



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

**Technical Reference
Electrical Engineering Safety
EES006**

**NSW DPI Technical Reference
Removal and Restoration of Power**

***Coal Mine Health and Safety Act 2002
Coal Mine Health and Safety Regulation 2006***

December 2006 (version 1)



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PREFACE

On 8 January 1979 a coal dust explosion occurred at West Wallsend Colliery. Fortunately no one was killed however the mine was closed for an extended period. It was determined that power was restored at the mine surface onto a fault on an underground high voltage circuit which in turn initiated the explosion. From this evolved the principles of having removal and restoration of power rules so that electricity is not turned on unless it has been determined that it is safe to do so and that when power is turned on at the surface this action does **NOT** energise circuits in a hazardous zone.

There have also been incidents where mine workers have been injured when power has been restored onto a circuit after an electrical fault trip. In these incidents it was revealed that if a proper investigation by a qualified electrical person had been carried out the faulty electrical equipment would have been identified.

There have been other incidents where mine workers have been put at extreme risk when power has been restored to overhead power line circuits after a fault trip and machinery has still been in contact with the overhead power line.

There are numerous other scenarios that can lead to a significantly increased safety risk if the removal and restoration of power is not undertaken in a systematic and rigorous manner.

This Technical Reference will be used by Mine Safety Operations to assess the effectiveness of coal operation arrangements for the removal and restoration of power.

This Technical Reference can also be used by coal operators as guidance to establishing the minimum safety requirements applicable to the removal and restoration of power at coal operations as part of an Electrical Engineering Management Plan.

Coal operators can use this Technical Reference to assess their arrangements for removal and restoration of power at all parts of the operation including underground and in the hazardous zone.

John Francis Waudby

Senior Inspector of Electrical Engineering



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Chapter 1 Establishment

1.1 Title

This is the DPI Electrical Engineering Safety Technical Reference – Removal and Restoration of Power.

1.2 Purpose

This Technical Reference is intended to provide a framework for DPI officers to assess coal operation arrangements for removal and restoration of power as part of the Electrical Engineering Management Plan. It can also be used by coal operators as guidance material for implementing, managing or reviewing their removal and restoration of power arrangements.

The outcomes sought to be achieved by this Technical Reference are to protect people and property from the risks associated with the Removal and Restoration of Power at coal operations including:

- Uncontrolled Removal and Restoration of Power.
- Uncontrolled Introduction of Electricity to Underground mine working.
- Electrocutation.
- Electric Shock.
- Electrical burn injuries.
- Arc blast injuries.
- Injuries sustained through operation of the switching apparatus.
- Unintended operation of plant.
- Ignitions of flammable mixtures of gas or dust.
- Fire.

1.3 Scope

This Technical Reference extends to all coal operations in New South Wales. It is intended to be applied to Removal and Restoration of Power at all locations in coal operations including surface areas, coal preparation plants, train loading facilities and underground and in hazardous zones. This Technical Reference should apply to all sources of power.



The *Coal Mine Health and Safety Act 2002* and Regulation require mine operators to prepare an Electrical Engineering Management Plan, including arrangements for the safe Removal and Restoration of Power



Arrangements for the Removal and Restoration of Power at a coal operation must be part of the Electrical Engineering Management Plan. Regard must be made to mine ventilation management and emergency management (in particular in the event of a fire) for underground coal operations.

It does not cover practices for isolation of electrical power circuits.

➤ **Refer to MDG 40 Guideline for Hazardous Energy Control (Isolation or Treatment)**

This Technical Reference is supplemented by the following Technical References:

- EES001 NSW DPI Technical Reference – Electrical Engineering Management Plan
- EES002 NSW DPI Technical Reference - Control and Supervision of Electrical Work
- EES003 NSW DPI Technical Reference - Practices for the Life-Cycle of Management of Explosion Protected Equipment
- EES004 NSW DPI Technical Reference – Practices for Portable Electrical Apparatus
- EES005 NSW DPI Technical Reference - Electrical Protection and Earthing

1.4 Authority

This is an industry Technical Reference recommended by the Department of Primary Industries.

1.5 Definitions

Competent person for any task means a person who has acquired through training, qualification, experience, or a combination of them, the knowledge and skills to carry out the task.

