TESTING AND MEASUREMENT METHODS FOR CONDITION-BASED MAINTENANCE OF MEDIUM VOLTAGE NETWORKS

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ABSTRACT

Cable and sheath testing, loss factor measurement and partial discharge measurement deliver measurement values that provide different statements on the proper functioning and condition of a medium voltage cable. The article presents test and measurement processes and describes what results and information are useful during condition-based maintenance. In addition, it explains why diagnostic procedures can increase the profitability and availability even in new cables.

KEYWORDS

Maintenance, distributed network, medium voltage, XLPE cable, paper insulated mass-impregnated cable, joint, sheath testing, cable testing, loss factor measurement, partial discharge measurement, aging, quality check.

INTRODUCTION

Distributed network operators are in a dilemma: From the technical viewpoint and complying with the customers' wishes, they have succeeded in providing high network availability, while on the other hand they have to achieve network expansion and maintenance at low cost. Therefore, more operators are emphasising on condition-based maintenance of their medium voltage network. However, this strategy requires in-depth knowledge of the cable age. Equipment data such as manufacturer, type and age or experience values such as the failure rate and maintenance history can already deliver reference points. In fact the actual "technical age" of a cable is influenced by other factors. Diagnostic measurements such as the loss factor and partial discharge measurement allow you to analyse the age of a cable line with more certainty. Because of the progress in device technology today, both measurements can be carried out at low cost and in less time, which in turn has made cable diagnostics more important. Besides, experience from different countries in XLPE and paper insulated mass-impregnated cables and in various cable types enables reliable interpretation of the measurement results and produces additional fundamentals for maintenance decisions.

Diagnostic processes are not only used during evaluation of existing cable lines, but also new sections, as they allow us to assess the quality of the cable laying - in particular joint assembly - and to prevent subsequent failure or damage due to the early detection of poor assembly.

CABLE TESTS

Cable testing

Cable testing is done according to the VDE (Verband der Elektrotechnik Elektronik Informationstechnik e.V.) on XLPE cables with $3xU_0$ (VLF) for 1 h. This test after laying a new cable (Fig. 1) or restoration of a cable line conveys if the cable endures the test voltage at the time of testing. It is a pure function test and a positive result indicates no damage in the old cables.

Fig. 1: After laying, a cable is tested for problem-free operation

Sheath testing

Sheath testing is used to test the function and operational safety of the outer, electrically isolating sheath of a cable. It is carried out in the form of the withstand voltage test - the sheath is tested for breakdown by applying a direct voltage - or as insulation measurement using direct voltage stimulation (Fig. 2). Here, the conductor is grounded and the voltage excitation and leakage current is recorded at the end of several minutes of measurement. The apparent insulation resistance determined in this way shows whether the insulation effect is reduced, e.g. due to moisture. On suspicion of damage, a sheath fault location is used to locate the fault.
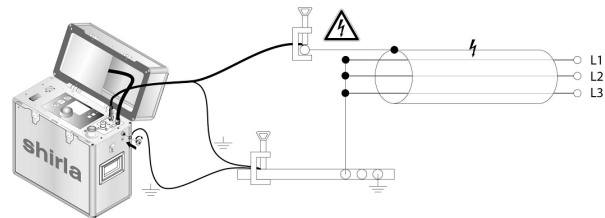

Fig. 2: Sheath testing is used for testing the function and safety of the outer cable sleeve