Monitoring Substations: Ongoing or Periodic?

The use of instruments to detect and measure Partial Discharge (PD) activity is well established as a way to identify substation assets which are in danger of failing. But which makes the better business case – ongoing PD monitoring or periodic PD surveys?

By Neil Davies, EA Technology Pty Ltd

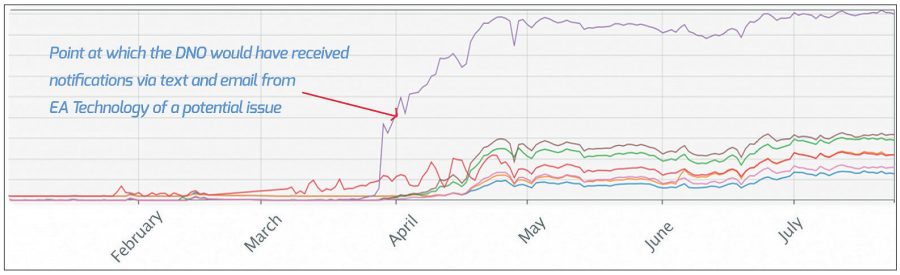
Regular checking of substations for PD activity every few months, or annually, has been adopted by many companies as an important part of their asset management best practice regimes. Many have also chosen to deploy permanent or semi-permanent monitoring and alarm systems to provide alerts of critical PD activity 24/7. Each of these options has its advantages. So which should you choose?

EXAMPLE 1 – A $600K AVOIDABLE FAILURE

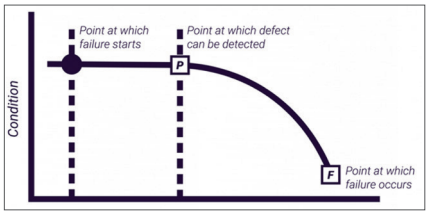
This UK distribution network operator experienced a catastrophic failure of critical switchgear in late July. PD activity was being recorded at the time (hence the plot above) but the results were not connected to any alarm or monitoring system, nor were they being observed by engineers, so nobody intervened before the failure. The result was an eight hour outage in part of a major city, which cost the company $600,000 in fines by the UK regulator, plus the expense of replacing a devastated switchboard.

The failure process in this case progressed over many weeks, providing ample opportunity to identify and rectify the problem before disaster – if anyone had been observing what was happening. But it was nobody's day job to do so.

Would periodic PD surveys have picked up the problem? Possibly. But only if a survey happened to coincide with the spike in PD during late April and developing into July. So the odds of success were around 4-1 against it being spotted in an annual PD survey regime.



This circuit breaker truck failed in July. The top line shows PD activity developing over weeks – and the point at which a monitoring system would have triggered a critical alert



Failure processes may follow this pattern, but unfortunately, time-to-failure can vary significantly with different assets and defects. PD-related failures may develop over weeks, months or years. Incidences of deterioration on the surface of insulation tend to develop more quickly than internal problems, such as voids in insulation, which can manifest themselves over several years.

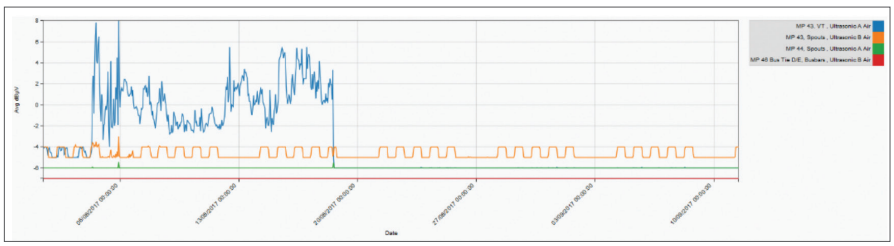
In the case above, the window of opportunity for detecting and averting the problem was around three months, so there was a fair chance the defect would have been picked up with frequent manual PD surveys – say monthly. Alternatively, had it been the subject of permanent monitoring, for example using EA Technology's Astute HV Monitoring™ services, the operator would have received email and phone alerts in good time, at a point where the failure could have been averted. Either way, measurement of PD activity would have identified the problem – and as exampled below, handheld PD instruments also play an important role in resolving issues which are picked up during ongoing monitoring.

