



Petroleum Safety Significant Incident Report No. 02/2018

Inadequate electrical isolation leads to electric shock from a potentially fatal 'floating neutral' situation

Summary of incident

In November 2017, an electrical installation was de-energised in preparation for the disconnection of temporary power cables and reconnection of permanent power cables at a facility's electrical distribution boards.

During the works, an electrician received an electric shock when he inadvertently created a 'floating neutral' situation.

Work was suspended and the electrician was taken to hospital for a precautionary electro-cardiograph (ECG) before being cleared to return to work.

Immediately after the incident, voltage measurements were taken between earth and neutral terminals in the distribution board which indicated a voltage of 87 V AC.

The following procedural controls were in place at the time of the incident:

- the operator's permit to work (PTW) system was followed, including review of the single line diagrams
- an isolation list was finalised and isolations in the field were completed, which included independent verification of the isolations
- a 'test for dead' (zero volt test) was performed at the distribution boards by the electrician, and a zero volt reading was witnessed by all personnel involved in the task.

Direct factors

- A downstream uninterruptable power supply (UPS) distribution system was not identified and isolated as a power source. Consequently, the electrical supply had not been completely isolated when the electrician removed the neutral conductor.

Contributory factors

- When the temporary cables were disconnected at the distribution boxes, the UPS system also lost its main earth neutral (MEN) connection point. The UPS neutral cable lost its voltage reference resulting in the neutral conductor's potential going above zero volts with reference to earth. This is called a 'floating neutral' situation.

Note: the supply side neutral conductor on the distribution side of the MEN connection point connects the earthing conductor and the neutral conductor. That is, it carries the out of balance return current under normal operating conditions and earth fault current when an active-to-earth fault occurs.

- While the 'test for dead' confirmed that the circuits to be worked on were considered to have zero potential, this condition could not have been verified until the neutral conductor was disconnected from the MEN.
- Shutting the plant down (which would have included the UPS) was not considered necessary during the risk assessment process, as it was on the downstream or distribution side of the boards.
- The permit did not indicate that the required isolations were independently verified.

Actions required

To prevent similar incidents, the following actions are recommended. Before undertaking electrical work, facilities should confirm that:

- all points of supply are isolated if the MEN is to be disconnected
- an appropriate 'test for dead' is conducted
- isolations are independently verified as per the PTW system, and the completed permits reflect this process
- the isolation procedure within the PTW system supports the provision that isolation of neutral and earth should only be considered if the electrical system has been verified as totally isolated
- workers are aware of the importance of maintaining neutral and earth at the same continuous potential. That is, isolation of neutral and earth should not be allowed without due consideration and measures put in place to mitigate any consequences
- there is full compliance with Australian Standard AS/NZ3000.

Further information

- Department of Mines, Industry Regulation and Safety
www.dmp.wa.gov.au/Safety/Guidance-about-the-isolation-of-6652.aspx (web page)
 Guidance about the isolation of hazardous energies
www.commerce.wa.gov.au/sites/default/files/atoms/files/cop_for_persons_working_on_or_near_energised_electrical_installations_0.pdf
 Code of practice for persons working on or near energised electrical installations
www.dmp.wa.gov.au/Documents/Safety/MSH_G_IsolationofHazardousEnergies.pdf
 Isolation of hazardous energies associated with plant in Western Australian mining operations guideline
- Standards Australia, www.standards.org.au
 AS/NZS 3000 Electrical installations (the Australian/New Zealand wiring rules)

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