NSW Resources Regulator

Electrical engineering control plan

NSW code of practice | WHS (MPS) legislation

NSW GOVERNMENT

NSW RESOURCES REGULATOR

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Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (December 2018). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the NSW Department of Planning and Environment or the user's independent advisor.

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Contents

Foreword

This *NSW code of practice: Electrical engineering control plan* is an approved code of practice under section 274 of the *Work Health and Safety Act 2011* (the WHS Act)

An approved code of practice is a practical guide to achieving the standards of health, safety and welfare required under the WHS Act, Work Health and Safety Regulation 2017 (the WHS Regulation) *Work Health and Safety (Mines and Petroleum Sites) Act 2013* (WHS (MPS) Act) and the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 (WHS (MPS) Regulation)[1].

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the WHS legislation, in relation to the subject matter of the code. Like Regulations, codes of practice deal with particular issues, but do not cover all hazards or risks that may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which Regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS laws. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

Compliance with the WHS legislation may be achieved by following another method, such as a technical or industry standard, if it provides an equivalent or higher standard of work health and safety.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice.

The development of this code of practice

This code of practice was developed under the Inter-Governmental Agreement for Consistency or Uniformity of Mine Safety Legislation and Regulations in NSW, Queensland and Western Australia and forms part of the mining safety legislative framework for these states. Under this agreement, tri-state model legislation was developed, although designed to be structured and customised differently in each of these states.

This code was also developed in consultation with the Non-Core (tri-state) Legislative Working Group representing the following stakeholders from the mining industry in the tri-states including:

NSW Minerals Council

Cement Concrete & Aggregates Australia (CCAA)

Construction Forestry Mining and Energy Union (CFMEU) – NSW and QLD

NSW Department of Planning and Environment, Resources Regulator

[1] It will sometimes be convenient to refer generally to 'WHS laws', which includes:

- WHS Act
- WHS (MPS) Act
- WHS Regulation
- WHS (MPS) Regulation

Queensland Resources Council

Queensland Department of Natural Resources and Mines

Western Australia Department of Mines and Petroleum

Various industry organisations,

The Resources Regulator developed this NSW version of the code for the WHS laws. Any public comment and feedback from mining stakeholders will be considered in finalising the code.

The code will be reviewed as required or when legislation is reviewed.

Scope and application

The code of practice provides guidance for mine operators to prepare, implement and review an electrical engineering control plan (EECP) to control risks to health and safety associated with electricity at a mine, as required under the WHS laws. Risks associated with electricity may exist across the mining operation and involve other plans, hazards and controls.

Details are also provided in this code on sources of guidance that may help develop an EECP and select control measures.

This code may also be relevant for other duty holders involved with electrical matters at the mine, such as designers and suppliers of plant or contractors, hirers at the mine as well as workers and their representatives.

To provide appropriate guidance on technical matters, the advice given in some parts of this code assumes a basic level of electrical engineering competence as expected of an electrical tradesperson.

This code does not apply to the following types of mines under clause 184 of the WHS (MPS) Regulation, as they are not required to have an EECP:

- → opal mines
- → an underground small gemstone mine (see definitions in clause 3 of the WHS (MPS) Regulation)
- → tourist mines

However, surface small gemstone mines are required to have an EECP if there are risks from electricity.

How to use this code of practice

This code includes references to both mandatory and non-mandatory actions. The references to legal requirements contained in the WHS Act and Regulation, and the WHS (MPS) Act and Regulation are not exhaustive and are included for context only.

References to publications in the code are to be assumed to be to the current version of the document. See the References section for further details.

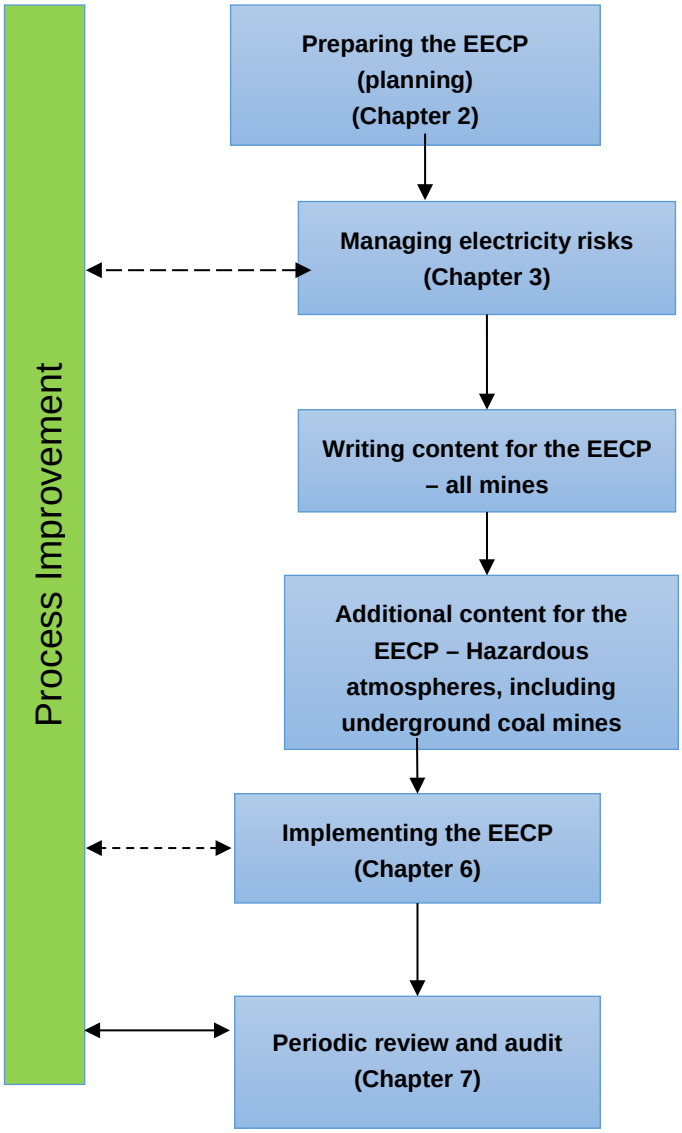
The words ‘must’, ‘requires’ or ‘mandatory’ indicate that legal requirements exist and must be complied with. The word ‘should’ indicates a recommended course of action, while ‘may’ indicates an optional course of action.

Unless otherwise indicated in the text, lists of points in the code should not be read as exhaustive.

Code of practice structure

This code of practice follows a structured approach to preparing, implementing and periodically reviewing an EECP. This is reflected in figure 1 below for the structure of the code:

Figure 1: Code of practice structure.



Acronyms

A – amps

AC – alternating current

AS – Australian Standard

AS/NZS – Australian and New Zealand Standard

DC – direct current

EECP – electrical engineering control plan

ELV – extra low voltage

Ex – explosion protected

HV – high voltage

ILO – International Labour Office

IP – ingress protection

IT – information technology

LV – low voltage

mA - milliamperes

NZS – New Zealand Standard

PCBU – person conducting a business or undertaking

PCP – principal control plan

PHMP – principal hazard management plan

PPE – personal protective equipment

RCD – residual current device

SMS – safety management system

SWA – Safe Work Australia

TARP – trigger action response plan

WHS – work health and safety

Key terms

This glossary includes terms used in this code of practice. Definitions, where indicated, have been sourced from WHS laws and NSW or Safe Work Australia codes of practice. Elsewhere, the meanings are, as far as possible, commonly understood in electrical engineering applications or in mining operations.

Alteration - changed from the original design that may affect health and safety. Wear and tear due to normal service, whether or not specified by the designer or manufacturer, does not constitute alteration.

Competent person –a person who has acquired through training, qualification or experience the knowledge and skills to carry out the task, other than in respect of work for which a particular competency is prescribed, for example clause 5 definition of 'competent person' paragraphs (a)-(f) of the WHS Regulation, or in clause 3(1) of the WHS (MPS) Regulation.

Control measure – in relation to a risk to health and safety, means a measure to eliminate or minimise the risk (source: clause 5 of the WHS Regulation).

Earth fault current – means a current that will flow between an energized conductor and earth as the result of insulation failure (source: AS/NZS 2081).

Earth leakage current – means a current that flows between an energized conductor and earth as the result of a reduction in the value of insulation resistance (source: AS/NZS 2081).

Electrical plant - means plant, all or part of which is powered by electricity

(source: clause 3 of the WHS (MPS) Regulation)

Electrical engineering practices - activities undertaken during the lifecycle of electrical plant and installations, including the implementation of controls to manage risk.

Electrical installation - means a group of items of electrical equipment that:

(a) are permanently electrically connected together, and
(b) can be supplied with electricity from the works of an electricity supply authority or from a generating source.

(source: clause 145 WHS Regulations – Note: this clause only applies to Part 4.7 of the WHS Regulation)

Electrical safeguards - controls that use electrical technology to control workplace hazards and that are of a reliable nature to reduce risk.

Fit for purpose – something that is sufficient to do the job for which it was designed.

Functional safety - part of the overall safety (of plant or installations) that depends on a system or equipment operating correctly in response to its inputs (source: 61508.0-2006).

