. A mass of actual 66kV XLPE cable lines were tried out, where some of the cables were dismounted and their performance characteristics were scrutinized.

Keywords: water trees, degradation diagnosis, harmonics

Résumé: Les arborescences électrochimiques sont les principaux facteurs de dégradation des caractéristiques des câbles PRC. Il en résulte une forte demande de méthode de diagnostic de câbles vieillis en présence d'eau. Nous avons ainsi évalué les caractéristiques des arborescences d'eau. Nous avons constaté la non-linéarité des paramètres de tension-intensité, qui donnent naissance à des harmoniques de courant de pertes alternatif. Partant de ces constatations nous avons conçu un système de diagnostic de terrain, et établi la logique de détermination des dommages observés. De nombreuses lignes de transport à cables PRC de 66kV en service ont servi aux mesures. Après l'essai, certains cables ont été mis hors service et nous avons mesuré leurs caractéristiques.

Mots clés: arborescences d'eau, diagnostic, harmoniques

1. Introduction

The water tree deterioration forms one major category of the long-term deterioration of XLPE cables. A water tree arise from a micro void or a speck of impurity as involved in the insulation of an XLPE cable or a protrusion in a semi-conductive layer of an XLPE cable, where electric fields are focused and wet is condensed. Water trees grow in a radial pattern, with the result that the cable insulation will be undermined, fraction, ending up with a dielectric breakdown in the insulation. Such dielectric breakdown incidents, not only derange the electric power utilities, but also make great demands on the workforce and costs for searching out failed points over the power supply systems, followed by replacing the failed cables with sound ones.

Against the background, various methods of cable diagnosis have been under study, with a design to figure out guidelines for timely replacing live cables in anticipation of failure. The water tree degradation augments the current component in phase with the applied voltage of all the current components in the cable insulation. Our study brought out an interesting action. With the loss current under observation, its waveform was deformed by the harmonic components over time, in step with the growth of water trees. Those harmonics involved more information about water trees.

We applied model samples and cable samples to study out the characteristics of water trees, along with computer simulation. As a result, we confirmed that harmonic components in the loss current resulted from the water tree degradation. Taking those findings into consideration, we made an on-site diagnostic system, and on trial measured a great number of live 66kV cable lines, in proof of the adequacy of its workings. This diagnostic method using harmonies in AC loss current has been in practice, since April 2002.