



**Industry &
Investment**

Information Sheet 6

Electrical Engineering Safety Electrical Isolation

*Mine Health and Safety Act 2004
Mine Health and Safety Regulation 2007
Occupational Health and Safety Regulation 2001*

Information Sheets are developed by the Inspectors of Electrical Engineering in response to issues identified during site electrical engineering audits at extractive mines and questions raised by the mine operators. They are provided as guidance material for mine operators in the development of electrical safety standards.

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ISOLATION OF ELECTRICAL CIRCUITS AND SYSTEMS

Purpose

This information within this document outlines the principles and procedures for the isolation of electrical circuits and systems operating at voltages up to and including low voltage.

The information provides minimum safety requirements to assist in the development of electrical isolation procedures and procedures for the security of the isolation.

Scope

The scope of the document is to provide sufficient information to enable operators at extractive operations to develop, implement and manage electrical isolation procedures at their operation to reduce the risk of electric shock.

Definitions

Extra Low Voltage: is a voltage not exceeding 50 volts a.c. or 120 volts ripple free d.c.

Low Voltage: is a voltage exceeding extra low voltage, but not exceeding 1000 volts a.c. or 1500 volts d.c.

Isolation Process

Occupational Health and Safety regulation 2001, clause 207 - Electrical work on electrical installations—safety measures – specifies that:

1. *An employer must ensure that any electrical work on an electrical installation at a place of work is carried out using a safe system of work.*
2. *An employer must ensure that such work is not carried out while the circuits and apparatus of the part of the installation that is being worked on are energised.*
3. *The safe system of work must include:*
 - (a) *Checks to ensure that the circuits and apparatus of the part of the installation that is being worked on are not energised before work commences and remain that way until the work is completed, and*
 - (b) *Measures to eliminate or control the risk of the person carrying out the work inadvertently contacting any part of the installation that remains energised.*

The accepted standard within the mining and extractive industries for safe access to electrical circuits or systems is total electrical isolation.

All electrical equipment and conductors should be regarded as energised (live) until isolated and proven de-energised (Test Before You Touch).

Work must not be carried out on, or near, electrical conductors until an electrical worker has:

1. Positively identified the electrical equipment, all of its energy sources and their isolation points.
2. Isolated and discharged where necessary, the electrical equipment from all sources of electrical supply.
3. Secured the isolation.
4. Proven the electrical conductors to be de-energised and electrically safe.

5. Identified the safe area of work.

a) Identification of Equipment and Isolation Points

The electrical equipment to be worked on, all of its energy sources and the appropriate points of isolation must be positively identified by an electrical worker.

It is not uncommon for electrical enclosures to have more than one power source supplied into the enclosure. The safety of the electrical tradespersons relies on identifying and isolating all electrical power sources that are normally present. e.g. Two electrical control panels, each with their own power supply, interconnected with low voltage control circuits – a control circuit in one of the control panels is powered from the second control panel. In this instance, both control panels would be electrically isolated.

b) Isolation of Electrical Equipment

All electrical equipment and electrical circuits must be isolated from all sources of electrical supply before any work is started on the equipment and circuits. This will be achieved by operating the appropriate controlling device(s) and include:

- Opening switches;
- Opening circuit breakers; or
- Removal of circuit connections, after the power supply to the circuit connections has been isolated;
- Disconnection of battery

(i) **Batteries:** Where a battery isolation device is installed, the device should be switched off and locked in the open position to isolate the battery power source before working on the circuits.

When disconnecting a battery where one leg is earthed, always disconnect the earthed lead first then the un-earthed lead.

(ii) **Capacitors:** Capacitors store electrical energy and, to prevent the potential for an electric shock must be discharged before any work is carried out on circuits containing capacitors. i.e. power factor correction systems.

Where an automatic capacitor discharge circuit is fitted to capacitive circuits, the discharge time, nominated by the designer, must be displayed on the enclosure cover or door used to access the capacitive circuits. The time period MUST be allowed to lapse before removing the cover or opening the door.

Before work is carried out on circuits containing capacitors, a "Test Before You Touch" process is achieved by discharging residual capacitive energy by earthing the circuits with a suitably designed earthing discharge stick.

All electrical isolation must be carried out through the operation of manually operated control devices that directly control the power source. Control circuits and control systems must not be used as a means of isolation, e.g. PLC systems, emergency stops, lanyard switches, etc.

(iii) **Uninterruptable Power Supply:** UPS systems contain a battery power source. The operation should identify the type of system installed and develop specific steps for the isolation of the battery supply to enable total isolation of the power source.

c) Secure the Isolation

All points of electrical isolation are to be "locked off" where possible. Switches used for isolation should be provided with a device for securing the switch in the open position that requires a deliberate action to operate it. The securing device need not be an integral part of the switch but may be an additional component, such as a toggle clip or pad bolt, that will prevent the switch from being operated and provides a facility to attach a personal security lock. Every person working on the isolated electrical circuit or system should attach a personal security lock.

Locks used to secure electrical isolation should be "fit for purpose". The locks should have labelling to provide warning of "Danger" and the display name of the person that attached the lock.

Where electrical isolation locks do not provide this information, a danger tag that provides this information should be attached to the lock.

An example of two methods used by the mining industry for electrical isolation security is shown in photographs No 1 and 2.



