Understand Why One PD Method May Be Better Than Another

In this article we will discuss the differences between some of the more common techniques in use today for detection of Partial Discharge along with their typical applications, finishing with an example whereby an incorrectly used technique failed to identify activity eventually leading to failure.

By Greg Linton, HV Diagnostic Services Limited

UltraDish from EA Technology

The term Partial Discharge is all-encompassing and broadly speaking includes, but is not limited to Internal void-type discharge and surface related activity or tracking. As alluded to several detection methods exist employing complementary sensor technology's, and depending on the type of discharge you are looking for will each have their own strengths and weakness' for a given asset class.

Some of the more traditional approaches include Transient Earth Voltage (TEV), UHF, High Frequency Current Transformer (HFCT, also known as RFCT) and Ultrasonic (sometimes referred to as acoustic) and a competent PD professional should be aware of the differences between, and be able to advise on where one technique may be more appropriate than another for your particular scenario.

On a typical distribution network if we think about 11 and 33kV metalclad extensible switchboards, Ultrasonic detection optimised at 40kHz is unrivalled at finding surface anomalies however can only be dependably used on air insulated components where a signal path to the 'outside' exists (although contact probes can overcome this limitation somewhat). Therefore it's unlikely to identify anything in a compound filled chamber, primarily because Surface discharge is much less likely to be present where bulk insulation was originally used. This is where TEV, operating up to around 60MHz steps in because it measures the tiny voltage rises induced onto the earthed metal-skin by the electromagnetic wave generated at the site of an internal void discharge and can successfully work irrespective of the insulating medium used, in this way providing the perfect foil to Ultrasonic.

PD Hawk by EA Technology – UHF

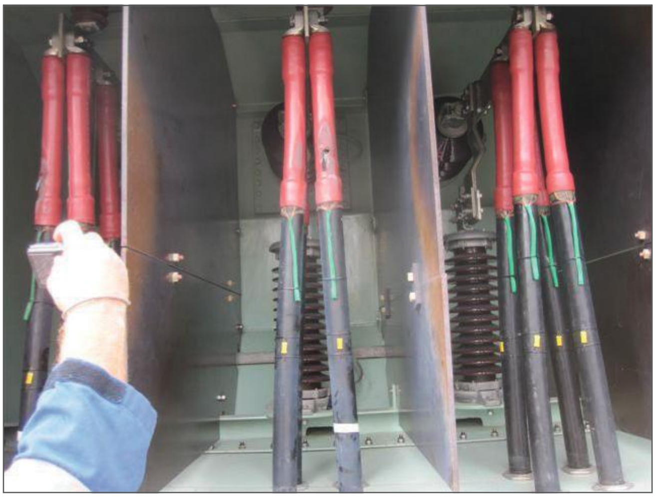
However Ultrasonic also finds application outdoors and can identify developing problems in the overhead network by simply exchanging microphone for a parabolic sensor or dish. But how can we check for internal problems within the live, uninsulated and MAD dominated switchyard environment? Directional UHF detection supplants TEV and is able to work from safe distances, in fact without requiring measurement 'contact' with anything thanks to its higher operating frequency and tuned antenna, typically around 800MHz.

From our list this leaves only HFCT which was developed primarily for, and in this writers opinion mainly suited to finding discharge within cables (and their inline Joints) by measuring any current pulses travelling along the earthed screen of a live cable. More sophisticated equipment will also calculate a location along the route length however this is really no different to the more accurate Offline VLF style of test (although an outage is obviously not required for the online method). There are however times when it may also be possible to detect issues inside the connected equipment but for this to work well a number of conditions must first be met: 1) The type of HFCT - it must be of high quality and the frequency being used at. 2) The Earthing arrangement and coupling to the inside and 3) The knowledge of the operator.

Being able to confirm using multiple appropriate sensors can add value and sadly there is no silver bullet. If something seems too good to be true then it probably is so ask yourself whether what is being proposed sounds credible. Do your due diligence and make an informed decision understanding what the reasonably expected outcomes are for any given methodology.

CASE STUDY

The following account is from a major wind generation site located in the North Island of New Zealand whereby a termination failure occurred within the LV Box (33kV) on one of the two identical 90MVA Station Transformers approximately 6 months after commissioning.



Continued over

Continued from page 27

Following repairs which involved a new length of 33kV cabling to be jointed in and a new termination installed, plus additional heating applied to the remaining terms the cables then underwent a CT type partial discharge test by a competitor 'PD' company in early 2009 with good results. So job done right?

