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Cable System accessories reliability and QA

Generally speaking, cable systems are not affected by weather conditions. Due to their intrinsic property they do not suffer from high wind or heavy rain/snow. Extreme weather conditions may still affect their ability to meet the limit of their design. For example an extreme dry season/high temperature seasons would have a detrimental effect on the ability of the cable system to exchange the heat generate by the joule effect reducing the cable system rating. A few elements of the cable system may be exposed to the weather, i.e. External Cable Sealing Ends, and these would be affected by heavy rain, high wind or polluted air conditions. Therefore, it is fundamental the cable system design account for expected regional extreme weather conditions. Also, in consideration of the climate change process unexpected extreme weather condition should be accounted considering the expected lifetime of the cable system.

A secondary effect of weather conditions that would affect cable system is the abundance of water around Joints and Terminations. Due to quality issues with the jointing process, if the joint is immersed in water, it is probable the water capillary trave toward the centre of the joint causing a phase to earth fault. According to CIGRE TB 379 for XLPE insulated cable systems joint and termination have a failure rate of 0.05 fault per year every 100 components while the cable itself have 0.133 fault per year every 100km. In terms of a real cable system 50km long, 400kV, with a JB every 700m the actual expected Joint / termination failure probability is 0.103 fault/year while the cable expected failure probability is 0.066 fault/year.

A joint/termination fault may require several weeks to be rectified. Sometime the required material to be replaced (joint) is not available "on the shelf" and it needs to be included in the manufacturer production schedule. Quite often Jointers resource are not available neither and it may required several weeks to have the team back on site to replace the faulty joint. This led the cable circuit to be unavailable (on outage) for several weeks and this will generate monetary losses for the TSO in addition to the cost associated with the repairing works, very often the Operational monetary losses are far greater than the repairing works costs.

EirGrid experience on 110kV and 220kV cable systems built in the last 15 years shows that jointer workmanship is the main source for cable system faults.

In consideration of the repairing cost and operational costs linked to a cable accessory fault we increased the Project Quality Assurance (QA) we perform on cable system accessory material/construction-installation and testing.

The aim of the additional checks we perform during construction, commissioning and energisation is to reduce the probability of joint/termination failure.

EirGrid QA system for cable system accessories includes:

- Jointers to be certified by accessories manufacturers
- Jointer CV reviewed and accepted by TSO, minimum 5 years proven service
- Cable to be clamped for jointing
- Jointers to fill a QA report for every joint
- 10kV DC test on every joint with results recorded

As part of our commissioning tests we introduced an offline High Voltage Partial Discharge test.

This is a quite expensive test for Transmission cables and also complicated to arrange due to its testing procedure and circuit configuration.

The HV PD test produced very good results in several projects finding faulty joints/terminations pre-energisation. Without this test these faulty joints could have generated catastrophic failures during energisation or post energisation producing substantial damages to the cable system and risk of fault propagation for the Transmission System.

Depending on the specific issue with a cable accessory a fault may occur as an HV is applied to the accessory or develop later depending on the degree of the issue. Therefore, it is important to monitor the status of the cable system and its accessories for its entire life.

EirGrid introduced an “on-line” HV PD test on the cable system to be completed during the first energisation and every 3 years as part of the cable regular maintenance programme. During this test the HV PD test is done using the system voltage and the PD activity is monitored and recorded for 24hrs. Results for every cable system are filed and used as base line for the following on-line PD testing. An increased PD activity observed in subsequential tests are considered as an alarm and raise concerns, the cable system in question is tested more often and if the PD activity pattern don't change a planned joint replacement is scheduled, thus avoiding an unexpected catastrophic failure.