Hazardous area – means an area in which:

(a) an explosive gas is present in the atmosphere in a quantity that requires special precautions to be taken for the construction, installation and use of plant ; or
(b) a combustible dust is present, or could reasonably be expected to be present, in the atmosphere in a quantity that requires special precautions to be taken for the construction, installation and use of plant.

(source: clause 5 of the WHS Regulation)

Hazardous zone – in an underground coal mine means each of the following:

(a) any part at the mine in which the concentration of methane in the general body of the air is 1.25% by volume or greater,

(b) a return airway,

(c) any part of an intake airway that is on the return side of such points that are within 100 metres outbye of:

(i) the most inbye completed line of cut-throughs, or

(ii) (ii) any longwall or shortwall face, but only to the extent that the intake airway is on the intake side of that face (but not if the longwall face is an installation face at which the development of the face, and mining for development coal, have been completed and at which longwall mining has yet to commence).

(source: clause 3 WHS (MPS) Regulation

Ignition source – means a source of energy capable of igniting flammable or combustible substances (source: clause 5 WHS Regulation).

Isolated - disconnected from all possible sources of electricity supply and rendered incapable of being made energised without premeditated and deliberate action. (source: NSW *Code of Practice: Managing Electrical Risks in the Workplace*)

Life cycle - in relation to plant or structures, includes the period of its design, manufacture, construction, installation, commissioning, operation, maintenance, repair, decommissioning and disposal.

Live electrical work – The actual physical work of installing, maintaining, repairing, altering, removing or adding to electrical equipment and electrical installations, whilst the installation or equipment is energised, or the supervising of that work (source: AS/NZS 4836 but adapted for use in this code).

Modification - alteration (see meaning above).

Plant - includes:

(a) any machinery, equipment, appliance, container, implement and tool, and

(b) any component of any of those things, and

(c) anything fitted or connected to any of those things.

(source: section 4 WHS Act)

Portable electrical equipment - electrical equipment intended to be held in the hand during use or which is capable of being carried by one (1) or more people while energised.

Total connected power – sum of the power ratings of all electrical energy consuming devices installed at the mining operation.

Voltage -

- ***Extra low voltage*** means voltage that does not exceed 50 volts alternating current (50 V ac) or 120 volts ripple-free direct current (120 V ripple-free dc).
- ***Low voltage*** means voltage that exceeds extra-low voltage and does not exceed 1000 volts alternating current (1000 V ac) or 1500 volts direct current (1500 V dc).
- ***High voltage*** means voltage that exceeds low voltage.

(Source: NSW *code of practice: Managing electrical risks in the workplace and AS/NZS 3000*)

1. Introduction

Where electricity is used or is present, a hazard exists. Electricity includes stored energy such as lightning, static discharge, electro-magnetic devices, batteries and so on. The EECP is a principal control plan (PCP) used to manage risks associated with electricity at a mine.

The electrical aspects of plant or installations represent a significant risk that can cause death and injury in workplaces, if not adequately controlled. The consequences of these electrical risks may be caused either directly or indirectly, and include:

- → electric shock causing injury or death (electrocution)
- → arcing, explosion or fire causing burns or death
- → toxic gases causing illness or death
- → unintended operation of electrically controlled plant or equipment causing crush injuries or entrapment that results in injury or death
- → other injuries or illnesses such as muscle spasms, palpitations, nausea, vomiting, collapse and loss of consciousness.

Workers using electricity may not be the only ones at risk. Faulty electrical equipment and poor electrical installations can lead to the transfer of hazardous voltages to locations remote to the faulty equipment. This may also cause fires that may result in death or injury to others.

Electricity is used in virtually all mining enterprises, and an EECP, as part of the overall safety management system for the mine, is an important tool for establishing a systematic way of acquiring, operating, maintaining and working on the plant and installations.

The EECP applies to all sources of electricity, including solar or battery power, automotive or from other sources that are extra low voltage. It must also include power distribution assets owned by a mine such as high voltage supply aerials.

1.1. What is an electrical engineering control plan (EECP)?

An electrical engineering control plan sets out how a mine operator will manage the risk to the health and safety associated with electricity at the mine, and forms part of the safety management system for the mine. It includes information on how a mine operator will ensure that any plant developed, purchased or modified is fit for purpose and safe to use, is installed correctly and is operated safely and maintained in a safe condition by workers who are competent in its safe use.

1.2. Who has duties in relation to an EECP?

The mine operator of a mine in which there is a risk to health and safety associated with the electrical aspect of plant and structures at the mine must prepare an EECP:

WHS (MPS) Regulation

26 Principal control plans

…

(5) **Electrical engineering control plan**

The mine operator of a mine in which there is a risk to health and safety associated with electricity at the mine or petroleum site:

(a) must prepare and implement an electrical engineering control plan for the mine or petroleum site that sets out the means by which the operator will manage those risks in accordance with clause 9, and

(b) must ensure that the plan is developed and periodically reviewed by a person who is, or who is under the supervision of:

(i) the individual nominated to exercise the statutory functions of electrical engineering manager or electrical engineer at the mine or petroleum site, or

(ii) if no person is required to hold either of those positions at the mine or petroleum site, a competent person.

In practice, most mines use electricity so most mine operators will need to prepare an EECP.

When developing an EECP, it is important that the relevant electrical technical matters are understood and taken into account. This will require a competent person who can provide appropriate electrical technical knowledge (refer to 2.2 of this code).

1.3. What needs to be included in an EECP?

An EECP must set out how the mine operator will manage the risks associated with electricity at the mine. In doing so, it should provide for compliance with the WHS laws, so far as they relate to managing risks associated with electricity at a mine.

The detailed matters that must be addressed in an EECP are set out in Schedule 2 of the WHS (MPS) Regulation, which are summarised and extracted below:

- → Clause 3(1) sets out a range of overarching considerations that must be taken into account.
- → Clause 3(2) sets out five specific risks to health or safety associated with electricity in plant and installations.
- → Clause 3(3) sets out a range of matters that must be considered when developing control measures to manage the risks in clause 3(2).

Chapters 4 and 5 of this code provide guidance on these requirements.

WHS (MPS) Regulation

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

...

3 Electrical engineering control plan

1. The operator of a mine or petroleum site must, in preparing an electrical engineering control plan, take the following into account in determining the means by which the operator will manage the risks to health and safety from electricity at the mine or petroleum site:

(a) the overall life cycle of the electrical aspects of plant and electrical installations at the mine or petroleum site,

(b) the reliability of electrical safeguards used at the mine or petroleum site to protect persons from electrical or other hazards,

(c) the electrical engineering and electrical work practices to be employed at the mine or petroleum site,

(d) the competency required by workers to safely work on electrical plant or electrical installations at the mine or petroleum site.

2. An electrical engineering control plan must set out the control measures for the following risks to health and safety associated with electricity at the mine or petroleum site taking into account the matters set out in subclause (3):

(a) injury to persons caused by direct or indirect contact with electricity,

(b) injury to persons caused by working on electrical plant or electrical installations,

(c) the unintended initiation of gas or dust explosions,

(d) the unintended operation of plant,

(e) the occurrence of uncontrolled fires.

3. The following matters must be taken into account when developing a control measure referred to in subclause (2):

(a) the location of the electrical plant and electrical installations at the mine or petroleum site,

(b) the rating and design of plant for the prospective electrical fault level, electrical load, operating frequency, operating voltages and arc fault control,

(c) the design and operation of any electrical plant that contains flammable liquid,

(d) the carrying out of the selection, installation and use of electrical cables and electrical cable accessories at the mine or petroleum site,

(e) the control of static electricity at the mine or petroleum site, including preventing the ignition of flammable gas,

(f) the impact of lightning on the mine or petroleum site (especially on an underground mine) including the effect on electrical systems,

(g) the need for reliable circuit interruption for all points in electrical distribution system at the mine or petroleum site when faults occur taking into account the operating time and tripping current of circuit protection devices,

(h) the type of earthing system used, including levels of earth fault limitation,

(i) the potential for persons to contact electricity indirectly,

(j) the prospective touch, step and transfer voltage,

(k) variations in operating conditions,

(l) preventing persons inadvertently contacting energised parts of electrical plant and electrical installations,

(m) the consultation, co-operation and co-ordination of activities between persons conducting businesses or undertakings at the mine or petroleum site (including the operator) and persons conducting

businesses or undertakings installing, maintaining or carrying out work on an electricity supply authority's infrastructure,

(n) the procedures for the following:

(i) the use of electrical welding plant,

(ii) the use of electrical test instruments,

(iii) work near overhead power lines and cables,

(iv) the treatment of electric shocks and electric burns,

(v) accessing and working on high voltage electrical installations,

(o) signage and notices in relation to the risks arising in relation to particular electrical plant and electrical installations such as electrical switchgear,

(p) the security and maintenance of the electrical control system software and control circuits at the mine or petroleum site,

(q) the use of lasers and fibre optic equipment at the mine or petroleum site,

(r) the construction, installation and maintenance of battery powered vehicles and battery charging stations at the mine or petroleum site,

(s) the supply of electricity in hazardous atmospheres and, in the case of underground coal mines, in hazardous zones,

(t) the use of electrical plant in hazardous atmospheres and, in the case of underground coal mines, in hazardous zones,

(u) safe work systems for persons dealing with electrical plant and electrical installations including the isolation, dissipation and control of all electrical energy sources from the electrical plant or electrical installation,

(v) the use of switchgear and electrical protection devices that can automatically detect an electrical fault in a circuit and disconnect the supply of power to the circuit.

