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Aging of electrical underground distribution cable joints

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Résumé

Les jonctions de câble sont en général les points faibles dans un réseau souterrain de distribution. Leur fiabilité est affectée par des charges de courant cycliques ainsi que par la conception des jonctions prémoulées en caoutchouc. Nous avons étudié la vie résiduelle de jonctions de câble ayant des défauts au niveau de leur contact électrique. Nous avons effectué un suivi des températures tant à l'intérieur qu'à l'extérieur de ces jonctions jusqu'à leur défaillance. Nous avons développé un logiciel pouvant diagnostiquer l'état de santé des jonctions.

L'effet de cyclages thermiques sur le comportement de l'interface câble-jonction a aussi été étudié. La pression interfaciale est l'un des paramètres influençant le plus la performance des jonctions. L'objet d'essai consiste en une jonction moyenne tension installée sur un câble dans lequel une cellule de charge a été incluse. La force exercée par la jonction sur le câble a été mesurée en continu lors des essais.

Abstract

Electrical joints can be weak points in an underground distribution supply system. Cyclic loads and the fact that electrical contacts are inside premolded rubber cable joints both greatly affect their reliability. We have studied the life expectancy of underground cable joints with defective electrical contacts. Temperature was monitored at several points both inside and outside the cable joints. Experiments were conducted until electrical breakdown or loss of electrical contact. A computer software has been made to diagnose the defective cable joints.

The effect of thermal cycling on the complex behavior of the cable-joint interface has also been studied. The interfacial pressure is known to be one of the key factors in the performance of a cable-joint assembly. The test object consists in a medium voltage cable joint installed on a cable in which a load cell has been imbedded. The force exerted by the joint on the cable was thus monitored continuously during the experiments.

Introduction

A great deal of power failures occur at cable joints in Hydro-Québec underground conduit network. Many failures are due to the degradation of the electrical connection inside these joints and the corresponding degradation of their electrical insulation. Hydro-Québec started a few years ago an infrared thermography program for underground cable joints. This program has been implanted to help doing a predictive maintenance and withdraw the defective joints before failure. This program has very strict withdrawal criteria. Those criteria have until now no real scientific and experimental basis. Moreover, there are serious discussions as to whether a punctual measurement of the temperature of a cable joint can really represent the health state of its electrical connection. Also, for how long a temperature measurement is valid and therefore what should be the best frequency of temperature measurement ?

A computer program based on sound cable joint withdrawal criteria has been developed. It diagnoses defective cable joints by detecting signs of electrical connection degradation before their failure.

Besides overheating of the internal connectors, one of the most common failure mode of premolded cable joints is attributable to the occurrence of dielectric breakdown at the interfaces [1]. Many parameters are known to affect the dielectric strength of a cable-joint interface : surface roughness, the presence of dielectric grease, the length of the interface to name a few. Nevertheless, the interfacial pressure is known to be a key factor in the cable-joint interfacial breakdown strength. The dielectric strength is proportional to the interfacial pressure until a threshold pressure. In fact there is a direct link between both parameters [2]. The effect of thermal cycling on the interfacial pressure has been investigated for two types of straight premolded 25kV underground cable joints from two manufacturers : A and B.