Off-line diagnostic measurements: Type of measurement versus insulation weakness targeted.

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In Europe off-line MV cable diagnostic methods have been widely used by utilities in order to help underground network asset management to take the best possible replacement time decisions. Even if on-line assessments are targeted for future applications, off-line methods are actually very useful and sometimes preferable to identify certain defects.

EDF R&D, SINTEF and IREQ are laboratories that have for a long time been involved in evaluating diagnostic methods and editing guidelines for diagnostic methods and criteria to be used by national utilities networks, according to their specific needs.

This paper intends to summarize some of the work performed by the three laboratories in order to present a convergent approach of the use of available diagnostic tools. The aim of this paper is to give an objective and clearer idea of what could be achieved with the different measurement methods used today in terms of identifying cable systems defects limiting the service life. The two main aspects of diagnostic applications, i.e. technical and economical, will be addressed. The technical challenge is to define which methods are best suited to reveal specific types of weakness targeted, e.g. for cases where those are known or “expected” (e.g. from service experience).

In a first section, ability of dielectric measurements will be discussed. Frequency domain spectroscopy constitutes probably the more accurate dielectric measurement method; however it may not be very suitable for on-site testing because of the amount of power required for higher frequencies and of the long duration of measurements at very low frequency (VLF). Nevertheless, the method is useful for characterization of cable insulation ageing in the laboratory. Time domain spectroscopy (TDS) could also be considered. Even if the method has been shown to be less adapted to identify non-linear behaviour, TDS tends to be more suitable for on-site tests, since it does not require any significant amount of power supply, while it allows obtaining dielectric loss values at VLF within a reasonable time frame. Ability of alternative time domain dielectric measurement methods will also be discussed (e.g. voltage recovery, current discharge). Actually VLF tan delta measurements are the most popular ones and they are mainly used to identify non-linear behaviour versus voltage and typically water penetration related problems.

The second measurement category could be defined by "transient" measurement based on detection of pulse propagation along the cable. The most popular one is partial discharge (PD) measurement. Relevance of signal treatment and operator interface for PD results pertinence will be underlined and the effect of the type of source used will be reviewed. Typically systems offering the most important control of measurement parameters and the best accuracy need skills and amount of time which is not often available for on-site measurements. So system providers are proposing various degrees of automation of knowledge rules and we will see that if automation could be time saving, impact on accuracy must be carefully considered. In this range of technique, impedance change analyses with TDR are also considered.

Thus for the panel of topic addressed, main possible uses will be addressed and examples from each laboratory will be described. Perspectives for use of new methods will then be discussed in terms of their potential ability to focus specifics weaknesses and to better manage on-site campaign efficiency. The need of previous accurate laboratory characterization to establish evaluation criteria will also be discussed and underlined.

Key words

Diagnostic, Medium voltage cables, Dielectric measurement, Tan delta, Partial Discharge, Off-line