1.4. Does an EECP need to be documented?

An EECP must be documented and must, so far as is reasonably practicable, be set out and expressed in a way that is readily understood by people who use it (clause 26(2) WHS (MPS) Regulation). Workers who may be affected by risks associated with electricity, such as those who operate or work on electrical plant or installations, must be able to understand the requirements of the EECP as it relates to the particular work being carried out. This may require technical content for electrical workers and non-technical content for others.

An EECP may index other documents and plans that form part of it.

An EECP, as with all principal control plans (PCPs), must be readily accessible to all workers at the mine. EECP documentation should be version controlled and may be kept in an electronic or paper form, or a combination of both.

1.5. What consultation is required?

The mine operator has a duty to consult with workers on matters that relate to work health and safety that are, or are likely to be directly affected (section 47 of the WHS Act). In particular, this involves

implementing a safety role for workers to consider control measures for risks to be managed under the principal control plans. It also involves consulting with workers in conducting risk assessments for the principal control plans (clauses 120 and 121 WHS (MPS) Regulation). This consultation may be undertaken in accordance with the arrangements for consultation agreed at the mine such as consulting with HSRs, SHR and or any health and safety committee.

The mine operator must, so far as is reasonably practicable, consult, cooperate and coordinate with other people who also have a duty to consult, including in relation to the risks associated with electricity at the mine. This includes other PCBUs and workers (sections 46 and 47 of the WHS Act).

Consultation, coordination and cooperation between the mine operator and other PCBUs, especially contractors, is critical in ensuring that all risks associated with the electricity are identified and managed in a consistent way.

General guidance on the duty to consult under the WHS Act can be found in the *NSW code of practice: Work health and safety consultation, cooperation and coordination* and for mines specifically in the *NSW code of practice: Safety management systems in mines*.

1.6. Other duties in relation to the electrical plant and installations

1.6.1. Primary duty

The mine operator (as well as any other PCBUs at a mine) has a primary duty under section 19 of the WHS Act to ensure, so far as is reasonably practicable, that workers and other people are not exposed to health and safety risks arising from the business or undertaking. This duty includes ensuring, so far as is reasonably practicable:

- → the provision and maintenance of safe plant and installations
- → the safe use, handling, and storage of plant
- → provision of information, training and instruction
- → supervision.

1.6.2. Management or control of plant

A PCBU with the **management or control of fixtures, fittings or plant at a workplace**, including the mine operator, has a duty under section 21 of the WHS Act to ensure, so far as is reasonably practicable, that the fixtures, fittings and plant are without risks to the health and safety of any person.

The WHS Regulation (Chapter 5, Part 5.1, Division 7) includes specific duties in relation to plant, other than plant that relies exclusively on manual power for its operation and designed to be primarily supported by hand (for example, a screwdriver). This includes requirements for PCBUs with the **management or control of plant** to (among other things):

- → manage the health and safety risks associated with such plant
- → prevent unauthorised alterations to, or interference with, such plant
- → use plant only for the purpose for which it was designed, unless the proposed use does not increase the risk to health or safety.

1.6.3. Design, manufacture, import and supply

Designers, manufacturers, importers and suppliers of plant, substances and structures have duties under sections 22-25 of the WHS Act that will also apply to a mine operator if they design, manufacture, import or supply plant, substances or structures. In relation to plant, substances and structures these duties may be summarised as a duty to ensure, so far as is reasonably practicable, that the plant, substance or structure is without risks to the health and safety of people at a workplace who:

- use the plant, substance or structure for a purpose for which it was designed or manufactured
- handle the substance
- store the plant or substance
- construct the structure
- carry out any reasonably foreseeable activity in relation to:
  - the manufacture, assembly or use of the plant for a purpose for which it was designed or manufactured or the proper storage, decommissioning, dismantling or disposal of the plant, or
  - the manufacture or use of the substance for a purpose for which it was designed or manufactured or the proper handling, storage or disposal of the substance, or
  - the manufacture, assembly or use of the structure for a purpose for which it was designed or manufactured or the proper demolition or disposal of the structure, or

are at or in the vicinity of the workplace and:

- who are exposed to the plant, substance or structure at the workplace, or
- whose health or safety may be affected by a use or activity referred to above.

1.6.4. Calculation, analysis, testing or examination

Designers, manufacturers, importers and suppliers must also carry out, or arrange for the carrying out of, any calculations, analysis, testing or examination that may be necessary for the performance of the duty imposed by sections 22-25 of the WHS Act, or alternatively, in the case of importers and suppliers, ensure that such calculations, analysis, testing or examination have been carried out. For electrical installations, this may include voltage drop calculations, load flow studies, protection studies and arc blast calculations.

1.6.5. Information to be provided

Sections 22-25 of the WHS Act, also require designers, manufacturers, importers and suppliers to give adequate information to each person to whom they provide the design, plant or structure (and subsequently upon request) concerning:

- each purpose for which the plant, substance or structure was designed or manufactured
- the results of any calculations, analysis, testing or examination referred to above, including, in relation to a substance, any hazardous properties of the substance identified by testing
- any conditions necessary to ensure that the plant, substance or structure is without risks to health and safety when used for a purpose for which it was designed or manufactured or when carrying out any activity discussed in the previous list.

1.6.6. Install, construct or commission plant

PCBUs that **install, construct or commission plant or structures**, including the mine operator, have a duty under section 26 of the WHS Act to ensure, so far as is reasonably practicable, that the way the plant or structure is installed, constructed or commissioned ensures the plant or structure is without risks to the health and safety of people who:

- → install or construct the plant or structure at a workplace
- → use the plant or structure at a workplace for a purpose for which it was installed, constructed or commissioned
- → carry out any reasonably foreseeable activity at a workplace in relation to the proper use, decommissioning or dismantling of the plant or demolition or disposal of the structure
- → are at or in the vicinity of a workplace and whose health or safety may be affected by a use or activity referred to above.

1.6.7. Supply of second-hand plant

Mine operators and other PCBUs may acquire or be suppliers of second-hand plant. Suppliers of second-hand plant, other than hand-held, manually operated plant, must ensure, so far as is reasonably practicable, that any faults in the plant are identified. A written notice outlining the condition of the plant, any faults identified and, if appropriate, that the plant should not be used until the fault is rectified, must be provided to the person to whom the plant is supplied.

If second-hand plant is to be used for scrap or spare parts, the supplier must tell the person they are supplying it to, that the plant is scrap or spare parts and that the plant in its current form is not to be used as plant. This must be done in writing or by marking the item of plant.

These requirements are stipulated in clauses 198-200 of the WHS Regulation.

1.6.8. Acquisition of plant

Acquisition involves the obtaining or procuring of new, second-hand or hired plant for the mine. Acquisition also includes the procurement of spare or replacement parts.

The EECP should provide systems to ensure the acquisition of plant includes the processes to verify that any plant, new to the mine, is fit for the intended purpose in the intended operating environment and is safe to use (introduction to mine site).

The EECP should also provide processes to ensure replacement parts are fit for purpose. Plant introduced to the mine by others, such as contractors, must also be considered.

In managing acquisition of plant, the EECP should address, or link to other control plans that do address, the following matters:

- → identification of the intended purpose and operating environment of which the plant is to be used. This may include:
  - o intended life, loads and maintenance strategies
  - o carrying out a preliminary or broad-brush identification or hazards and risk assessment on the intended use of the plant

- identifying safety requirements (including specific controls required by WHS laws as well as industry standards or practices and requirements to meet the safety standards of the mine)
- identifying any environment specific issues that the supplier may not be aware of e.g. elevated ambient temperatures or the use of plant in a potentially explosive atmosphere.

→ if the plant is new or hired, the information above should be provided to the plant supplier along with any mine specific requirements or mine engineering standards. The supplier should verify the plant being supplied is safe to use for the mine requirements.

→ if the plant is second-hand, a competent person (with appropriate electrical skills) should verify the plant is safe for the intended use at the mine, or identify what needs to be done to allow the plant to be used safely. Where available, previous maintenance history and risk assessments should be reviewed. The supplier of second-hand plant must ensure, so far as is reasonably practicable, that any faults in the plant are identified (clause 199 WHS Regulation)

→ the provision of information from the supplier or hirer on the safe use and maintenance requirements for the plant or structure

→ consultation with the electrical engineering manager or electrical engineer or other people with appropriate electrical engineering competence throughout the process, particularly at critical times such as agreement on technical specifications, maintenance requirements and the initial release of plant into service

→ arrangements for ensuring plant is operated in accordance with its purpose. For example, considering any training, competence, registration or licensing requirements, as well as arrangements to ensure plant is used only for its intended purpose and within its designed parameters.

