Explosion in a High Voltage Substation

WHAT HAPPENED

During normal site running conditions, an explosion occurred within the termination chamber of a transformer at a Substation, which is one of a number of substations across site and it forms a critical part of the site 11kV network.

The substation was unoccupied at the time, and power was restored to affected plant within four hours.

The initial inspection of the components below the vacuum circuit breaker indicated that there had been a phase to phase discharge within the termination chamber (evidence of this is shown in the photo where a discharge occurred between the edge of the busbar nearest the photo and a second phase). It was confirmed that there was no fault to earth.

The initial inspection also concluded that disconnection under fault conditions was virtually instantaneous as there was no evidence of any copper residue “splash” on walls or on the inside of the chamber. This indicates that all circuit protection operated and discriminated as per the

original design parameters.

The rear panel of the switchgear is fitted with bolts that are designed to allow the panel to yield in the event of over-pressure in the chamber. The square washers retaining the panel functioned correctly and the upper and lower section of the panel hinged upwards and downwards respectively.

The photo shows the retaining nuts and square washers (identified by the red rectangle) that secure the panel in normal operational conditions had yielded as per their design.

Subsequent examination of the cable involved, indicated that the Raychem heat shrink insulation applied to one of the phases was showing signs of heat damage with some partial melting. The insulation is an orange colour and is used to protect the core when the outer insulation is stripped back during installation.

Possible cause(s):
As part of the investigation, a review meeting was convened to consider the possible causes of the incident. The review concluded that there were three possible causes:

1. Damage had occurred at the time of original installation (two years previously). When the outer

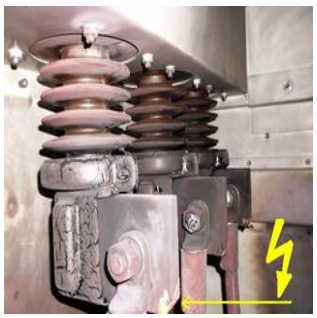
lead sheath had been pulled back to allow access to the conductors, the sheathing is marked using a blunt knife and mallet and then drawn back. A risk with this process is to create an unknown pressure point on the cable that can lead to incipient failure.

2. The Raychem insulation was faulty on original installation – it is used to protect the crutch of the cable and conductors to termination.

3. The cable had a manufacturing defect which was not apparent at the time of installation but resulted in the incident.

After consideration of possible causes, an inherent cable fault was considered very unlikely as no evidence of this has been identified (the cable terminations are subject to further test and examination). The remaining two potential faults were considered equally likely.

Termination Chamber



Phase to Phase Discharge

LEARNING POINTS / ACTIONS TAKEN

Following the incident the following action points were taken immediately or will be when the

were taken immediately or will be when the equipment is available:

1. No access to the rear of HV switchgear at any time until further measures are adopted (previously this was only during switching operations). The “no access” areas are marked by a red painted floor in prohibited areas.

2. Transient earth voltage (TEV) meters (two off) have been ordered which are designed to identify and warn of partial discharge (PD) when working in the close proximity of HV equipment. Electricians, cleaners and electrical contractors will be required to use the TEV meter when entering a substation.

3. Currently only one HV substation has an externally monitored infrared IP camera installed, the intention is to install a camera of this type in the remaining substations so that conditions within the substation can be assessed remotely should fault conditions arise prior to entry.

4. An exit route to be painted on the substation floor in a contrasting colour.

5. A secure door access/locking system to be installed to control access (note: prior to the incident HV substations were securely locked

incident HV substations were securely locked using padlocks).

6. All personnel entering HV substations will have to have helmet lights fitted.

Retaining Nuts & Square Washers

LOCATION:	**CEMENT PLANT**	**ALERT STATUS:**	**Normal**
ACTIVITY:	**PRODUCTION AND PROCESSING**	**DATE ISSUED:**	**08/02/2014 13:50:00**
SUB ACTIVITY:	**CEMENT PRODUCTION**	**INCIDENT No:**	**00374**