

ANATOMY OF PARTIAL DISCHARGE TECHNOLOGY

One of Australia's major international airports was experiencing random, insulation-based, cable termination/joint failures due to varying age of assets and different levels of maintenance. They now use On-Line Partial Discharge to improve electricity reliability.

Partial Discharge (PD) generally begins within voids, cracks, at conductor-dielectric interfaces within a solid insulation system, or in bubbles within liquid dielectrics. Since discharges are limited to only a portion of the insulation, the discharges only partially bridge the distance between electrodes. PD can also occur along the boundary between different insulating materials.

GAS-FILLED VOIDS

Partial discharges within an insulating material are usually initiated within gas-filled voids within the dielectric. Because the dielectric constant of the void is considerably less than the surrounding dielectric, the electric field (and the voltage stress) appearing across the void is significantly higher than across an equivalent distance of dielectric. If the voltage stress across the void is increased above the corona inception voltage (CIV) for the gas within the void, then PD activity will start within the void.

PD DETECTION EQUIPMENT

Once begun, PD causes progressive deterioration of insulating materials, ultimately leading to electrical breakdown. PD can be prevented through careful design and material selection. In critical high voltage equipment, the integrity of the insulation is confirmed using PD detection equipment during the manufacturing stage as well as periodically through the equipment's useful life using On-Line Partial Discharge surveys.

PD prevention and detection are essential to insure reliable, long-term operation of high voltage equipment as used by high voltage clients such as airports/refineries/industry and network operators i.e any client who cannot afford an unplanned outage.

CASE STUDY

Background

One of Australia's major international airports was experiencing random, insulation-based, cable termination and joint failures over a 2 year period. The Challenge was how to ascertain (while on-line and without loss of productivity) the insulation integrity of critical feeders and to prioritize which high voltage switchboard required maintenance in order to avoid a forced outage. International airports have many high profile tenants that run a 24/7 operation. Having to turn these clients off to carry out cable/switchgear maintenance was not an option.

PROCEDURE TO FOLLOW

Using new technology such as on-line partial discharge, it is now possible to carry out maintenance inspections without anyone being aware of what is happening behind the scenes. When a potential fault is identified, the procedure to follow so that a controlled shut down can be planned includes:

- Temporary generators installed where no alternative supplies are available.
- Tenants are advised in advance and each of their particular needs meet (e.g. EFTpos machines must be kept going)
- An IT / Comm's person made available to deal with each of the tenant's electronic wizardry (just in case computers don't reboot

etc) at the times of changeover from mains to generator and generator back to mains.

- And of course, getting the real problem sorted out (Isolations/ getting the right expertise/jointers/testers/spare parts)

By using On-Line Partial Discharge, it is possible to determine which **cable** and **where within the feeder** a potential fault is developing. Once located, repairs can be planned at the next outage thus ensuring increased reliability.

LONG TERM SOLUTION

The airport now uses regular On-Line Partial Discharge surveys. High Voltage Solution Ltd (HVS) were appointed to monitor all cables/switchgear and cables (11/33kV) on a 2.5 yearly cycle and provide their client with a detailed report grading the condition of each high voltage asset (cables, switchboard and circuit breakers)

The client was provided with the following information.

- 1 Identified problems within a switchboard/circuit breaker that allowed maintenance staff to look more closely in the areas identified.
 - 2 Report on each cable concerned. (Showing levels of discharge if these were present) and a rating applied that allows the client to plan the order of repairs based upon the rating provided.
 - 3 Report on each HV termination concerned. (Showing levels of discharge if these were present) and a rating applied that allows the client to plan the order of repairs based upon the rating provided.
 - 4 By revisiting the substations every 2.5 years, HVS was also able to revisit the substations/cable circuits that had maintenance work carried out to ensure the work that was done did in fact correct the discharge problem. (It is important that the report giving recommendations on how to carry out repairs is actually given to the field staff)
 - 5 Correcting a Partial Discharge problem requires experience in this area. Again, HVS can provide on-site training to your staff to show them where to look/ how to repair or replace faulty parts (depending upon degree of damage that has occurred).
 - 6 The report is provided in Excel format. This allows for other fields to be entered by the client and also allows the report to be easily inputted into other dedicated asset management systems.
- By approaching the problem in this manner it allowed for targeted maintenance within this complex airport distribution system by identifying which substation needed more work than others. Burnt jet fuel creates a lot of dirt within a substation – hence the need to clean these substations on a monthly basis.

SUMMARY

Using On-Line Partial Discharge surveys allows critical information about the condition of the high voltage assets to be obtained without any outages occurring and the asset owner will always know the status of his equipment's insulation without having an outage. This enables better financial management of assets/ forecasts/capital funding requirements.

For further information, contact Peter Rhodes at High Voltage Solution on +64 274 199 952 or email prhodes@highvoltage-solution.com