Other items to consider in the acquisition of plant should include:

→ identifying safety-critical systems on the plant

→ identifying potential failure modes of safety critical components

→ providing inspection, testing and maintenance practices to ensure the plant is safe to use, having regard to information provided by the supplier

→ interaction between duty holders (designer, manufacturer, supplier) in the supply chain so that they consult and cooperate as required under the WHS Act, such as when developing technical specifications

→ developing schedules to modify existing plant to meet minimum mine standards

→ developing procedures for the safe operation of new plant, including monitoring provisions to detect failure before it occurs and identifying isolation arrangements.

Interaction of EECP with other plans

Principal control plans (PCPs) together with principal hazard management plans (PHMP) form part of the safety management system (SMS) for a mine.

PCPs cover hazards and controls that exist across the mining operations for a particular matter, such as risks from the electrical aspects of plant and installations.

PHMPs deal only with the identified principal hazards (PH), that is, hazards that have a reasonable potential to result in multiple fatalities in a single incident or a series of recurring incidents. PMHs may exist only in a certain part of the mining operations, such as ground instability where extraction is taking place.

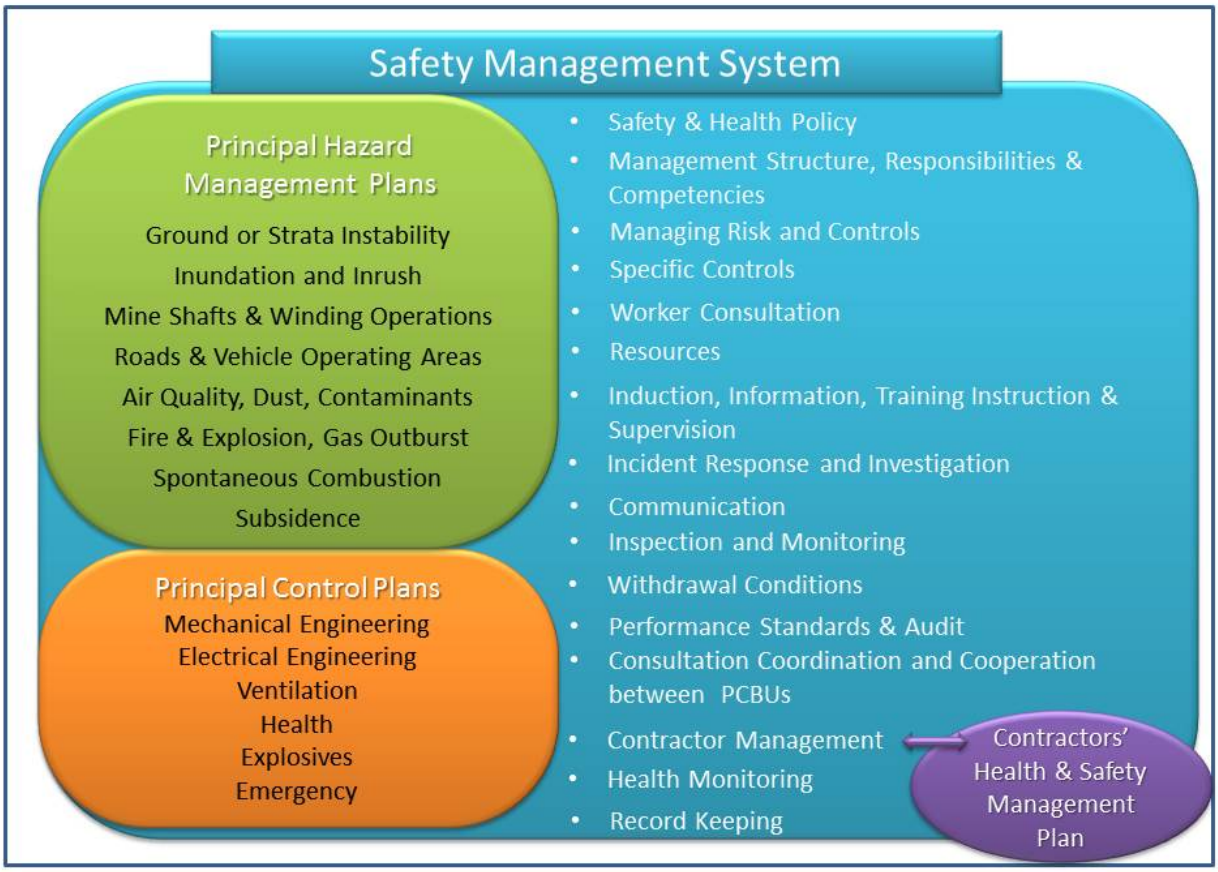
PCPs manage specific hazards that may be part of or affect principal mining hazards and controls, and consequently the plans for them. A PHMP, for example, may directly refer to the EECP in relation to preventing fires and explosions arising from electrical plant or installations. The EECP may also directly refer to other plans and/or specify electrically related standards and controls for them. The mine operator may find it appropriate to have one plan that combines the legislated content of several control plans and PHMPs.

The mine operator may also create additional control plans to manage other specific risks or hazards, as long as any specific controls or other legislative requirements are satisfied. For example, a mine operator may want to use a control plan for processes such as chemical treatment for water or mineral extraction. Where these additional control plans require the use of electricity, the EECP and the additional control plan should be linked to ensure the risks from electricity associated with the additional control plan are managed.

The mine operator may also choose to have their EECP made up of sub plans or to reference additional control plans. For example, sub plans for particular types of electrical plant and installations or for particular activities such as construction, portable electrical tools or management of high voltage.

Figure 2 shows the mine safety management system and the relationship of PHMPs, PCPs, and specific control measures.

Figure 2: Mine safety management system.



1.7. Plant registration and licenced activities

1.7.1. Registration of mining industry plant under WHS (MPS) Regulation

The design of certain mining plant must be registered with the NSW Resources Regulator. The EECP should provide for the management of the plant registration, in conjunction with the mechanical engineering control plan, so that electrical requirements are considered in the risk management of the plant. This should include processes to ensure only registered plant is used where the legislation requires that only registered plant is used.

The EECP should also provide for management of the alteration to design registered plant when any alteration to the plant is required to be carried out.

Appendix A provides further information on plant that requires either design, or design and item registration requirements.

1.7.2. Licensing of activities in coal mines

Mine operators of underground coal mines must ensure that no person carries out certain activities unless carried out under, and in accordance, with a licence under Part 9 of the WHS (MPS) Regulation.

Relevant licensed activities include the overhaul, repair or modification of explosion-protected plant, and the repairing of flexible reeling, feeder or trailing cables for use in a hazardous zone.

A licence will detail the scope of the activities and the locations where the activities are permitted to be undertaken. A licence may contain conditions that must be complied with for the licence to be valid.

An EECP should contain processes to ensure that only workers with a valid licence are permitted to undertake a licensable activity, and that the activity is undertaken in accordance with the scope of the licence and pursuant to any conditions contained in the licence.

2. Preparing an EECP

2.1. General

Before developing an EECP, the mine operator should consider how it is to be prepared, implemented and integrated within the mine SMS (including other PCPs and PHMPs). The development and review of an EECP must be undertaken by or under the supervision of the electrical engineering manager, electrical engineer or an electrically competent person (see section 2.2). The preparation should also involve consultation with relevant workers.

When preparing an EECP, the mine operator should consider the matters in sub sections 2.1.1 to 2.1.7 of this code.

2.1.1. Relevant WHS information, standards and other guidance

The effectiveness of the EECP will be enhanced if all relevant matters are considered.

Gathering information about WHS law requirements and recommended controls will help make the process as efficient, yet comprehensive, as possible. Legislation, codes of practice, standards, safety alerts, safety bulletins, published incident data, original equipment manufacturer (OEM) information and general WHS guidance may all help identify requirements, foreseeable hazards, risks and controls. The relevant parts of these types of documents should be considered in the preparation of an EECP.

Relevant standards may include those published by Australian Standards (AS), International Electrotechnical Commission (IEC) or the International Organisation for Standardisation (ISO).

Guidelines produced by various regulatory authorities, including NSW Resources Regulator and electricity supply authorities, may also aid in the identification of risks associated with electricity, along with providing recommendations for methods of management of those risks.

It is important to note that compliance with a standard or a guideline, either in part or in full, does not necessarily manage all risks associated with a particular hazard.

2.1.2. Nature and complexity of the mining operation

Different mines, depending on their level of risk and complexity, will have differing hazards and risk controls to identify and implement in an EECP. As part of the safety management system, an EECP must contain a level of detail that is appropriate to the mine, having regard to the particular risks at the mine and the nature, complexity and location of the mining operation (refer clause 14(2)(a) WHS (MPS) Regulation).