1.6 Applicable legislation

The Occupational Health and Safety Act 2000

The Occupational Health and Safety Regulation 2001

The *Coal Mine Health and Safety Act 2002*

The *Coal Mine Health and Safety Regulation 2006*

1.7 Referenced Gazette Notices

Gazette Notice for the conditions of use of non-Explosion protected plant in a hazardous zone

1.8 Referenced Standards and Guidelines

AS/NZS 3000: Electrical installations (known as the Australian/New Zealand Wiring Rules)

AS 3007 Series - Electrical installations - Surface mines and associated processing plant

EES001 NSW DPI Technical Reference - Electrical Engineering Management Plan.



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EES004 NSW DPI Technical Reference - Practices for Portable Electrical Apparatus
MDG 40 Guideline for Hazardous Energy Control (Isolation or Treatment)

1.9 Acronyms

AS – Australian Standard

AS/NZS – Australian New Zealand Standard



Chapter 2 Provision of switchgear for the removal and restoration of power

2.1 Legislative requirements



Clause 19(1)(j)

Requires suitable switchgear to be provided for all parts of the coal operation.

Suitably rated and designed switchgear (low voltage & high voltage) must be provided at strategic locations as a means of removing danger to any person. The switchgear should be adequately rated with regard to:

- Voltage.
- Frequency.
- Temperature.
- Normal operating current.
- Overload current.
- Ability to make and break the maximum prospective fault current.
- Ability to withstand the maximum prospective through fault current.
- Working environment.
- Electromagnetic compatibility and the ability to withstand electromagnetic radiation interference.

Information Note: The rating of the switchgear needs to be reviewed regularly to ensure that fault levels have not increased beyond that of the switchgears rating.



Clause 19(n)

Requires the safe operation of high voltage installations throughout their Lifecycle.

Particular attention needs to be given to high voltage installations. This requires the implementation of a high voltage management plan consistent with the requirements of the local supply authority.



2.2 General requirements

Switchgear that can remove all the power to the operation must be provided at the incoming supply point (or at the generator, as the case may be).

The electrical reticulation system should be sectionalised so that specific parts of the system can be isolated without affecting other parts. The sectionalisation should facilitate inspection, maintenance, testing (minimal disruption to the part of the installation not being maintained) and fault finding.

The switchgear must be able to be operated without endangering the switchgear operator. Particularly the risks from arc blast injuries need to be considered. This may require remote switching capabilities.

Automatic re-close after a trip is NOT acceptable. The operation will need to make arrangements with electricity supply authorities to disable all automatic re-close facilities on the switchgear supplying the mine.

Standards of Engineering Practice should specify design and installation requirements for this switchgear including adequate signage and circuit and distribution diagrams. In particular, the switchgear shall be clearly and durably labelled to identify the equipment/circuit it supplies and the voltage level of the switchgear.

For surface installations refer to AS/NZS 3000 and AS 3007.

2.3 Additional and particular requirements for underground operations

Switchgear that is dedicated to supplying underground power must be provided at the surface of the mine. As such the switchgear installation must comply with AS/NZS 3000 and AS 3007

Switchgear shall be provided at each air split.

Switchgear shall be designed and arranged so that when power is switched on at the surface to underground parts power shall not be applied to any equipment located in a hazardous zone as a result of that switching.

Switchgear shall be designed and arranged so that where cables reduce in CSA and where the type of cable changes from fixed to flexible suitably rated switch gear must be installed e.g. paper lead or XLPE to rubber trailing cables.

Standards of Engineering Practice shall be developed for switchgear locations and must consider the following:

2.3.1 GENERAL

The location shall have good roof and rib support.

- The location shall be well ventilated.
- The location shall be well clear of moving traffic.



- The location shall be such that persons operating, inspecting or maintaining the switchgear shall be well clear of moving traffic.
- There shall be adequate access to the switchgear for operational, inspection and maintenance purposes.
- The area shall be free of slip trip and fall hazards.
- There shall be two egress points or there shall be sufficient space from the switchgear to effect safe egress.
- It is not to be located in wet areas in particular near or in pools of water.

