

## REE's research and development projects related to predictive maintenance based on monitoring of critical parameters in High Voltage underground cables.

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In order to increase the useful life of underground circuits, it is very important to identify (and monitor, if possible) the critical elements and parameters of the installations, so their condition can be controlled.

Two different projects have been developed, within the REE Research and Development policy, in order to achieve the target of online monitoring two different critical parameters related to underground lines: partial discharges and sheath currents.

The project of online monitoring of partial discharges (PD) was the result of an association between REE and DIAEL (High Voltage Electrical Insulation Diagnosis). This system has been installed in an underground cable system of the electricity transmission network in the metropolitan area of Madrid.

This pilot R&D initiative will allow us to know the insulation behavior of underground cable systems under different network conditions and external factors that could affect their integrity.

The monitoring system employs PD measuring units placed in the cable system accessories (terminations and joints). Each PD measuring unit has HFCT sensors installed around the ground connection cables of the accessories and communicates with the other units and with a control and analysis unit by fiber optic links. The data acquisition is synchronized and sent to control and analysis unit for analysis.

The system includes a software tool to discriminate between PD pulses and noise signals, to determine the PD measurement sensitivity, to identify and locate existing PD sources and to analyze the correlation between each PD source and its associated defect.

The project of online monitoring of sheath currents (SC) was the result of an association between REE and Prysmian Cables and Systems. The underground line chosen for the pilot project is located near Madrid. It is composed of two parallel circuits with different bonding connections of the cable sheaths in the joint bays (cross-bonding and single point) and in the terminations (one end has GIS terminations located in a substation and the other one has outdoor terminations at a transition tower).

The monitoring system is composed of a distributed network of devices called nodes, which communicate among them and with a local modem via radio, sending the data continuously (SC values and other information) to a distant computer. Different autonomous power generation systems have been tested (i.e. solar cells and induction current transformers) to supply the local modems.

Finally, data are stored and managed in a central server that can be accessed online by a web interface with several management features. Real-time alarms can be activated when the measured parameters exceed the established thresholds.

The added value of these projects consists in making possible to assess the current condition of the installation by means of continuous online monitoring. Through proper analysis of these values it is possible to design a behavior model of any given circuit with specific features. As a result, maintenance design plans are more adequately adapted to reality.