Mines differ considerably in their nature and complexity of operation. For example, a small mine may have two to three items of plant, whereas a large mine may have more than 200 items of plant. Likewise, mines will vary in complexity. For example, a quarry will have different risks and control measures compared with an underground coal mine. There will also be differences in the risk profiles of mines of the same type. For example, a quarry with long steep gradients will be different to a quarry operating on a level surface.

2.1.3. Intended audience

The mine operator must ensure that all workers who undertake tasks associated with electrical aspects of plant and installations at the mine are provided with suitable and adequate information, training and instruction in the risk control measures implemented under an EECP. As such, an EECP must be written so it is easily understood by the workers who undertake activities where electrical risks may exist. In the case of larger and/or more complex mines with a substantial plan, an overview document may explain how the plan interfaces with other plans and operates as a whole.

Things that may help workers understand and follow an EECP include providing a summary or outline of the EECP, or parts of it. An EECP may contain technical content for electrical workers and non-technical content for others. The mine operator should consider levels of literacy of workers and language limitations in determining minimum skill requirements for workers to be able to use the plan. This may also require providing translations into different languages, as necessary, for the workforce.

2.1.4. Identification of plant and its intended use

The mine operator must prepare an EECP in relation to the risks from electricity, including unintended operation, associated with all plant and installations at a mine, not just plant and installations provided by the mine operator

Therefore, the mine operator must ensure the risks from all plant and installations, including plant and installations provided or introduced by contractors, other PCBUs and workers are identified and considered in an EECP.

A common cause of risk in relation to plant is the plant being used for a purpose other than for which it was designed and therefore is not fit for purpose. Assumptions are sometimes made about plant, and the tasks that the plant can be used for, without understanding that the plant has been specifically modified for that alternative use or that the circumstances of its use are actually different. Identifying the intended use and operating environment of plant is critical in managing the risks associated with plant, as is understanding the limitations and constraints imposed by the plant design.

2.1.5. Existing plans and procedures

Any existing documents created before the commencement of the WHS (MPS) Regulation setting out how electrical risks are managed at the mine can provide a helpful starting point for the preparation of an EECP. Risk assessments, safe work method statements, documents of controls and engineering standards for the mine, should all be considered for inclusion in an EECP. Mines may have existing plans that may assist in the development of an EECP, such as electrical engineering management plans for coal mines.

It is critical that any existing documents are reviewed before being included in an EECP to ensure they are still relevant to the risks and practices at the mine as well as meeting requirements under the WHS legislation.

2.1.6. Use of generic plans

Larger organisations may prepare and implement a generic plan that is applied across multiple mines. Although the use of generic plans may provide consistency for the organisation across several mines, these may need to be modified for each mine as the mine operator must ensure an EECP is prepared to suit the nature, complexity and location of each particular mining operation and the risks associated with that mining operation.

Consultation with workers at each mine must occur so site-specific issues are identified and are appropriately managed. Skills and competencies of the workforce at each operation may also be different and may require changes to the generic plans to achieve the appropriate level of risk control.

2.1.7. Responsibilities for plant and installations at the mine

As an EECP sets out how risks associated with the use of electricity are managed, requirements of the individual position holders within the mine management structure who are responsible for the day-to-day implementation of the plan, or parts of it, should be contained in or referenced in an EECP. This should include the relationships between people with responsibilities in an EECP and other plans, including contractors, together with details of how any interaction issues are to be resolved.

2.2.Who can develop and review an EECP?

The mine operator must ensure the plan is developed and periodically reviewed by a person who is, or is under the supervision of the person performing the statutory function of:

- → for an underground coal mine, the electrical engineering manager
- → for coal mines other than underground coal mines, the electrical engineer
- → for other mines where total connected power at the mine is greater than 1000 kilowatts or where high voltage is used, the electrical engineer.

For other mines where the total connected power at the mine is not greater than 1000 kilowatts and where high voltage is not used, the mine operator should develop an EECP in consultation with an electrically competent person.

Refer to clause 26(5) of the WHS (MPS) Regulation and section 1.2 of the code and statutory electrical functions in 2.3 of this code for additional guidance.

The electrical engineering manager, the electrical engineer or competent person should have an active role in the implementation of the EECP, as their skills and knowledge will help ensure technical aspects of the plan are fully understood and introduced effectively. Where the plan, or portion of the plan, is developed by a person under the supervision of the statutory position holder, then some form of endorsement or approval arrangement must be in place to confirm the statutory position holder is satisfied with the EECP and that technical matters have been properly addressed.

The EECP should be reviewed according to a schedule determined by the mine operator in consultation with those exercising relevant statutory functions and workers, as part of the mine safety management system.

2.3. Statutory electrical functions for mines

2.3.1. General

The WHS (MPS) Regulation requires that certain functions are exercised only by individuals who have been nominated to exercise the function by the mine operator. The requirement to develop, supervise, monitor and review the electrical engineering standards and procedures forming part of mining operations at the mine is one such function that exists for all mining operations. This is identified as a key statutory function. The eligibility requirements for people to be nominated to exercise this key statutory function vary between the different types and sizes of mining operations. Sections 2.3.2 to 2.3.5 below provide more information relating to the functions and competencies of a person who is eligible exercise those functions. In all cases listed below, a person who is acting under the supervision of the person nominated to exercise the key statutory function may also develop the plan or sections of the plan. In this situation, the key statutory position holder must still approve the plan, or the sections of the plan developed by others.

To ensure appropriate implantation of electrical engineering standards and procedures for the management of electrical risks, there is also a function to supervise the installation, commissioning, maintenance and repair of electrical plant and installations at the mine. This function is required to be exercised by the key statutory position holder and by any person nominated as a qualified electrical tradesperson.

For larger mining operations, it may not be possible for the key statutory position holder to effectively supervise all activities of all electrical tradespersons across all shifts of the operation. In this situation, the mine operator should nominate persons to exercise the function of the qualified electrical tradesperson to assist with supervision across the different shifts. The person nominated to exercise the key statutory function still has a duty to supervise these activities but this will be at a higher/broader level than the supervision effected by the qualified electrical tradespersons. For further information on statutory functions, refer to the Resources Regulator guide: *Statutory functions.*

The mine operator must only nominate people to perform these statutory electrical functions at the mine if the individuals meet the requirements set out in Schedule 10 of the WHS (MPS) Regulation.

Details of statutory functions must be contained in the mine safety management system, as per clause 14 of the WHS (MPS) Regulation. The mine operator must only nominate people to fill the statutory functions who possess the required competencies, and should have a system to ensure this is fulfilled. There is also requirement for mines to notify the names of the people nominated for key statutory functions to the regulator upon commencement of operations, and for coal mines, when key statutory function holders change (refer to clause 129).

2.3.2. Underground coal mines

For underground coal mines, Schedule 10, clauses 4 and 15 of the WHS (MPS) Regulation requires the following statutory positions to carry out specified functions:

WHS (MPS) Regulation

Schedule 10 Statutory functions at mines (Clause 136)

…

(4) Electrical engineering manager

(1) The statutory functions of electrical engineering manager are:

(a) to develop, supervise, monitor and review the electrical engineering standards and procedures forming part of mining operations at the mine, and

(b) to supervise the installation, commissioning, maintenance and repair of electrical plant and installations at the mine.

(2) The requirement for nomination to exercise the statutory functions is that the individual nominated must hold a current practising certificate that authorises the exercise of the statutory functions.

…

(14) Qualified electrical tradesperson

(1) The statutory function of qualified electrical tradesperson is to supervise the installation, commissioning, maintenance and repair of electrical plant and installations at the mine.

(2) The requirement for nomination to exercise the statutory function is that the individual nominated must:

(a) have a supervisor certificate that authorises the doing of electrical wiring work, or

(b) have a proficiency certificate (issued by State Training Services) in an electrical trade, or

(c) have been continuously employed as an electrical tradesperson at a coal mine since 21 December 2004.

2.3.3. Surface coal mines

For coal mines other than underground mines, Schedule 10, clauses 20 and 22 of the WHS (MPS) Regulation requires the following statutory positions to carry out specified functions:

WHS (MPS) Regulation

Schedule 10 Statutory functions at mines (Clause 136)

…

20 Electrical engineer

(1) The statutory functions of electrical engineer are:

(a) to develop and review the standards and procedures for the installation, commissioning, maintenance and repair of electrical plant and installations at the mine, and

(b) to supervise the installation, commissioning, maintenance and repair of electrical plant and installations at the mine.

(2) The requirement for nomination to exercise the statutory functions is that the individual nominated must:

(a) hold an electrical engineer certificate of competence (surface coal) or electrical engineering manager certificate of competence (coal) that is in force, or

(b) have evidence of compliance with Australian Engineering Competency Standards Stage 2 in respect of mining operations at a mine and be:

(i) a professional electrical engineer who is registered on the National Professional Engineers Register, or

(ii) an electrical engineering technologist who is registered on the National Engineering Technologists Register, or

(iii) an electrical engineering associate who is registered on the National Engineering Associates Register.

...

22 Qualified electrical tradesperson

(1) The statutory function of qualified electrical tradesperson is to supervise the installation, commissioning, maintenance and repair of electrical plant and installations at the mine.