2.3.2 HV SWITCHGEAR REQUIREMENTS (OTHER THAN LONGWALL PANTECHNICON)

- Should be housed in a room or cut through set aside for the purpose.
- Should be fitted with fire alarms and fire extinguishing equipment – automatic fire detection and suppression may be required where electrical equipment contains flammable fluids.
- Should have provision for the removal of power in an emergency (emergency stop on the intake side of the room or cut through).
- Permanent lighting shall be provided.
- There shall be no combustible material stored in the room or cut through.
- Where the equipment contains combustible liquid the ventilation should have provision for short circuiting to the return airway in the event of a fire.
- Access shall be for authorised personnel only.



Chapter 3 Provision of automatic removal of power



Clause 13(1)(e)(v)

Requires the provision of electrical safeguards for electrical and non-electrical hazards, with a safety integrity level appropriate to the degree of risk posed by the hazard.

All of the automatic arrangements for tripping off electric power can be considered as electrical safeguards. These arrangements must have:

- An appropriate safety integrity level
- Engineering provisions (locks, special access keys or codes) so that only authorised persons can reset the tripping mechanism and restore power
- Alarms and/or annunciations that clearly identify the reason for the trip.



Clause 19(1)(u)

Requires the automatic removal of power in the event of the main ventilation system failing.

Automatic tripping of the underground power that is not intrinsically safe Ex ia must be provided in the event of the main ventilation fan failing. This arrangement must be incapable of being restored before the main ventilation system is repaired and restarted.



Clause 19(1)(f)

Requires the automatic tripping of power to a face machine when the gas concentration is greater than or equal to 2%.

Automatic tripping of the power to the face machine (continuous miner and mobile roof bolters) when the gas is at 2% or greater at the machine. This system must trip off at the DCB supplying the machine, or some other point further outbye than the DCB.



Clause 19(1)(g)

Requires the automatic tripping of power to a longwall, shortwall or miniwalls faces when the gas concentration is greater than or equal to 1.25%.

Automatic tripping of the power to the longwall, shortwall or miniwalls face when the gas is at 1.25% or greater. This system must trip off at the switchgear on the longwall pantechnicon, or some other point further outbye of the longwall pantechnicon.



3.1 Additional automatic trip systems

Where auxiliary fans are used to ventilate parts of mines then in the event of the auxiliary fan/ventilation failing the power shall be automatically removed to any non Ex ia electrical equipment in the ventilated area.

Where booster fans are used to ventilate parts of mines then in the event of the booster fan/ventilation failing the power shall be automatically removed to any non Ex ia electrical equipment in the ventilated area.



Chapter 4 Procedures for the removal and restoration of power



Clause 19(1)(k)

Requires the safe removal of power under certain circumstances

Removal and restoration of power procedures must provide for the removal of electric power in any of the following circumstances:

- In the presence of flammable gas: for non Ex equipment the maximum gas concentration is 0.5%; for Ex equipment other than specified types (eg Ex ia) the maximum gas concentration is 1.25%.
- If ventilation falls below a specific quantity (to be determined by the operator in consultation with the manager of mining engineering and the manager of electrical engineering).
- If inspections required by the inspection program have not been conducted.
- In the event of an electrical fault.
- If there has been a failure to maintain equipment in accordance with the electrical engineering management plan.
- If unsafe electrical equipment or practices have been detected.
- Procedures to ensure that in the event of a failure of the main ventilation system the electric power supply entering the coal operation (other than power to equipment registered as intrinsically safe) is not restored until it is safe to do so.

Note: Removal of electric power in the event of an electrical fault must be automatic

Note: Miners have to be withdrawn to a safe place when the gas concentration is at 2%. This infers the removal of miner's caplamps to a safe place also.

Note: Whilst ever power is supplied to the undergoing working of a mine there shall be a person who is competent to remove power to the underground working. A suitable system shall be provided that allow the competent person to remove the power and to be able to check that the power has been removed.

Note: People must be competent to remove the power. The removal competencies may be very different from the restoration competencies if removal can be effected remotely from the switchgear by, for example, an emergency stop systems.

