TECHNICAL BULLETIN
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Electrical Testing of HV XLPE Cables

A number of different Voltage tests may be considered for HV cables. Some have their origins in MV or Fluid Filled cables. This document aims to highlight some of the risks and limitations of the various options, specifically when applied to HV cables.

The main contents of the technical bulletin follow….

To offer the best test regime the ideal test equipment consists of an over-voltage (near) power frequency test supply with PD and tan delta capability. HVAC with PD is necessary for commissioning tests. HVAC with PD and tan delta is ideal for maintenance tests (after repair). Other (cheaper) test options are technically inferior. While some of the techniques have been used on MV cables with success, the impact at higher electrical stresses is not yet proven.

Cables and accessories are designed for 50(60)Hz operation. The stresses experienced at DC or VLF are quite different from those at 50Hz [1]. The PD inception is lower than for VLF [1].

1. DC

DC testing is accepted as being inappropriate [2] as it is not able to detect major defects in workmanship as it does not stress the screen cut. It also excessively stresses (much higher than under AC) the HV end of a termination or joint. Further, DC converts water trees into electrical trees. The space charge forming around the ends of the tree branches during testing provides “shielding” during the test. Subsequently during the application of AC (switch on power) the superimposed DC on the AC stress can lead to premature failure.

2. VLF (Very Low Frequency - 0.1Hz)

This is a convenient power supply due to its size and relatively low cost. However, it does not find “common” defects (screen cuts; leftover semicon; incomplete heat shrinking; missing yellow mastic; bad semicon peeling) [6]. Such cables are likely to fail after several years of operation under normal load [7]. VLF degrades aged cables quite dramatically [2]. It appears to accelerate aged cables to a point of failure. Tree growth under VLF is faster than under AC [2][4]. The principle is that if you weed out all weak cables you are left with a reliable network. At the end of the withstand test, the cable may be less reliable and have a shorter life expectancy. It is not recommended to apply VLF to severely aged XLPE cable systems [2][4][5].

3. DAC (Damped AC)

This is an oscillation which is close to power frequency and ideally initiates PD in the first few cycles. Unfortunately it is not recognised as a Voltage withstand test [NRS 077], so you have difficulty convincing a customer each time you offer it. It is not considered a withstand test. PD which often takes some time to form may not be detected using this method

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4. Near Power Frequency (20 - 300Hz)

50Hz power supplies are rather bulky and hence expensive. The input power requirement at LV is excessive and such power is not readily available. The option of resonant systems overcomes this matter. Keeping the frequency to 50Hz requires a variable inductor which (due to moving parts) does not travel well. The fixed inductance alternative allows test frequencies in the range of 20 - 300Hz.

Variable Frequency (20 - 300Hz) AC is accepted [IEC 60840, 62067] at HV and EHV as being close enough to 50(60) Hz to ensure that all stresses within the cable system are appropriately tested. CBI-electric: African cables have been testing with this variable frequency since 2014.

The PD option (at power frequency) ensures that poor workmanship issues are detected during the commissioning test. Since PD inception is lower and the tree growth rate is slower (less than VLF), aged cables are not adversely deteriorated during the maintenance testing.

The Tan delta option is recommended for aged PILC cables where PD is not as effective in determining bulk performance of the cable system

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