

## CONTINUOUS PD MONITORING OF HV XLPE CABLE LINES

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### ABSTRACT

The components to assess and monitor the condition of the insulation of joints and terminations of XLPE HV cable lines are described. The particular attention is put to review of technologies of PD acquisition unit and inductive power supply solution. In order to identify PD effects, an automated system which combines probabilistic pattern recognition approach and deterministic knowledge-based analysis approach is proposed. The PD data processing, PD defect identification and risk assessment are implemented in a modular monitoring software system. It allows reliable long term storage of monitoring data and provides access via web interface. The extension of the system to verify the status of Sheath Voltage Limiters is also presented. The separate chapters are dedicated to the procedure of site acceptance of monitoring system and to the system maintenance strategy.

### KEYWORDS

HV XLPE cable, cable accessory, monitoring, partial discharges, pattern classification

### ROLE OF MONITORING SYSTEM PROVIDER

A major part of dielectric failures in HV XLPE cable lines can be assigned to the defects in the electrical insulation system of joints and terminations. These defects develop over cable line lifetime and in order to detect such changes at an early stage, detailed information on the actual insulation condition is necessary. This information can be derived by monitoring certain diagnostic parameters during the operation of the equipment. Consequently, continuous monitoring is an essential tool for proper maintenance management to guarantee the high level of asset reliability [1,2,3].

The implementation of the system starts with the understanding of customer problems and needs. The tailor made design of the system is manufactured, routine tested in factory and installed in site. During the commissioning of the system, its performance check is performed and the sensitivity of the system to detect the critical defects is established. The customer is trained to take the advantage of the system and to be able to retrieve the monitoring data. The results of the measurements undertake the automated evaluation in the

system and only in most difficult cases the help of human expert is necessary. The monitoring system is generally maintenance free but some activities like e.g. functionality checks and re-calibration has to be planned.

The monitoring system should be a piece of mind while matching the actual needs of asset manager. It is not only a set of excellent components but also the knowledge provider in data evaluation and a long term partner supporting any utilities decision over the complete asset live cycle (Figure 1).

### MONITORING CONCEPT

The advanced concept of continuous monitoring system is presented in Figure 2. The signals from different sensors (partial discharge, distributed temperature, oil pressure in terminations) are acquired in a multi-channel data acquisition unit.

In case of PD signal, the acquisition unit performs advanced pre-processing of the raw data. The disturbances are removed and main characteristics of the PD signal are determined. The output of the data pre-processing is transferred to a server that enables long-term data storage. Advanced intelligent pre-processing reduces the amount of data to adequate levels for transmission over a communication network. An expert system performs intelligent data post-processing to get useful information about the insulation condition.

The type of the PD defect is identified by means of automated pattern classification system. The main key to perform automatic diagnosis of the state of insulation is the exact separation of different PD sources and effective suppression of external noise. To achieve this, synchronous multi-channel (3PARD) and multi-spectral (3CFRD) evaluation techniques are applied.

3PARD was originally developed for evaluation of three-phase PD measurements because its application requires three independent PD observers like e.g. inductive sensors connected to the cross bonded box. The 3PARD (star diagram) visualizes the relation among amplitudes of a single PD pulse in one phase and its crosstalk generated signals in the other two phases.

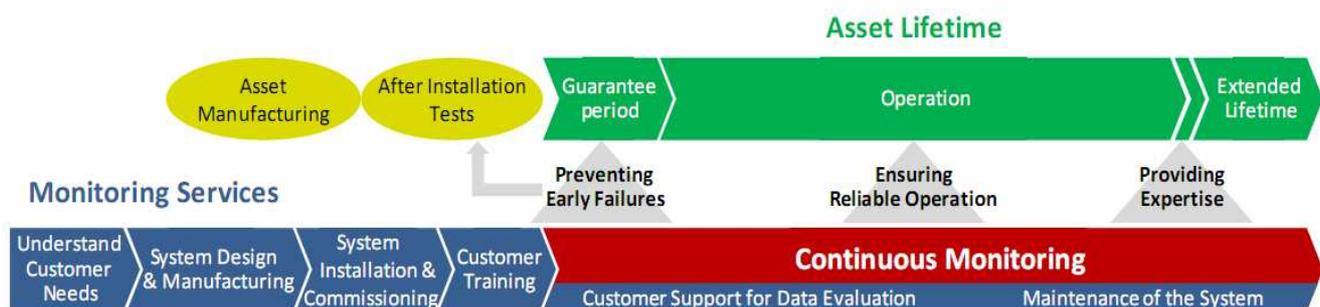


Fig. 1: Role of monitoring service provider