

Chapter 14

Partial Discharges Measurements for Power Cable Insulation System

ABSTRACT

On-site PD measurements on high voltage cables have to concentrate on the cable accessories because there is a remaining risk for assembling faults on site. PD sensors with an appropriate coupling behavior to accessory-internal PD give sensitivities of a few pC or even better. Unfortunately, two main reasons prevent the general use of PD sensors in cable accessories. First of all, the costs for PD sensors have to be balanced with the costs of the accessories, importance of the cable link, consequential costs for outage etc. This is the reason why PD sensors were mainly used EHV cable systems. The second reason is limited accessibility: the PD sensor cable at the accessory has to be connected to a PD detection unit. Accessibility is much more difficult for direct buried cable systems than for cable terminations and tunnel-laid cable systems: the sensor cable must pass the ground and the end up in a box on the surface to provide access. This solution causes additional costs and new problems like sealing the sensor cable against humidity, capability to withstand sheath testing etc. By looking for alternative access to PD signals from cable joints of long cable systems, a very simple solution proved suitable: detecting PD at cross-bonding links. To investigate the high frequency propagation of PD pulses in cross-bonding links, computer simulations and laboratory measurements were done.

14.1 ON-SITE PARTIAL DISCHARGE MEASUREMENTS

On-site PD measurements at cross-bonding links of a 220 kV-XLPE cable systems showed unexpected high sensitivity. Using HF transformers for PD coupling and appropriate signal processing led to PD sensitivities of few pC or even better. The use of cross-bonding links for on-site PD measurements is suited for direct buried systems, has no impact on the cable system, needs no PD sensors in the cable joints, offers a low cost solution and so opens a wider range of applications in cable testing.

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The investigators studied the different methods about on-site partial discharge measurements and reported on the experience have been gained in on-site cable PD measurements in the latest years. Good results are obtained using high frequency current transformer sensors (HFCT) at the cross-bonding links, and it is very important to carry out on-site performance check for the PD measuring system connected to the local cable system to be tested.

Awad, M., Tahoun, F., EL-Faraskoury, A., & Gouda, O. E. (2010). showed that the experiences from commissioning test of 220 kV – XLPE cables with frequency tuned resonant test system have been gained in on-site testing, with all routine tests on cables before laying. Also using the HFCT sensor inside cross-bonding links gave good results, and on-site withstand voltage testing combined with sensitive partial discharge measurements reduced the risk from the service. Also after repair the joint reassembling was done exactly in the same place. The experiences also showed that the test voltage with U_0 for 24 h is not feasible for incidence of failure after the test could be occurred.

14.2 PARTIAL DISCHARGE MEASUREMENT LABORATORY

Partial discharge (PD) Laboratory has designed to house a shielded enclosure to prevent external electromagnetic interference which affects the partial discharge, laminated with zinc coated steel sheets.

The shielded hall has an inner dimensions 30.75 m length, 26.5 m width and 15 m height, and it measurements. The walls, floor and ceiling consist of modular shielded panels made of particle boards has a main door double springing leaf 5 m width, 6 m height, it can easily be operated electrically by remote control, and allowing transportation of heavy cable reels and large power transformers. In addition, four personal doors which give access to the test area and are integrated into safety interlock system for the high voltage source.

The shielded hall is equipped with specially designed system for ventilation and lighting to prevent any electromagnetic interference. As a result the background noise level is less than 2 pC, and the control room consists of similar panels as the shielded enclosure with glass windows for direct view to the test area and it includes:

- Manual and automatically tuning for resonance condition.
- Voltage measurement in true RMS or $U/\sqrt{2}$.
- Partial discharge detector for PD measurements according IEC 60270 (2000).
- Schering bridge for capacitance and $\tan \delta$ measurements.
- External calibration unit.
- Security device.

The circuits used in the Laboratory tests inside shielded enclosure and control room are shown in (Figures 1 and 2).

The measuring equipment includes:

- Coupling capacitor with high voltage filter inductance 400 kV, 7 nF, 70 A consists of two parts, high voltage primary part with top electrode and secondary part for voltage and PD measurement.
- Cable test terminations 400 kV with maximum outer semiconductor layer diameter 120 mm.
- Standard capacitor 400 kV- 50 PF for measuring capacitance and dissipation factor.

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