(2) The requirement for nomination to exercise the statutory function is that the individual nominated must:

(a) have a supervisor certificate that authorises the doing of electrical wiring work, or

(b) have a proficiency certificate (issued by State Training Services) in an electrical trade, or

(c) have been continuously employed as an electrical tradesperson at a coal mine since 21 December 2004.

2.3.4. Underground mines other than coal mines

For underground mines (other than coal), Schedule 10, clauses 28 and 29 of the WHS (MPS) Regulation stipulates:

WHS (MPS) Regulation

Schedule 10 Statutory functions at mines (Clause 136)

...

28 Electrical engineer (only required if total connected power at mine is greater than 1,000 kilowatts or if high voltage is utilised)

(1) The statutory functions of electrical engineer are:

(a) to develop and review the standards and procedures for the installation, commissioning, maintenance and repair of electrical plant and installations at the mine, and

(b) to supervise the installation, commissioning, maintenance and repair of electrical plant and installations at the mine.

(2) The requirement for nomination to exercise the statutory functions is that the individual nominated must:

(a) hold an electrical engineering manager certificate of competence (coal) or electrical engineering manager certificate of competence (surface coal) that is in force, or

(b) have evidence of compliance with Australian Engineering Competency Standards Stage 2 in respect of mining operations at a mine and be:

(i) a professional electrical engineer who is registered on the National Professional Engineers Register, or

(ii) an electrical engineering technologist who is registered on the National Engineering Technologists Register, or

(iii) an electrical engineering associate who is registered on the National Engineering Associates Register.

29 Qualified electrical tradesperson

(1) The statutory function of qualified electrical tradesperson is to supervise the installation, commissioning, maintenance and repair of electrical plant and installations at the mine.

(2) The requirement for nomination to exercise the statutory function is that the individual nominated must:

(a) have a supervisor certificate that authorises the doing of electrical wiring work, or

(b) have a proficiency certificate (issued by State Training Services) in an electrical trade, or

(c) have been continuously employed as an electrical tradesperson at a mine since 20 December 2005.

2.3.5. Surface mines other than coal mines

For mines other than underground or coal mines, Schedule 10 and clauses 33 to 34 of the WHS (MPS) Regulation stipulates:

WHS (MPS) Regulation

Schedule 10 Statutory functions at mines (Clause 136)

…

33 Electrical engineer (only required if total connected power at mine is greater than 1,000 kilowatts or high voltage is utilised)

(1) The statutory functions of electrical engineer are:

(a) to develop and review the standards and procedures for the installation, commissioning, maintenance and repair of electrical plant and installations at the mine, and

(b) to supervise the installation, commissioning, maintenance and repair of electrical plant and installations at the mine.

(2) The requirement for nomination to exercise the statutory functions is that the individual nominated must:

(a) hold an electrical engineering manager certificate of competence (coal) or an electrical engineering manager certificate of competence (surface coal) that is in force, or

(b) have evidence of compliance with Australian Engineering Competency Standards Stage 2 in respect of mining operations at a mine and be:

(i) a professional electrical engineer who is registered on the National Professional Engineers Register, or

(ii) an electrical engineering technologist who is registered on the National Engineering Technologists Register, or

(iii) an electrical engineering associate who is registered on the National Engineering Associates Register.

(3) This clause does not apply to a mine at which the total connected power to the mine is 1,000 kilowatts or less unless voltages greater than 1,000 volts AC or 1,500 volts DC are used at the mine.

34 Qualified electrical tradesperson

(1) The statutory function of qualified electrical tradesperson is to supervise the installation, commissioning, maintenance and repair of electrical plant and installations at the mine.

(2) The requirement for nomination to exercise the statutory function is that the individual nominated must:

(a) have a supervisor certificate that authorises the doing of electrical wiring work, or

(b) have a proficiency certificate (issued by State Training Services) in an electrical trade, or

(c) have been continuously employed as an electrical tradesperson at a mine since 20 December 2005.

For all other mines that have not been referred to directly in 2.3, a competent person is required (refer to 2.3.2 above).

2.3.6. Competent person

For mines that are not required to nominate either an Electrical Engineering Manager or an Electrical Engineer, a competent person must develop and periodically review the EECP. Competence requirements for a person to prepare the plan may vary according to the nature, complexity and risks of the mining operations. The mine operator should consider the needs for experience, skills and qualifications, depending on the hazards at the mine.

Alternative methods of demonstrating competence may be for a person to hold a recognised certification or qualification, such as:

- a certificate of competence to be the electrical engineering manager at an underground coal mine, or
- a certificate of competence to be the electrical engineer at a surface coal mine, or
- registration or eligibility for registration with Engineers Australia as an:
  - professional engineer
  - engineering technologist
  - engineering associate
- evidence of compliance with Australian Engineering Competency Standards Stage 2 in respect of electrical engineering at mining operations, as required for statutory functions above.

The mine operator may determine that additional competencies (not alternative competencies) are required by a person who is on one of the engineering registers for their mine. For example, a person with appropriate competence in operating and maintaining mine winding systems would be needed at a mine with a mine winding system.

3. Identifying and managing risk

3.1. Managing risks

An EECP must set out how the mine operator will manage the risks associated with electricity at the mine in accordance with clause 9 of the WHS (MPS) Regulation and clause 147 of the WHS Regulation.

Part 3.1 of the WHS Regulation sets out general obligations for managing of risks to health and safety while Subdivision 1, Division 1 of Part 2 of the WHS (MPS) Regulation (including clause 9 above) sets out additional general obligations for the management of risk at mines. Both the general requirements and any specific requirements for managing or controlling a particular risk must be complied with such as in:

- → chapter 4 of the WHS Regulation in relation to hazardous work, in particular Part 4.7 'General electrical safety in workplaces and energised electrical work'.
- → clause 32 Electricity of the WHS (MPS) Regulation, and in relation to underground coal mines clauses 78-80 and 82-83.
- → chapter 5 of the WHS Regulation in relation to plant and structures.
- → mining plant specific requirements in the WHS (MPS) Act and Regulation, such as plant registration.

An EECP should use the mine's existing risk management processes, so the plan manages risk as required by WHS legislation. This should ensure that the EECP is consistent with other plans, such as a fire and explosion principal mining hazard management plan, for all risks associated with electricity at the mine.

This risk management process involves four steps:

- → identify hazards – find out what could cause harm
- → assess risks – understand the nature of the harm that could be caused by the hazard, how serious the harm could be and the likelihood of it happening
- → control risks – implement any mandatory control measures or the most effective control measure that is reasonably practicable in the circumstances
- → monitor and review control measures to ensure they are working as planned.

Each of these steps is discussed in the following sections of this chapter as they relate to developing an EECP for controlling risks.

It is essential that any risk management process be undertaken having regard to the specific circumstances or context in which the risk is being considered. When assessing the risks associated with electrical aspects of plant or installations, someone with appropriate electrical engineering competence should be involved in, or possibly conduct, the risk assessment.

The *NSW code of practice: How to manage work health and safety risks* provides guidance on how to comply with requirements under the WHS laws.

3.2. Hazard identification

All reasonably foreseeable hazards associated with electricity must be identified. Identifying hazards in the workplace involves finding things and situations that could potentially harm people.

Where electricity is used or is present, a hazard exists. Electricity includes stored energy such as lightning, static discharge, electro-magnetic devices, batteries and so on.

Hazards generally arise from the following aspects of work and their interaction:

- → physical work environment
- → plant, installations and energy sources
- → work tasks and how they are performed
- → work design and management.

The *AS 4024 Safety of machinery* series of standards contains useful guidance material for designers and users of plant in ways to identify hazards and provide risk control measures.

There are different methods for undertaking hazard identification and risk assessments. One method is to do a 'broad brush' risk assessment as a first step in identifying the risks which the EECP should address. A broad brush risk assessment is used to identify general hazards so that priorities can be determined for further risk identification and action. This should be followed by an engineering-focused risk assessment to identify all the risks associated with the identified hazards on plant or installations.

3.2.1. Hazardous energy sources

The following tables list categories of hazards that may be present at a mine site. The lists are not exhaustive, but may help in identifying hazards associated with mining plant or installations.

Figure 3: Consequences of loss of control of electrical energy that may be present at a mine.

Energy/hazard	Mechanism/scenario	Potential consequences
Electrical energy		
	direct contact	electrocution electric shock burns
	indirect contact,	electric shock
	loss of control of plant	entanglement injuries crush injuries
	arcing	pressure wave airway damage vision impairment hearing damage fire burn injuries
	electrostatic discharge	electric shock gas ignition dust ignition

The mine operator may include details of the following related hazards and their control measures in the EECP or reference their details from another appropriate document such as the mechanical engineering control plan.

Figure 4: Additional hazards and consequences that may be present at a mine.