Note: Persons who are to operate switch gear as part of their role should receive training. This training should be competency based and should be refreshed periodically or if there is a system change. This competency should include low voltage and high voltage operations. All persons working at a mine should be trained in the switching of electricity in the area of their work. Such training should include shutdown and emergency shutdown.



Clause 19(1)(l)

Requires only competent people can restore power

Procedures must provide for the restoration of power only by people competent to operate the switchgear.

Note: The actual task of restoring power may require more than one person and a wide range of competencies. For example competencies in operating the switchgear and understanding of the electrical distribution system and competencies in determining that it is safe to restore the power with regard to mine atmosphere or other matters. For high voltage switchgear this may require special operator competencies and in certain circumstances it can only be done by electrically qualified people.

Note: Mains power must not be restored after a main ventilation fan failure until a mining supervisor has determined it is safe to do so.

Note: Similarly people must be competent to remove the power. The removal competencies may be very different from the restoration competencies if removal can be effected remotely from the switchgear by, for example, an emergency stop systems.

Note: Persons who are to operate switch gear as part of their role should receive training. This training should be competency based and should be refreshed periodically or if there is a system change. This competency should include low voltage and high voltage operations. All persons working at a mine should be trained in the switching of electricity in the area of their work. Such training should include shutdown and emergency shutdown.



Clause 117 Operators duty where failure of main ventilation system

Requires every battery operated portable or mobile machine is taken to a safe place (main intake airway or properly constructed charging station).

Procedures are required to deal with non-Exia battery powered portable or mobile equipment in the event of a failure of the main ventilation system for part of the mine. This equipment must be brought out without delay to the main intake airways or a charging or repair station of suitable fireproof construction that is normally ventilated with intake air.

It is recognised that cap lamps will be used until withdrawal of men at 2% methane.

- Refer to EES004 NSW DPI Technical Reference – Practices for Portable Electrical Apparatus
- Refer to the Gazette Notice for the conditions of use of non-explosion protected plant in a hazardous zone



Note: The operation must also consider what is required with portable battery powered equipment, battery powered mobile equipment and diesel powered equipment incorporating electrical generators and batteries. Diesel powered generator sets (Powertrams) should be immediately shut down in the event of a failure of the main ventilation system. Similarly if a powertram is being used in an area ventilated by booster fans or auxiliary fans it should be shut down immediately in the event of a failure of the booster fan or auxiliary fan system

4.1 Other matters to consider in developing removal and restoration of power procedures

As part of determining removal and restoration of power requirements the coal operation must consider all electrically powered installations from the supply authorities metering point through to the final drives on the distribution system. In developing arrangements for the safe removal and restoration of power the coal operation should consider as a minimum the following matters:

4.1.1 GENERAL (SURFACE AND UNDERGROUND INSTALLATIONS)

Complexity of the electrical distribution system (ring main systems, any 'T' off arrangements).

Note: 'T' distribution arrangements are strongly discouraged in surface installations and are NOT acceptable in underground operations.

Supply points being remote from the coal operation.

High voltage supplies that are supplied from other switch yards, via transformers and bore holes e.g. a longwall supply via a surface overhead power lines to seam bore hole that is relocated at the completion of a longwall block or where a second underground supply is taken from another mine entry.

Changes to the distribution system that have not been referenced or changed on the system.

Interaction with electricity supply authorities – contact phone numbers and personnel must be kept up to date. In particular, removal of power from overhead power line crossing the mining lease. If overhead power lines transverse the mining operation and are not associated with the mine, the mine shall have procedures for removal of high voltage power in an emergency. These procedures are to include contact details and protocol for liaison with transmission operators, network service providers and local supply authorities (Country Energy, Integral Energy, and Energy Australia).

Interaction with emergency services. Emergency service personnel should be able to confirm that all power is removed.

A dangerous situation that could affect the electrical distribution system such as:

- Bush fire.
- Fire involving electrical switch gear and transformers.
- Flood of water or mud.
- Land slip or failure of a high wall.

Loss of power to the coal operation.



Suitable means of turning the power off in the event of an emergency by operation of an emergency shut down device (an emergency stop). There may be several devices located around the surface and/or a number of devices that control specific areas. These systems shall have a suitable safety integrity level.

