Trade & Investment Mine Safety

SAFETY ALERT

Electrician injured after making contact with live high voltage conductor

INCIDENT

An electrician at an underground coal mine sustained an electric shock and minor burns after making direct contact with a live 11000 volt terminal.

The man's right hand and forearm were injured when he attempted to remove a high voltage fuse from the control transformer installed in a section isolator in the 18 December, 2014 incident.

He was transported by ambulance to hospital, where he was assessed by emergency department medical staff and later released.

The injured man was one of three electricians in a work team assigned the task of locating a suspected fault on a section of the mine's 11000V distribution network. The work team also included three mineworkers tasked to assist with the handling of cables and plugs.

CIRCUMSTANCES

The work team was locating the source of low insulation readings in a section of the mine's high voltage distribution network.

The equipment to be tested had been isolated and the work team had disconnected some equipment and completed some of the required testing work immediately before the incident.

The electricians were in the process of preparing to undertake further testing on the cable connected to the outgoing adaptor of the section isolator that was also the isolation point for the work.

This required gaining access to a purpose-designed test compartment within the section isolator. After gaining access, the electrician removed a cover from a control transformer that was not included in the isolation so was still energised.

After removing the cover, the electrician then attempted to remove a fuse from the live 11000V terminals on top of the control transformer using a large through-tang screwdriver to lever the fuse from its carrier.

INVESTIGATION

The investigation identified:

1. There was no direction given to remove the fuses from the live control transformer and there was no identified requirement to do so. Access to this control transformer was not covered under the access permit.

2. None of the electricians recognised the hazard, despite the presence of warning signs and the fact they were actually working at the isolation point for the task, and had identified moments earlier that some components of the section isolator were energised.
3. Requirements identified in the site's high voltage management plan for testing and verifying the control transformer was de-energised were not applied after the cover was removed.
4. Immediately before the incident, the electricians had removed the fuses from the control transformer in a similar section isolator at another location. They had not tested the control transformer was de-energised in accordance with requirements of the high voltage management plan in this instance as they considered there was no requirement to do so when they had disconnected the incoming cable from the section isolator.
5. By their own admission, the workers involved were distracted at the time of the incident, and not focussed on the task at hand.
6. The procedure was changed by the supervisor of the crew in consultation with the other electricians but these changes were not undertaken in accordance with site requirements.
7. The work team did not complete SLAMs (Stop, Look, Assess, Manage) before starting work or when changing the procedure, despite the procedure template indicated these should be completed for all tasks, regardless of the risk.
8. The process followed for placing the isolator into the test position immediately before the incident did not comply with requirements identified in the high voltage management plan.
9. The procedure used by the work team contained errors and ambiguities.
10. Personal protection equipment worn by the injured electrician at the time of the incident did not comply with the requirements of the high voltage management plan.
11. The electricians involved were trained and assessed as competent in accordance with requirements identified in the high voltage management plan.
12. A "risk review" was not completed on the task before the preparation of the switching and access permit, in accordance with the requirements of the high voltage management plan.

RECOMMENDATIONS

1. Mine operators should review their operational risk assessments for high voltage switching, equipment access and testing for both surface and underground installations with regard to the effectiveness of administrative controls identified in these assessments (for example, training, procedural controls and signs).
2. Subject to the outcomes of the risk assessment review, mine operators should review and update their high voltage management plans, subordinate procedures and training documents.
3. Mine operators should consider implementing a requirement for draft high voltage switching instructions and access permits to be reviewed and verified as correct by a competent person independent of the task before being issued to a party tasked with performing the work.
4. Mine operators should review the retraining frequencies for workers appointed to undertake high voltage switching or other high voltage work.
5. Mine operators should review the retraining frequencies for workers for the correct use of risk management tools such as JSAs and SLAMs, as detailed in the mine health and safety management system.

6. Mine operators should consider the implementation of engineering controls, such as door and cover interlocks designed to remove power, or devices warning that equipment is energised, where reasonably practicable to do so, and that under a functional safety approach such controls would be considered a safety function (Refer to Section 7.6 of Australian Standard HB 242-2007 *High Voltage Mining Equipment for Underground Use*).
7. Mine operators should review electric shock protocols for their sites, in consideration of issues relating to the specific outcomes of a person being subjected to an electric shock from a high-voltage source.

NOTE: Please ensure all relevant people in your organisation receive a copy of this Safety Alert, and are informed of its content and recommendations. This Safety Alert should be processed in a systematic manner through the mine's information and communication process. It should also be placed on the mine's notice board.