Energy/hazard	Mechanism/scenario	Potential consequences
Chemical energy		
– chemicals	diesel particulate matters, dust fluids fumes gases (toxic) mists	asphyxiation burn injuries - chemical burn injuries - temperature cancer chronic respiratory disease death - asphyxiation dehydration disturbed judgement eye irritation hypoxia, poisoning, lung damage nausea mood changes throat and bronchial irritation temperature burn injuries
– chemical reactions	coal dust explosion, fires, flammable gas explosion self-heating self-ignition uncontrolled exothermic reaction	burn injuries death – pressure wave death – asphyxiation impact injuries
Fluids		
– pressurised fluids	escape of fluid (liquids and gases) under pressure component failure loss of control of plant	burns, crush injuries death, fluid injection injuries impact injuries
– stored or trapped fluids (water)	engulfment head pressure suction pressure	drowning suction injuries
Heat energy		
– extreme temperatures	contact with cold machine components contact with hot machine components explosions flames heat radiation hot or cold work environments	freezing burns scalds heat stress heat stroke dehydration hypothermia loss of consciousness
Kinetic energy		
– moving parts – velocity vehicles	collisions crushing drawing-in or trapping entanglement friction or abrasion	amputations crush injuries death entanglement injuries friction burns

	hazardous manual tasks (exertion, repetition, extended duration) impact shearing machine catastrophic failure unexpected plant movement	impact injuries strains unhealthy posture
– vibration	hand-held plant vibrations operation of moving plant	musculoskeletal disorders including - circulation disorder - impairment of vision and balance - neurological disorders - vascular disorders - vision impairment - whole body vibration damage
Magnetic energy		
– including electromagnetic energy	interference with electronic devices (e.g. testing, monitoring) interference with medical devices (e.g. pacemakers)	unintended operation of plant cardiac arrest
Noise		
	excessive / harmful noise levels	tinnitus hearing loss Loss of concentration/make errors miss alarms or acoustic signals stress fatigue
Potential (stored) energy		
– gravity	fall of people from heights hazardous manual tasks mass in elevated machine components mass in raised material falling slips, trips and falls – access ways	bone breaks crush injuries death fall injuries shock sprains and strains unhealthy posture from muscular skeletal injuries
– stored elastic energy (spring energy)	deflection of springs deflection of metallic materials deflection of plastic materials e.g. pipe tension in elastic materials, e.g. belts strain in materials e.g. chains	bone breakages, crush injuries, death impact injuries shock
– stored fluid pressure	refer fluids above	
Radiation energy		
– non-ionising – ionising	e.g. welding arc flash emitted radiation	burns, dehydration loss of conscious heat stroke radiation sickness cancer death

3.2.2. Work design and management

Work design and management incorporates the principle of fit-for-purpose equipment, competent people, safe work practices within a controlled work environment (refer to the Nertney Wheel model of an ideal work process for achieving safe production for more explanation). A controlled work environment is one that is risk managed (refer to section 3.1 above). Management systems include appropriate job descriptions, extensive rules and clearly defined procedures covering the intended work

processes. The design of the work process and intended plant through life cycle activities relates to human – machine interfaces (refer to section 3.2.3 below). The elimination, control and minimisation of hazards (refer to figures 3 and 4) determines the productive nature of the managed system.

3.3. Assessment of risks

The WHS (MPS) Regulation clause 9 requires that a PCBU at a mine ensure that a risk assessment is conducted by a competent person and is recorded (with exceptions). For mine operators, it must be recorded as part of the mine's safety management system, and for contractors in the contractor health and safety management plan (if applicable). The record must also include the control measures implemented to eliminate or minimise any risk that was identified through the risk assessment.

In undertaking a risk assessment, the person must have regard to the:

- nature of the hazard or risk
- likelihood of the hazard affecting the health or safety of a person
- severity of the potential health and safety consequences.

Other matters that should be considered in assessing risks are:

- the effect of different operating conditions - normal or abnormal (for example shut down and
- start-up, weather and possible misuse of equipment)
- human and organisational factors, including:
  - not following procedures
  - access to information pertaining to the task
  - fatigue from shift work and extended working hours
  - communications between workers and supervisors
  - design of the work environment and plant, for example ergonomics, alarms, lighting
- past incidents and potential emergency situations
- the reliability and adequacy of existing technology used to control risk i.e. engineering controls
- state of knowledge (what the industry knows) about the hazard or risk and how to eliminate or minimise it.

In some cases, further risk assessment of the hazards may be required using an appropriate technique. For example, fault tree analysis, failure modes and effects analysis, human factors analysis, bow tie analysis or other techniques. Guidance on these techniques is available in AS/NZ 4024-1201; AS/NZS 4024-1303, as well as HB 89.

Note: Risks that must be addressed in the EECP and the factors to be considered in developing control measures, are set out in sections 4.4 to 4.8 and Chapter 5 below.

3.4. Control of risk

Hazard identification and risk assessment is undertaken to lead to the development of appropriate controls to eliminate the risks or, if that is not reasonably practicable, to minimise risks so far as is reasonably practicable (refer to clauses 33 to 36 of the WHS Regulation for requirements).

3.4.1. Specific concerns

Any specific control measures required in the WHS Regulation or the WHS (MPS) Regulation in relation to electricity must be complied with and should be included in an EECP. This code identifies many specific control measures required, particularly controls required under the WHS (MPS) Regulation, where they relate to plant and installations. However, these references are not exhaustive.

The WHS Regulation in Chapter 4, Part 4.7 'General electrical safety in workplaces and energised electrical work' contain specific controls that must be implemented at mines, including:

- → inspection and testing of electrical equipment
- → prohibition of work on energised electrical equipment
- → residual current devices
- → overhead and underground electric lines.

The SafeWork NSW code of practice *Managing electrical risks in the workplace* should also be read in conjunction with these requirements for general electrical safety and should be referenced in an EECP.

In the WHS (MPS) Regulation clause 32 deals with electrical safety. The specific control measures listed in clause 32 are discussed in chapter 4 of this code.

Chapter 5 of the WHS Regulation (clauses 203 to 226) contains specific controls for plant including:

- → installation and commissioning risks
- → prevention of unauthorised alteration or interference
- → the proper use of plant and controls
- → operational controls
- → emergency stops
- → warning devices
- → maintenance and inspection of plant
- → powered mobile plant
- → industrial robots
- → lasers
- → plant with presence-sensing safeguarding systems.

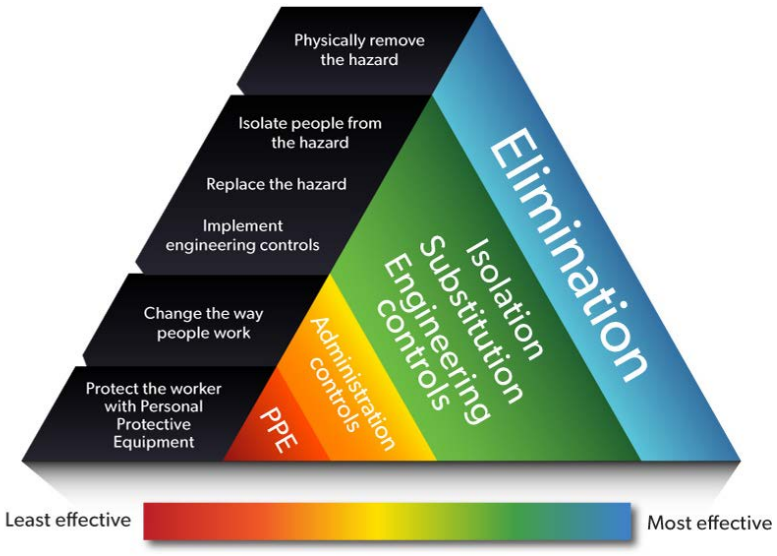
An EECP should give consideration to the electrical aspects of this plant and should include requirements that will manage the risks associated with each of these types of plant.

3.4.2. Hierarchy of controls

The hierarchy of risk controls ranks the effectiveness of controls from the highest level of protection and reliability (most effective) to the lowest (least effective) to either eliminate or minimise risks as shown in the figure below. The mine operator, and other PCBUs, are required to work through this hierarchy, and

implement the most effective controls, when managing risk in accordance with clause 36 of the WHS Regulation.

Figure 5 – Hierarchy of control measures.



If a hazard is eliminated, it can pose no risks. Therefore, the primary aim is to eliminate a hazard. This is the most effective action. If this is not reasonably practicable, risks must be minimised by working through the other alternative measures in the hierarchy, as prescribed in Part 3.1 of the WHS Regulation.

Risk controls can be classified as either preventative controls or as mitigation controls. Preventative controls are those that prevent the unwanted event from occurring. Mitigation controls are those that reduce the effects of an unwanted event following its occurrence. Where it is not reasonably practicable to eliminate a risk, a combination of both controls that reduce the likelihood of the event occurring and reduce the consequences if the event does occur are required in response to the identified risk.

The primary focus should be the implementation of preventative controls where possible.

Importantly, risks must be managed throughout the life cycle of plant and installations. The control measures selected should have the appropriate reliability. Refer to section 4.2.2 in this code for more information on control reliability.

