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On-site AC test after installation for long HV and EHV cables

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Résumé

Le but des tests effectués après l'installation de nouveaux circuits câblés est de vérifier leur " aptitude à l'emploi ". Les tests sont concentrés sur les accessoires. Le câble en soi a déjà été testé en usine. Les tests sur site de circuits câblés qui sont en service depuis longtemps sont effectués dans le but de vérifier l'état du circuit, câble compris. Ces tests doivent être efficaces sans toutefois endommager le circuit testé. Les tests de tension de C.C. se sont avérés inefficaces et dangereux pour les câbles XLPE. Des tests de tension de C.A. effectués sur site sont actuellement disponibles grâce à l'existence d'équipements de résonnance transportables, montés en série, qui peuvent également s'utiliser pour les câbles à très haute tension. Les origines des tests de C.A., la configuration des circuits et des expériences seront abordées.

Abstract

Tests after installation of new cable systems have the purpose to check the "fitness for use". The test focuses on the accessories. The cable itself was already tested at the factory. On-site tests on service aged cable circuit have the purpose to check the condition of the circuit, including the cable. On-site tests should be effective but not harmful to the circuit under test. DC voltage tests have been shown to be ineffective and harmful for XLPE cables. AC withstand voltage tests on-site has become available because of the existence nowadays of transportable series resonant equipment, also for extra high voltages. Background of ac testing, system set-up and experiences will be discussed.

Introduction and background

The test after installation of long lengths of medium voltage, high voltage and extra high voltage cables and their accessories serve as a tool to assist network owners to prevent unexpected outages. Less unexpected outages mean less costs and no loss of reputation (for the network owner and for the manufacturer). Purpose of on-site tests after installation is to detect defects in assembled accessories in new cable circuits and to check the reliability of accessories and of cables in service aged circuits. On-site tests should be effective but not cause any damage to the circuit under test.

Quality assurance is very important both during production as well installation. However, quality assurance will not assure detection of all defects arising during installation and during assembly of the accessories [1, 2]. Such defects have to be detected by tests and measurements. However one country relies completely on quality control on site, in combination with an intensive pre-qualification and training programme [20].

DC voltage tests on oil pressure paper cable systems are generally accepted. For polymeric cables the situation is quite different [3]. "DC tests on XLPE cable systems have been shown to be very ineffective, far from representative and even dangerous for the circuit under test. AC voltage withstand testing at levels of 2Uo to 3Uo give the most reliable results. The alternative using the system voltage Uo during one week apparently is still too weak and often cannot detect defects which have been found by short time ac voltage tests at higher voltage levels". This is the conclusion of a Cigré 1990 report [4]. This conclusion is still valid [5, 6].

The effectiveness of the ac test method has been demonstrated by field tests and research [1, 10, 11]. Test requirements are determined by the maximum allowable field stress. The test duration is coupled to the maximum allowable test voltage. The effectiveness of the test can be improved by including partial discharge measurement whenever possible [1, 11, 12, 13, 14].

Nowadays tests after installation are offered based on the series resonant principle, for MV, HV and EHV circuits. MV circuits can be tested up to 55 kV test voltage. HV circuits with a rated voltage up to 220 kV and with circuit lengths up to 25 km, can be tested with ac voltage up to 254 kV. Systems with a higher rated voltage can be tested up to 6,5 km length (XLPE/GIL) up to 504 kV. Because of the fact that these systems are based on the series resonant principle, either the frequency or the inductance