GWEFR Cyf

Case Study: Thermo-mechanical properties of underground power cables

This work was performed on behalf of the Strategic Technology Programme Cable Networks Module for EA Technology Ltd for whom GWEFR is an Associate Consultant.

The Problem

In the United Kingdom, electricity distribution in urban areas relies heavily on underground high-voltage (HV) cables. Every so often it is necessary to join two lengths of cable. This is done by enclosing the mechanical joint between the conductors in a highly insulative shrink-fit sleeve and then enclosing the complete joint in epoxy resin. However, even the smallest amount of moisture penetration can cause the joint integrity to deteriorate and the high voltage can then produce conductive tracks in the insulation. Eventually, this may lead to electrical breakdown and failures which are expensive to repair and can cause significant inconvenience to the public. It is therefore essential to understand the joint's failure mechanisms.

The current carried by a HV cable changes with the electrical load and this causes the temperature at a joint to vary, which in turn causes expansion and contraction of the insulation. Could this movement be large enough to affect the integrity of the joint? Engineers at GWEFR and EA Technology devised an experiment to answer this question.

The Solution

The critical requirement was to find a sensor that would yield stable and reliable measurement of the joint movement, even when subject to a wide range of temperatures. However, it also had to be small and thin enough to fit between the sleeve and the cable insulation so that it did not itself interfere with the measurement. It was also necessary to measure the temperature at several points in the joint.

GWEFR first performed a brief literature survey of relevant techniques for cable-joint measurement, followed by a market survey of relevant sensors that were potentially suitable. From these we selected a small number to investigate further and, on the basis of preliminary experiments, chose the combination of sensors most likely to succeed. GWEFR installed the sensors, the specialist instrumentation and real-time data logging system while EA Technology engineers set up the test rig at their dedicated high-current facility. Following several weeks of carefully monitored temperature cycling experiments, the data was collated and analysed by GWEFR and a comprehensive technical report presented to the client.

As a result of this work, much more is known about the effects of temperature variation on the integrity of a cable joint. This knowledge will be used to inform future working practices and in the design of new components for better performance and reliability. A copy of the report is available for sale from EA Technology – see http://www.eatechnology.com or telephone +44 (0) 151 339 4181.

GWEFR is an engineering consultancy which specialises in mathematical modelling of dynamic systems, computer simulation (including real-time and hardware-in-the-loop), feedback control, instrumentation and servomechanisms.

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