EXAMPLE 2: FAILURE AVERTED

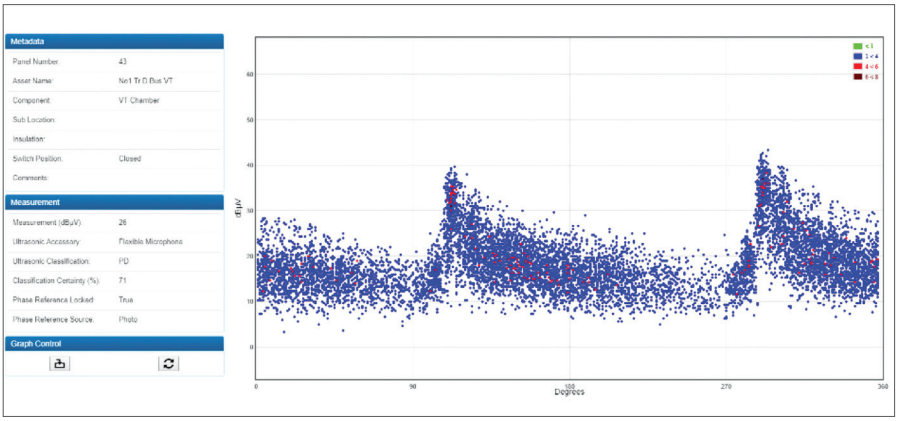
Now let us look at a typical outcome of ongoing substation monitoring, in a major Australian power utility. In summary: an 11kV VT began to fail in a critical substation. One of our permanently installed Astute HV Monitoring™ systems picked up the problem and triggered an alarm. Further investigation confirmed and identified the exact issue, which was fixed during a planned outage. Failure averted and major costs saved. Here's what happened:

PD ALARM TRIGGERED

One of the ultrasonic microphones picked up a step change in PD activity on an 11 kV VT. This was picked up and analysed remotely by EA Technology's monitoring team, who notified the client's engineers. Further analysis showed that no personnel were present and no switching activity had taken place at the time of the PD increase, so it was decided the alert was significant and needed further investigation. PD



PD activity at and after the failing VT was replaced.



The UltraTEV Plus² provided detailed information on the nature and location of the problem, so it was decided to switch out the rackable VT and remove it from service.

An UltraTEV Plus² was used to pinpoint the problem and measure PD activity in detail.

activity is monitored and analysed by our teams, who will alert the operator directly if it is judged to warrant further investigation.

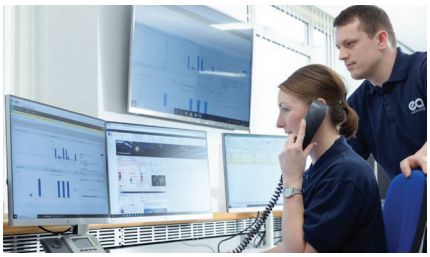
A site investigation was carried out by EA Technology and client engineers. They heard a loud buzzing/crackling sound in the switchroom, in the vicinity of the VT. One of EA Technology's UltraTEV Plus² handheld instruments (above) gave an initial reading of 26dBµV – a high level, with phase resolved patterns indicating PD activity.

PROBLEM CONFIRMED

Once taken out of service and with its cover removed, the VT showed long cracks through the outer casing. Black burning could be seen tracking from one of the cracks towards earthed metalwork. Time-to-failure for the whole unit was estimated at a few weeks, so the onset of the failure process could have been missed during periodic condition surveys.

REMEDIAL ACTION & FOLLOW UP

The VT was replaced in a controlled manner during a planned outage, a few days after the cause of the problem was identified. Ongoing monitoring after the replacement confirmed the problem had been rectified.