Inadvertent loss of power by the supply authority where there is a danger if the power is automatically restored.

Inadvertent loss of power to an area of the mine where there is a danger if the power is automatically restored.

Procedures for investigating causes of power failure and remedial actions to be taken e.g. power loss from supply authority, periodic shutdown (weekends, holidays).

Power being turned off (or arrangements to prevent access and activation) when no one is in attendance.

Power being removed in the event the event of a fire, electric shock or other emergency.

Following an electrical fault that has been detected by an electrical protection system an investigation shall be completed to establish the cause of the interruption. The system shall be tested before power is applied by suitably qualified electrical people. Unauthorised persons shall not reset protection devices.

Following an electrical fault, such as a short circuit, the circuit breaker that cleared the fault should be serviced and, if the circuit breaker is oil filled, then the oil should be replaced.

Restoring power at the start of a shift or following an interruption of power.

Restoration of power for remote controlled machines.

Absence of communication between control rooms and isolation points within the system.

Suitable signage that refers to fire, electrical shock and in case of an emergency.

For surface hazardous areas – refer to underground installations.

4.1.2 UNDERGROUND INSTALLATIONS

Power being turned on at the surface and hazardous zone equipment being energised.

Power being applied to a mine or part of a mine that has flammable gas present.

Power being applied to a mine or part of a mine that has not been inspected.

Power not being turned off to a mine or part of a mine if the ventilation system fails.

Power not being automatically removed when flammable gas concentrations rise to prescribed levels.

Power not being turned off in a hazardous zone when no one is in attendance.

Power not being automatically removed when there is a failure of ventilation fans, booster fans or auxiliary fans.

Power being applied to electrical equipment installed in a hazardous zone or area which is not explosion protected.



Mobile equipment tripping off as a result of an unplanned movement.

Restoration of power for remote controlled machines. Where power is lost to a machine locally the machine should have suitable diagnostic to indicate why power has tripped. If power has tripped to a machine at a remote location e.g. GEB or load center. Safe work systems are to be developed to establish the cause of the failure without putting persons at risk when restoring power e.g. following an unplanned movement of a continuous miner that trip power back to the GEB.

4.2 Risk factors when operating switchgear

When a person operates any electrical equipment there is a risk. Methods of reducing the risks to persons operating switchgear include:

- Switch gear should be operated remotely to remove the operator from any risks associated with arc blasts under fault conditions.
- Operators of high voltage switch gears are to be supplied with suitably rated PPE to protect them from arc blasts under fault conditions.
- Operators of high voltage switch gear to be trained in first aid.
- Operators of high voltage switch gear are to receive refresher training periodical to maintain their competency levels.
- Operator of low voltage switch gear should have the necessary training, safe work system, PPE and protection as is required.

4.3 Defect management & record keeping

4.3.1 REPORTING OF DEFECTS

The arrangements for removal and restoration of power should include measures for the reporting, monitoring and review of failures in removal and restoration power.

Note: Some of the matters associated with removal and restoration of power may be a notifiable occurrence under the *Coal Mine Health and Safety Act 2002 and Regulation*.

4.3.2 RECORDS

The Electrical Engineering Management Plan should identify the requirements for the keeping of records relating to the removal and restoration of power. These records should include records of:

- Removal and restoration at the completion and commencement of operations.
- Removal due to high concentrations of methane.
- Removal due to a dangerous situation being present.
- Removal due to an electric fault.
- Removal due to a person receiving an electric shock.
- Removal and restoration for maintenance purposed involving high voltage isolations.
- Where it has been identified by a risk assessment that records should be kept.
- Where lightening has caused power to trip.
- When a blackout occurs that affects the ventilation of the mine.



Chapter 5 Feedback Form

Your comments will be very helpful in reviewing and improving this document.

Please copy and complete the Feedback Form and return it to:

Senior Inspector Electrical Engineering
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PO Box 344
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Fax: (02) 4931 6790
Phone: (02) 4931 6641

How did you use, or intend to use, this Technical Reference?

What do you find most useful about this Technical Reference?

What do you find least useful?

Do you have any suggested changes to the document?

Thank you for completing and returning this Feedback Form.



Chapter 6 NSW DPI Contact Details

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