JICABLE'07
Rapporteur's Session Report

B.6 SESSION : AGEING AND DIAGNOSTICS

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Cable diagnostic is the most relevant issue for maintenance work. This session is of paramount importance for the reliability of the cable power network. Much experience has been acquired in the last decades but progress is still to be done since cables are reaching or exceeding their predicted time life.

Paper 6.3 presents advanced results on Time Domain Spectroscopy for diagnostic of medium voltage XLPE polyethylene cable, specially aimed to water trees. The most important contribution of the work is to analyze measurements to identify different contributions to polarization or depolarization currents, in particular, contributions from aged joints. Many cables have been tested in the field with their accessories and under laboratory conditions without accessories. Those measurements showed clearly the contribution of joints in form of a difference between polarisation and depolarisation currents. Other criteria such as comparison between phases of the same line and linearity with applied voltage give more information about link degradation.

In the same field, paper B 6.5 describes an improvement of the residual charge measurement technique by simplifying the voltage application system. Based on the residual charge as an index of water tree development, the work presented is aimed to validate a new pre-stressing voltage before residual charge measurement. Usually, residual charge measurement starts with a DC pre-stress voltage of nearly -30kV DC but very often only -10kV DC can be reached and results are less accurate. Using a 10kV AC voltage stopped at 0kV after a negative half cycle gives even better measurements than DC voltage. The authors claim the validity of the method and the advantages of the simplification for on-site testing.

Some technical problems in critical applications require a long term research work, like paper B.6.2 presenting results from 12 years aged cables under nuclear power plant conditions. The work is aimed to check a semi empirical model presented during Jicable 1995 and to test the mechanical behaviour and chemical degradation of the insulation (EPR) and the sheath (Hypalon). Cables have been aged in the reactor building of Bugey 4 during 12 years, some of them have been thermally pre-aged. The analysis yields to very good news and less good news. The very good news is that the life expectancy of cables in nuclear environment is upper than the life expectancy of power plants. The less good news is that the semi-empirical ageing model (elongation at break vs time) appears to be pessimistic and has to be improved; accordingly a new kinetic model is being developed.

In that sense, paper C.7.1.15 proposes a molecular interpretation of the first steps of ageing as a consequence of progressive C-C bond breaking due to mechanical deformation of nanovoids (or free volume). This approach suggests some relationship between sample volume and ageing. That mechanism can explain the validity of accelerated ageing based on high frequency test voltages.

Finally, it must be kept in mind that diagnostic is mainly a tool for utilities to plan maintenance and avoid network failures. Paper B.6.6 proposes three approaches for validating diagnostic based policies to plan maintenance and avoid network failures :

1. Direct Comparison, comparing results from diagnostic techniques as "good or bad" to field outcome, is said to be very onerous and to produce conservative results.
2. Performance Ranking, looking for correlations between performance rank (mainly from failure records) and diagnostic ranks (from diagnostic data)
3. Diagnostic Outcome Mapping, using failure and testing data to evaluate whether or not changes in failure rate are coincident with diagnostic activities.

Authors stress that the availability of appropriate information regarding both diagnostic and service records is quite important, and that a diagnostic testing and action programme to make a real impact on system reliability (Diagnostic Yield concept) must reach a minimum level of activity.