

Condition Assessment of Aged Medium Voltage Network Cables

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ABSTRACT

Accurate and economic condition assessment of in-service underground cables has always been a challenge for Asset Managers.

Over recent years, AusNet Services, one of the Australia's largest transmission and distribution companies, has been exercising various on-line and off-line tests to assess and improve the reliability of its distribution cable network.

On-line testing is less costly so is generally the preferred starting choice for Asset Managers. The online testing techniques and recorded results are not covered in this paper, instead the focus is toward off-line condition assessment test protocols and an analysis of the results obtained. Off-line insulation condition assessment testing, primarily Dielectric Dissipation Factor (DDF or $\tan \delta$) and Partial Discharge (PD) can provide a high degree of insight on cable insulation conditions.

This paper presents findings from a series of off-line tests that were undertaken throughout the Victorian Medium Voltage (MV) cable network comprising over 91km of installed three and single core cables, divided into over 280 tested cable lengths. The majority of these cable circuits are located in an area that was chosen for its cyclic loadings that made obtaining outages for longer periods of time more palatable at certain times of the year.

The paper also presents the Asset Management rationale behind the test program and a summary of the results obtained.

KEYWORDS

Medium Voltage, Diagnostic Testing, Asset Management

AUTHOR NAMES & AFFILIATIONS

Russell Wheatland is the Principal Engineer of Power Cables for AusNet Services, the owner of the Transmission network and the Eastern Sub-Transmission network in Victoria, Australia. He is the Convenor of CIGRE Australia Panel B1 – Insulated Cables and a regular member of CIGRE Study Committee SC B1. He has a Bachelor of Electrical Engineering having spent the majority of his 35-year career involved in high voltage testing of all types of primary plant, Power transformers, Instrument Transformers, Switchgear and of course power cables.

Dong Churl Lee is a Senior Test Engineer for Mondo, the HV testing division of AusNet Services. He has a Bachelor of Electrical Engineering with 23 years of experience in power cables and accessories, especially in the area of testing, quality control and condition assessment. He also previously worked on testing and evaluation of new insulating materials for power cables during his career in the cable industry. He is a member of CIGRE Australian Panel B1 – Insulated Cables.

INTRODUCTION

Accurate and economic condition assessment of in-service underground cables remains a challenge for Asset Managers. What percentage of the network to test, what tests to undertake, on-line or off-line tests, what voltage levels are best for diagnostics and how to determine the pass/fail criteria and are all questions to be reconciled.

This paper presents the combined findings from two testing programs incorporating a series of off-line tests

- 1) undertaken on a sample area of the Victorian Medium Voltage (MV) cable network comprising over 74km of installed three core cable (over 220km core length), divided into 81 tested cable lengths. The area was chosen for its cyclic loadings that made obtaining outages for longer periods of time more palatable at certain times of the year.
- 2) undertaken on various circuits throughout the remaining network as a part of resilience testing for a new rapid earth fault current limiting protection scheme being installed throughout the high bushfire prone areas of the state. This MV cable test program comprised nearly 17km of installed single and three core cable (nearly 50km core length), divided into over 200 short cable lengths.

Often such testing programs are seen as a step change in expenditure that normally attracts a significant resistance to sign-up by senior management.

The paper presents the Asset Management rationale behind the test program, the test equipment and methodologies used, summaries of the results obtained and the establishment of a remedial works program.

An alarmingly high rate of defect detection gave the authors an opportunity to collate well supported statistics and build a foundation for the company's on-going MV cable maintenance programs.

Finally, the authors advocate the advantages of having a combined approach of Asset Management objectives and well implemented test programs for condition assessment of aged MV cables within an electricity supply network.

CONDITION ASSESSMENT OF MV CABLES

Testing of cables is carried out at different stages of the cable's life [1]. The lower arrows in Figure 1 represent the opportunities that the asset manager has to measure the insulation degradation of the cable system with the desire to accurately predict the end of life.

The upper arrows represent when detrimental influences to a cable's lifecycle can occur.