DIAGNOSING SERVICE AGED CABLES

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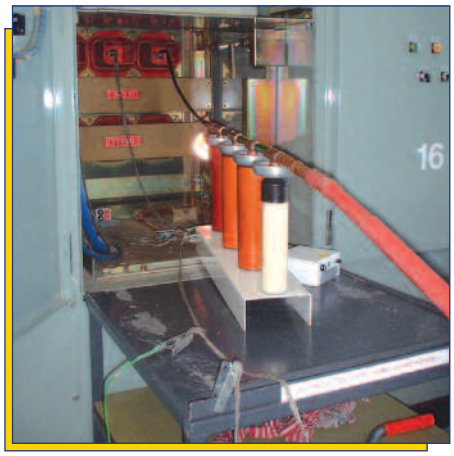
By Greg Linton, HV Diagnostic Services Ltd

During winter of 2005, the network company in South Canterbury, New Zealand commissioned an MV cable condition assessment project to determine the status of their existing underground network. The testing involved VLF Partial Discharge mapping of ten 11kV Transmission and Sub-transmission cables forming the backbone of their urban and CBD network. The data provided would form an integral part of their network planning towards a system reinforcement program.

HYBRID COMBINATIONS

The cable ages ranged from 20 to 40 years old and were generally all PILC construction; however, many circuits were hybrid combinations of varying age and/or insulation types as is now commonplace. The average circuit length was around 1.5km, the longest 5km and the shortest just 12m.

Testing of each 3 core cable takes approximately 2 hours after set-up, together with switching and travel between test sites. The entire project was completed in 3.5 days with approximately half the cables mapped later in the evening as loading in late June prevented release of circuits any earlier in the day.



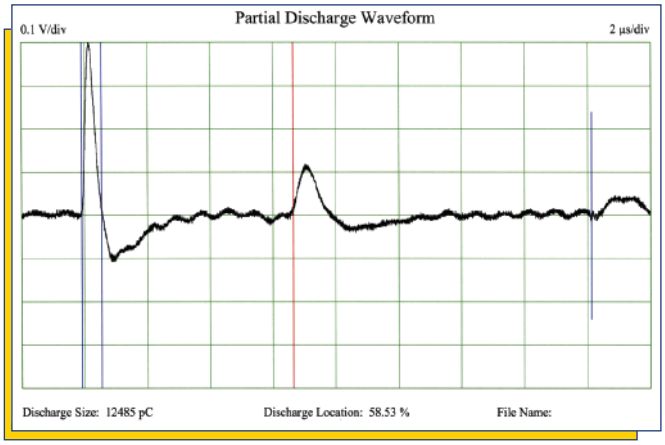
High Voltage test connection *made through HF filter to core under test via switchgear cable spouts. The two phases not energised are earthed out allowing individual testing between phases and earth.*

Of the 10 cables tested, 4 were clear, 4 recorded insignificant levels and 2 were found to have discharge activity. The first of these circuits displayed reasonably typical levels of discharge for a paper cable (2000 – 3000pC), but at a low inception voltage implying that the activity is always present. It was however located in an area of the cable where known sheath damage exists and therefore essential when evaluating the level of threat to their security of supply. The second cable recorded very much higher levels of discharge with a maximum of 13,500pC, again at a lower than service voltage inception. This activity was confined to approximately 40% of the total length and was quite nicely situated between existing joints; in fact the majority and worst of the discharge could be removed from the system with the replacement of an even shorter 250m section.

SOUND ENGINEERING DATA

The information reported can be used in one of several ways. First, the damaged section and associated risk can be removed as part of a capital replacement program. Second, this expense can be deferred pending a failure allowing repairs to then be individually 'tailored' to specific sites or third, designed out of the system entirely with future planning/network strengthening work. Whatever the Asset owner's final course, network reliability can be improved by basing their investment decisions on the sound engineering data that is provided.

Partial Discharges in the insulation are the main cause of accelerated ageing in high voltage paper insulated cables. The discharges are responsible for much of the deterioration seen in the insulation wall, such as pin-holing and electrical treeing, and will eventually lead to the breakdown of the insulation. Joint defects in polymeric cable circuits can also give rise to partial discharge activity.



One single partial discharge event
The first 2 blue cursors mark the beginning of the cable and calculate the discharge amplitude. The red cursor locates its position along the cable and the final blue cursor marks the far 'open circuit' end of the cable.

Many years of research in the UK at EA Technology have resulted in the development of this technique, which uses quantitative analysis of Partial Discharge activity to provide an assessment of condition. They perform mapping on several hundred cables each year and often as a follow-up to on-line measurements, usually the customer insisting on the detail provided by the off-line method in order to make their decisions. The technique uses a Very Low Frequency (VLF) discharge free high voltage power supply to energise long lengths of cable from a standard mains outlet. By combining information from many partial discharge events, a final graphical plot, or discharge map is produced. This displays discharge magnitude as a function of distance along the cable route with deterioration often found in localised areas.

SUMMARY

HV Diagnostic Services Ltd offer a comprehensive service to assess the insulation condition on aged 11 and 33kV cables throughout New Zealand. This service has been used by, and is also available to Utilities in Australia. The technique is suitable for testing new XLPE circuits at commissioning while the equipment can also be utilised to conduct straightforward VLF pressure tests.

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