CONCLUSION

Periodic surveys of the condition of HV assets, using PD instruments, is a cost-effective way of identifying problems that are developing PROVIDING surveys are carried out regularly. Indeed, one of the most valuable results of such surveys is the ability to record and compare changes in PD activity over time. But there is no escaping the fact that the ability to identify fast-developing PD issues with periodic surveys is a matter of chance. If problems hit in the gaps between surveys, they can be missed altogether.

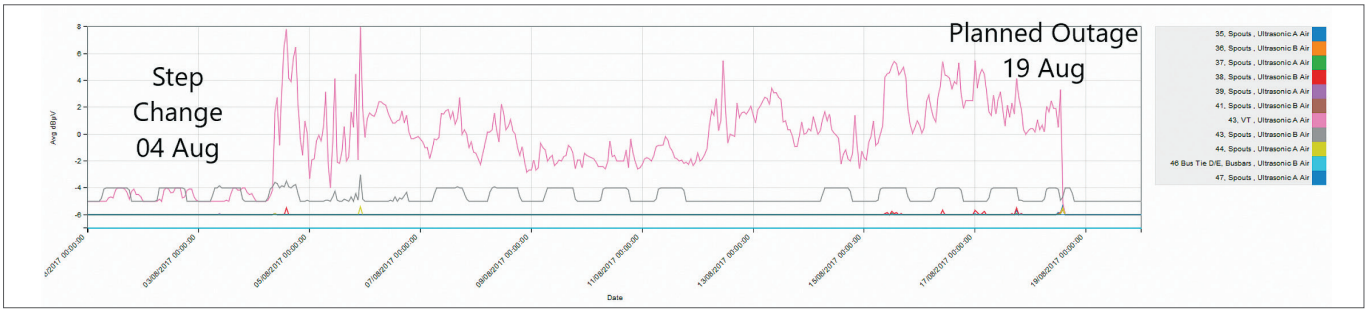
As shown in our first example, the $600,000+ cost of being unable to avert a failure in an un-monitored substation far outweighed what would have been the investment needed for more permanent monitoring over many years.

The business decision on whether to use periodic or ongoing substation monitoring can be considered from several perspectives, from best use of personnel resources, to the question of risk – and that can be expressed as: Risk = Probability of Failure x Consequences of Failure. In other words, the more an asset is known to be at risk of failure, and/or if its failure would have serious consequences, such as a costly outage, the greater the case for ongoing permanent monitoring.

HOW ASTUTE HV MONITORING™ WORKS

Ongoing monitoring of substations and other HV assets comes in two main flavours – buy or lease, with a range of support choices. In EA Technology's case, both options use the same equipment: the UltraTEV Monitor™. All the equipment used is modular and easily installed, so it can be deployed permanently, for defined periods or reconfigured to suit changing needs.

Our lease option is called Astute HV Monitoring™: a comprehensive monitoring service that includes hardware, software,



Time-frame: from identification of step change in PD activity to VT replacement.

remote monitoring, expert interpretation of results, automatic alerts, advice – and field engineering support if needed, to rectify problems.

The service is highly customisable, starting with condition surveys and risk analyses to agree with the operator which assets should be monitored.

Once installed, the whole system is monitored remotely by us. Results are analysed and filtered by our experts, to avoid false alarms. Where readings are deemed to indicate significant problems, we alert the client's engineers directly by phone and email. We can then give further advice on what the results indicate in terms of likely failure and time-to-failure, based on our experience of how assets deteriorate and fail, stretching over more than 50 years.

Our monitoring systems are far more than simple PD alarms, however. They record and analyse detailed information on PD activity and insulation breakdown over time, together with environmental conditions in the substation. The result is an evolving picture of the health of assets, which can be used to plan maintenance, replacement and investments as part of asset management procedures.

The alternative to leasing is to buy. Same equipment, plus the options of using our remote monitoring and reporting services, or any degree of support or self-management that suits. PD

The system can monitor, record and analyse the condition of hundreds of assets simultaneously, including cables. Results are filtered to remove false alarms and clients are alerted of problems automatically.