Testing the effectiveness of tests after installation on power cable systems

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ABSTRACT

There are various techniques for withstand tests during commissioning. While some have a good reputation, a literature survey has revealed that there is very little objective data on the effectiveness of these techniques – particularly the newer ones. Where effectiveness has been assessed, the investigation was either not independent or was based on unrealistically large fault defects. A 1-2 year project to objectively assess the various commissioning test techniques has been proposed, in which tests will be performed on a variety of realistic cable defects. The results of the project could also form input for new standards for commissioning tests.

KEYWORDS

Power Cable, Commissioning Tests, Tests After Installation, Series Resonance (SR), VLF, DAC

INTRODUCTION

Due to the increasing demand for power, the expansion of geographical need for power and the replacement of old circuits, the amount of new cable installations is increasing rapidly around the world. To test the quality of the insulation system after installation, the withstand tests are the tests described in the standards that should detect imperfections in the insulation system introduced during installation (and transportation). Various technologies exist (50Hz, Series-Resonance, VLF, Damped AC, DC, etc.), which can additionally be combined with detection of partial discharges (PDs) and tan delta measurement. Experience with one technology is broader and more excepted than with the other, but the actual effectiveness of these techniques is not really known, especially of the newer techniques. These newer techniques are trying to gain market share, and could be interesting from an economical, practical or technology point of view, but not without knowledge of the actual and real effectiveness of these techniques compared to the others.

This paper presents the results of a literature study, together with a proposed 1-2 year(s) project that will investigate the effectiveness of the various mentioned techniques in an independent way. To obtain unquestionable results, independency is obtained by involving network owners, cable manufactures, accessory manufactures and DNV GL (the part that was formerly known as KEMA).

A Cigré Working Group B1-38: “After Laying Tests on AC and DC Cable Systems with new Technologies” is also investigating this subject. The authors have cooperation with this working group to avoid double work and exchange knowledge and insights. The proposed project related to this paper has, however, a more experimental focus to actually test and prove effectiveness. The planned investigation involves a setup with a sufficiently large amount of cable systems (for reliable results) on which artificial, but realistic, defects will be made and on which tests will be repeated multiple times to obtain statistically proven results.

The paper and project focusses on power cable systems with extruded insulation (e.g. XLPE), as that is the most common insulation material for newly installed power cable systems.

THE NEED FOR COMMISSIONING TESTING

Failures of power cable systems have an important impact of the overall network reliability figures of many power systems. Failures can never completely be avoided. This is why, besides other quality assurance and control programs, extensive test programs have been developed and included in many standards. The manufacturer's abilities and overall resulting production process quality is verified with pre-qualification tests. During the design phase of cable systems, design related tests are commenced, finalized by showing the suitability of the various designs with type test programs, [6]. The continuous quality of the manufacturing process itself and its raw materials is checked with the routine and sample tests.

However, it has become clear that the largest part of power cable failures are related to degradation mechanisms that have been initiated due to imperfections during installation of the accessories, see e.g. [5]. This relates to failures that happen immediately after installation as well as to failures that only happen after several or many (sometimes >10) years of operation. This is explained by:

- network owners experience (international)
- failure statistics
- failure investigations (DNV GL, network owners and manufacturers)
- inherent circumstances during installation.

The reasons for this are closely related to the fact that accessories need to be installed in the field. The insulation system is only completely finished after the installation of the accessories, as the insulation system consists of partly the accessory parts and partly the cable insulation.