Effectiveness of tests after installation on power cable systems

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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.

Despite various test programs in combination with other quality assurance and control programs, failures can never completely be avoided. From failure investigations, together with statistics and experiences from network owners, it has become clear that the largest part of these failures are related to degradation mechanisms that have been initiated due to imperfections during installation of the accessories. 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. 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.

Standards describe many tests during cable and accessory design and production (pre-qualification, type tests, routine tests, sample tests), but the final installation quality (most crucial, see above) can only be tested after installation with the “tests after installation”. These tests are therefore a crucial element in the overall quality control and are also often the formal point of transfer of responsibility from the contractor (installer, supplier, manufacturer) towards the network owner.

To test the quality of the insulation system after installation, the withstand tests are the tests described in the standards that should detect imperfections introduced during installations (and transportation). Various technologies exist (50 Hz, Series-Resonance, VLF, Damped AC, Cosinus Rectangular, 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 economical, practical or technology point of view, but not without knowledge of the actual and real effectiveness of these techniques compared to the others. Literature studies have confirmed that the effectiveness of also the more established techniques is mainly assumed and only shown with some single field measurement examples here and there. Larger scale laboratory experiments are almost exclusively done on cable systems with artificial, unrealistically severe, defects.

This paper presents this literature study and its results, together with a planned 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. Furthermore, the planned investigation involves a setup with a large amount of cable systems on which artificial, but realistic, defects will be made and on which tests will be repeated multiple times to obtain statistically proven results