Unfortunately no as a second failure occurred around 11 months later with termination failure in an identical position as before, located just above the grading tape at the semiconductor cut off.

After further repairs (including testing Insulation Resistance, PI, sheath insulation resistance etc with good results) it was at this point that HVDS was asked to perform a PD survey on the Transformer Termination Boxes on the 16 Feb 2011. TEV results revealed a significantly higher level, 34 vs 9dBmV on the problematic Box as compared to its stablemate (plus excessive severity which also takes discharge pulse rate into account) leading to each of the 12 cables (4 per phase) being measured individually as shown in Figure 1.

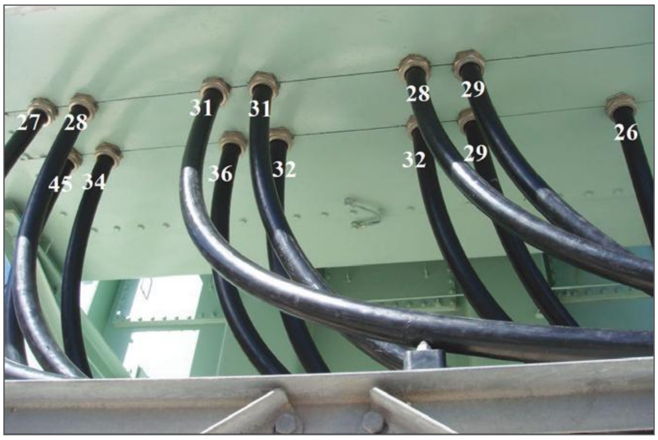


Figure 1 *(the number superimposed on each cable represents the measured TEV value in dBmV)*

Following this revelation the asset owner made the challenging decision to replace all 33kV terminations on T1 thereby placing a constraint on the parks output for a considerable period of time, and a further survey on T2 (with T1 out of service) on the 25th May 2011 confirmed both the abnormality on T1, but also proof that the risk of something similar occurring on T2 was low, Figure 2.

Figure 2 *T2 exhibits no indication of Internal Discharge problem*

With both transformers having ultimately been returned to service follow-up tests were carried out in both September and October 2011 under differing load and ambient conditions with results between the two now significantly more uniform and directly comparable, Figure 3.

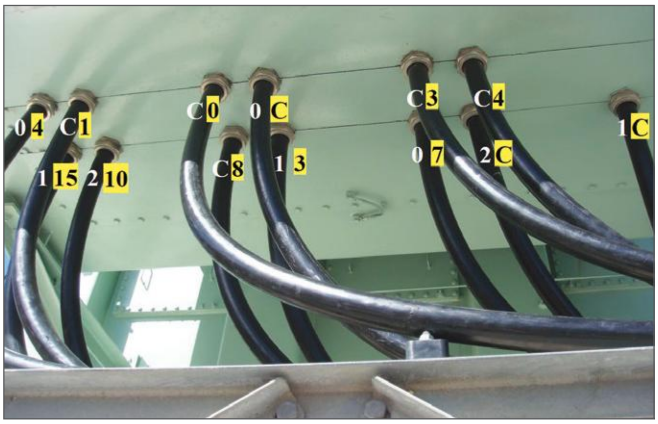


Figure 3 *September results - Both Transformers in service post T1 Termination replacement*

Further testing was requested at subsequent generation sites around the country to provide piece of mind in those installations and no evidence of similar defects were discovered.

A return in 2018 to complete a site-wide audit over several days of all switchgear, terminations and buried joint pits confirmed that the transformer improvement remained consistent with our earlier visits further justifying their confidence in the testing methodology used. It's also worth noting that in this example there had been no Ultrasonic activity detected at any time indicating an internal, rather than surface related problem within the failed components.

SUMMARY

So to revisit an earlier point, there can be multiple ways to 'test' for Partial Discharge and for it to be most effective you must understand the type of discharge likely to be present (or at least have an appreciation of what it is you hope to achieve). The technique selected for the type of asset being surveyed can therefore be of utmost importance, as can the M.O. of the individual PD 'specialist' engaged.

HV Diagnostic Services Limited does not promise the impossible and operates with the integrity to put the clients desired outcomes ahead of our own supply offering - if something falls outside of our specialised area of expertise then we will say so. T&D

For corroborating information
I invite you to review the
Customer Testimonials on our website
www.hvds.co.nz/customer_testimonials