Photograph No 1



Photograph No 2

i) Work not completed

Where the work is not completed and personnel are leaving the site, the locked security of the isolation point should not be removed until the installation is safe to re-energise.

e.g. Where an isolation task is not completed

- Replace the isolation lock (electrician's lock) with a "mine site" lock under the control of the mine supervisor.
- Attach an out of service tag - tag to contain detail of the reason for its fitment.

- Lock and Out of Service tag replaced with isolation lock of electrician and isolation checked before work continues.

d) Proving De-Energised

Until electrical isolation has been confirmed, all electrical conductors are to be treated as energised (live).

All circuits to be worked on and circuits in close proximity to the work area must be proven to be in a de-energised state before any work commences.

Initial testing to prove the circuits de-energised should be achieved by the use of non-contact voltage detector. These voltage detectors are to be tested for correct operation before and after use to confirm that the detector is working correctly.

Non- contact voltage detectors may not be suitable for metallic screened cable, cable carrying direct current (D.C.) supply and stored energy of capacitors. Subsequent testing should be carried out using a suitably rated voltage-testing instrument. These tests are to be conducted to an approved procedure. (Refer AS/NZS 3017)

The use of CAT III & IV multimeter is an acceptable method for testing a circuit to confirm electrical isolation. Multimeters should be used by competent electrical personnel with the appropriate tests and PPE

The use of "test lamps" and "test screw drivers" are not be permitted.

e) Identifying the Work Area

The safe area of work should be identified by erecting a barricade or warning signs or by other appropriate means if necessary. All personnel who are to work in the safe area are to be advised of its limits.

Low Voltage Overhead Power Lines

Isolation of overhead power lines must be verified through a process of "Test Before You Touch".

Before work commences on low voltage overhead power lines are to be effectively earthed through the installation of working earths to all phases of the system.

The working earths are to be placed on either side of the work area and are to be visible to the persons working on the overhead power lines.

Restoration of Power

Following repairs, alterations or modifications to the electrical system and before the electrical power supply is restored, those parts that have been repaired, altered or modified are verified as being in a safe state and are to be subjected to, and satisfy, the appropriate verification tests specified by AS/NZS 3000.

The test results are to be recorded and an electrical compliance certificate or equivalent document, and issued to the operator of the mine.

Before restoration of power supply to a circuit that has been isolated, a visual inspection should be made to verify that all tools, surplus material and waste have been removed, all covers, insulation barriers, doors and protection guards are in place and all persons are clear of the work area. All relevant personnel should be notified that the supply is about to be restored.

After the power supply has been restored, appropriate test are required to be completed to confirm that the earth leakage protection devices operate correctly, polarity is correct, actives are switched and, if applicable, phase sequences are correct.

For the safe restoration of battery supplies, e.g. automotive circuits, the unearthed battery lead should be connected before the earthed lead connection is made.

The restoration of power at an operation is required to be in accordance with the site procedures for the "Safe Removal and Restoration of Power".

Safety and Information Tags

Safety tags are to be clearly legible, understandable, dated and signed by the personnel attaching the tag.

a) Danger Tag

Danger tags are used to warn personnel of the dangers resulting from the operation of the device to which the tag is attached. Refer diagram (a).

Every person that isolates an electrical circuit or system is required to attach a danger tag where the safety lock, fitted to the isolation device, does not provide a warning of "Danger" or does not display the name of the person that attached the lock.

The danger tag is to have, as a minimum, the name of the person attaching the tag and the date. A danger tag should only be removed by person that applied the tag.

Restoration of power cannot occur until all danger tags have been removed.

i) Work not completed

Where a danger tag is attached, the work is not completed and the owner of the danger tag is leaving the site, that person must attach an Out of Service tag to the isolation point and remove the danger tag. Before continuation of the work, the isolation is to be confirmed in accordance with the isolation procedure, a danger tag attached to the isolation point and the Out of Service tag removed.

ii) Danger Tag Not Removed

Where the work has been completed and the owner of a danger tag has left the work site without removing their danger tag:

1. The person should be recalled to the site to remove the danger tag, or
2. A supervisor at the site:
 - is to confirm that all work is completed,
 - is to confirm that the person who placed the tag has indeed left the site
 - is to confirm that the circuit is safe to restore power
 - remove the tag
 - Complete a site incident report.

b) Out of Service Tag

An "Out of Service" tag is a warning tag. Refer diagram (b).

The tag is used to warn personnel that the device or equipment, to which it is attached, is not to be operated. The tag should detail the reason for removing the equipment from service, i.e. defect, fault, current work not completed, etc. Where equipment can be safely moved, attaching an "Out of Service" tag to equipment does not prevent the equipment being moved to a place where repairs are to be carried out.

The person that identifies a fault or defect attaches an "Out of Service" tag. The tag is only to be removed by the person that completes the repairs necessary to correct the fault or defect and render the equipment safe for use.

Where an Out of Service tag is replaced by a Danger Tag, the person attaching the Danger tag is to remove the Out of Service tag.

The tag, once removed from the device or equipment, is to be returned to the mine supervisor.

c) Information Tags

It is a proactive practice to provide "Information Tags" in addition to "Danger" tags and "Out of Service" tags. Information tags should be used to provide non-safety related information. Their use discourages the inappropriate use of safety tags for non-safety related matters.



Work On Live Circuits

Any work to be carried out on live electrical circuits are to conform to the requirements of the Occupational Health and Safety Regulation 2001, clause 207 - Electrical work on electrical installations—safety measures.

Important note

It is the view of Mine Safety Operations Electrical Inspectors, that there is no tasks on a mine site or within the extractive industry that would require a live ELECTRICAL circuit to be worked on