Signed

Rob Regan

DIRECTOR
MINE SAFETY OPERATIONS BRANCH
NSW TRADE & INVESTMENT

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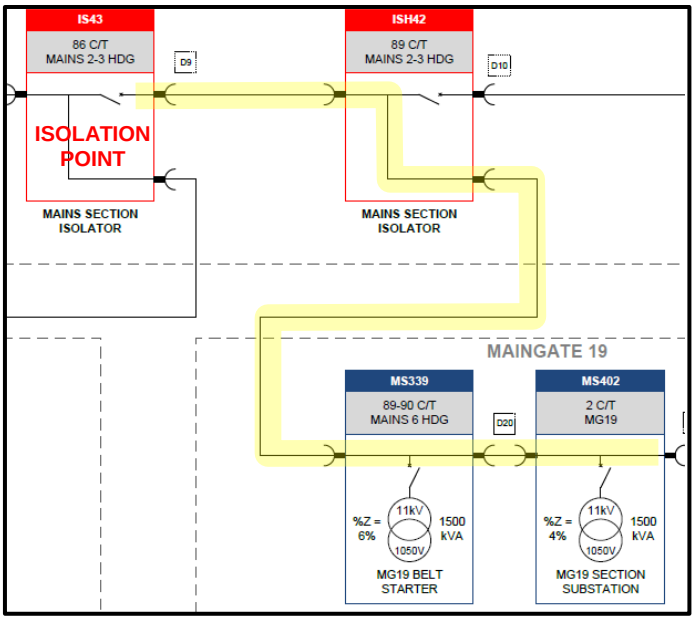
APPENDIX: Supplementary background information

The work team had the task of locating the source of low insulation readings in a section of the mine high voltage distribution network.

The work team was provided with a pre-prepared high voltage switching and access permit, a procedure that outlined the sequence in which the isolation, testing and restoration of power was to be performed and a copy of the single line diagram for the system (see figure 1).

Figure 1: Portion of single line diagram. Highlighted line indicates section of HV system to be tested.



In the lead-up to the incident:

- the electricians had completed the isolation in accordance with the switching instruction and all members of the work team had signed on the access permit and applied their personal locks at the isolation point for the job (refer to figure 1)
- the work team had then undertaken some of the work identified in the procedure including removing plugs from the section isolator ISH42 at 89 cut-through (refer to figure 1), and performing some of the required testing on the equipment.

Figure 2: Opened test compartment on IS43. Test points circled

Figure 3: Test compartment with Lexan cover above 11000V/110V control transformer installed.

Figure 4: 11000V/110V Control transformer located in bottom of test compartment. Lexan cover removed, as found after the incident.

The design of the section isolator allows testing of the outgoing switched feed cable to be undertaken while the incoming supply remains energised. The isolation switch has three positions:

- Closed – in this position the isolator switch connects the switched feed cable to the incoming supply.
- Earth – in this position the isolator is opened, disconnecting the switched feed cable from the incoming supply and simultaneously applying an earth connection to each phase of the switched feed cable.
- Test – in this position the applied earth is lifted from the switched feed cable and the switched feed cable is connected to the test points in the test compartment. The test compartment door is interlocked with the isolator operating handle and the isolator has to be in the test position to release the key that opens the compartment door.

The section isolators ISH42 (located at 89 cut-through), and IS43 (the isolation point, located at 86 cut-through) were the same design and similar in construction and configuration.

After completing work at 89 cut-through that included removing the control transformer fuses from ISH42, the work team relocated to 86 cut-though and began preparing to test the cable connecting section isolator IS43 to ISH42. This required isolator IS43 to

be placed into the test position, allowing access to the test compartment, which in turn necessitated the work team to remove their locks from the isolator.

The electrician who received the shock realised he had left his keys at 89 cut-through. He retrieved them, then removed his lock from the isolator, all other members of the team having already done so, placed the isolator into the test position and opened the test compartment door.

The electrician and the work team supervisor then verified the test points (refer to figure 2) were de-energised in accordance with site procedures.

At this point, the electrician proceeded to remove the Lexan cover protecting him from the energised control transformer in the bottom of the compartment. He removed the cover and placed it on top of the section isolator, then used a large through-tang screw-driver in an attempt to lever out one of the fuses from the top of the energised control transformer (refer to figure 5).

Removal of the cover, and the attempt to remove the fuse was undertaken in full view of the other electricians who were in immediate proximity. The electrician recoiled out of the compartment when the electric shock hit him. Members of the work party immediately reacted, taking him to a transport and out of the mine, and enacted the mine's emergency response procedures.

Figure 5: Re-enactment of the event, based on witness statements, position of burn marks on equipment and the arm of the electrician involved in the incident.