There are many ways to control risks, and various control options must be considered. This may involve a single control measure or a combination of controls that together provide the required level of protection (risk minimisation). Sometimes a single control is not adequate on its own to control a risk under all foreseeable circumstances, or if the reliability of the single control is uncertain.

3.5. Maintenance of control measures

Control measures implemented to control risks presented by hazards at a mine must be maintained to ensure their continuing effectiveness in accordance with clause 37 of the WHS Regulation:

WHS Regulation

37 Maintenance of control measures

A duty holder who implements a control measure to eliminate or minimise risks to health and safety must ensure that the control measure is, and is maintained so that it remains, effective, including by ensuring that the control measure is and remains:

(a) fit for purpose, and

(b) suitable for the nature and duration of the work, and

(c) installed, set up and used correctly.

An EECP should identify the methods and systems required to maintain electrical safeguards (control measures) thereby ensuring they remain effective.

An important part of maintaining control measures is dealing with change. Change management should be applied at a mine in circumstances where new or different plant or installations are being introduced. An EECP should integrate with other management systems, such as procurement, to minimise the effect of changes when new plant and installations are being introduced. Any changes required should be managed through mine change management processes to identify changes that may be required to engineering practices and competencies.

The effectiveness of a control measure may deteriorate due to factors including changes in:

- → environmental conditions
- → material and equipment specifications
- → supervision arrangements
- → the competence of workers.

Monitoring of the effectiveness of control measures is required to ensure the control measure continues to perform as intended. Where a control measure is identified as no longer achieving the required level of risk control, the risk controls must be updated or modified.

One method of achieving this involves the development of trigger action response plans (TARPs), which is a method of increasing or enhancing risk control measures in response to changing performance. A TARP is an example of a risk management tool that triggers a predetermined early response to prevent ‘normalisation’, i.e. accepting slow deterioration as 'normal' as there is little variation from day-to-day. If there is no planned response in place for these particular hazards, a decision to put a risk control in place may be delayed until the hazard cannot be easily controlled. Examples of where a TARP may be applicable are:

- → Monitoring the condition of motor bearings. A TARP may trigger if vibration levels exceed a set point such that further investigation is carried out.
- → Monitoring the temperature of electrical connections (thermography). A TARP may trigger if temperatures exceed a set point such that further investigation is carried out.
- → Monitoring insulation resistances of circuits. The TARP may initiate additional maintenance actions if the insulation resistance drops below a predetermined value.

An EECP should identify requirements for monitoring the effectiveness of the controls implemented, and include processes for identifying, reviewing and responding to uncontrolled events, such as near-miss incidents. This may include maintenance regimes, pre-start and scheduled inspections.

3.6. Review of control measures

Clause 10 of the WHS (MPS) Regulation (which refers to clause 38 of the WHS Regulation) requires the mine operator and other PCBUs to review and where necessary revise implemented control measures to maintain, so far as is reasonably practicable, a work environment that is without risk to health or safety. These provisions are copied in full and printed in chapter 7 below as part of the overall review requirements for an EECP.

If the mine operator becomes aware of circumstances where a control measure provided by designer, manufacturer or supplier does not control the risk it was implemented to control, the mine operator should notify the designer, manufacture or supplier of the plant or installation. This may be done by submitting the issue to the designer, manufacturer or supplier as a non-conformance through their quality management systems.

4. Content of the electrical engineering control plan – all mines

This chapter provides guidance on the matters that need to be addressed by an EECP for all mines (4.2) and other specific risk controls that relate to plant and installations in the mine (4.2 and 4.3). Additional guidance for underground coal mines is provided in chapter 5, but must be considered in addition to the information in this chapter.

4.1. Overview of an EECP

An EECP must set out how risks associated with electricity will be managed at the mine. Matters that must be considered when developing an EECP are set out in Schedule 2 clause 3 of the WHS (MPS) Regulation (refer to Chapter 1 section 1.3 for a complete extract of the schedule) and are examined in more detail below).

Both the WHS regulation and the WHS (MPS) Regulation contain specific risk controls in respect of certain matters. The specific risk controls that relate to electricity or that require electrical safeguards should also be considered when developing an EECP.

An EECP may provide for the processes to manage risks associated with electricity or may contain links to other parts of the safety management system for the mine.

To assist in managing these risks, an EECP should identify how (through fit-for-purpose equipment, safe systems of work and competent people) the mine operator will ensure that plant and installations being introduced into the mine are fit-for-purpose and can be operated and maintained safely.

In summary, this will involve:

- → identifying all electrical plant and installations on the mine including contractor plant
- → identifying foreseeable hazards associated with the use (including maintenance and disposal) of electrical aspects of the plant and installations

- → assessing these risks
- → taking into account the provision of reliable safeguards (risk control measures) to protect workers from the hazards posed by electrical plant and electrical installations including:
  - o selecting and commissioning plant and installations so they are suitable for the intended use
  - o ensuring plant and installations are operated safely and within their design limits
  - o providing safe systems of work for operating, maintaining and working on plant and installations
  - o ensuring plant and installations are inspected, tested and maintained so they remain in a safe condition of use
  - o providing for competent workers to carry out work safely on plant and installations
  - o providing for competent electrical engineering supervision.

4.2. Matters to be taken into account when preparing an EECP

When determining the means by which the mine operator will manage the risks to health and safety from electricity used in plant and installations at the mine, the following matters from Schedule 2 clause 3 of the WHS (MPS) Regulation must be taken into account:

- → Subclause (1) identifies a range of overarching considerations that must be taken into account, see 4.3
- → Subclause (2) identifies certain risks to health or safety associated with electricity in plant and installations that must have controls set out in the EECP, see 4.4
- → Subclause (3) identifies a range of matters that must be considered when deciding on the control measures that will be set out in the plan for the risks in subclause 2, see 4.5.

Guidance is provided for each of these provisions in 4.3 – 4.5 below.

4.3. Key considerations

4.3.1. Lifecycle

WHS (MPS) Regulation

Schedule 2 Principal control plans – matters to be addressed (clause 26)

…

3 Electrical engineering control plan

(1) The operator of a mine or petroleum site must, in preparing an electrical engineering control plan, take the following into account in determining the means by which the operator will manage the risks to health and safety from electricity at the mine or petroleum site:

(a) the overall life cycle of the electrical aspects of plant and electrical installations at the mine or petroleum site,

…

The life cycle of plant and installations involves the following phases:

- → design
- → manufacture
- → installation
- → commissioning
- → operation
- → maintenance (including repair and overhaul)
- → decommissioning

It is preferable to eliminate and/or minimise the risks from plant and installations during the design phase by eliminating hazards and risks before plant is introduced to the workplace. This means identifying potential hazards and risks associate with all phases of the life cycle and incorporating solutions into the design. For example, using extra low voltages on field control devices, interlocking of enclosure covers to prevent access to energised electrical components and wiring when energised, or using enclosure designs and component selections that minimise risk of arc faults.

The mine operator should provide relevant information to designers, manufacturers, importers and suppliers about the intended use of the plant or installation, its intended operating environment and conditions, together with any specific controls required by the mine and legislation. This will help the mine operator meet their obligations in relation to the WHS legislation.

The operation phase of the life cycle constitutes the largest portion of the life cycle. To ensure that the plant or installation continues to operate throughout this phase in the manner in which it was designed, appropriate maintenance activities, including overhaul must be undertaken. An EECP should require the identification of appropriate maintenance frequencies and strategies including trigger points that initiate overhaul actions. Guidance in identifying appropriate maintenance frequencies and strategies should be sort from the manufacturer, or if there are no manufacturer recommendations then a competent person. Refer to WHS Regulation clause 213.

A PCBU must satisfy their duties and the specific risk controls prescribed in WHS laws. The PCBU should determine if risks associated with existing (legacy) plant are adequately controlled so far as is reasonably practicable, including any specific risk requirements such as the provision of earth leakage on electrical sub-circuits and ensuring the reliability of electrical safeguards provided to control the risks from both electrical and non-electrical hazards is sufficient for the level of risk being controlled.

4.3.2. Reliability of electrical safeguards

WHS (MPS) Regulation

Schedule 2 Principal control plans – matters to be addressed (clause 26)

…

3 Electrical engineering control plan

(1) The operator of a mine or petroleum site must, in preparing an electrical engineering control plan, take the following into account in determining the means by which the operator will manage the risks to health and safety from electricity at the mine or petroleum site:

(b) the reliability of electrical safeguards used at the mine or petroleum site to protect persons from electrical or other hazards,

Electrical safeguards are those controls that use electrical technology to manage risks.

A control provided for a particular risk should be expected to perform with a predictable level of reliability. Where it is identified that a control does not have the required level of reliability, then other additional controls will need to be provided, either to provide additional layers of protection or to provide indication that the control has failed. Where there is only a single control for a risk, then the fault indication should cause the plant to be brought automatically to a safe state. This is normally a stop condition.

Where there are several independent layers of control for a risk, the failure of a control should, where possible initiate alarms to warn operators that the control has failed and allow for operators to bring the plant or installation to a safe state. A layer of control for a risk is only independent from another layer if, in the event of it failing it does not impact on the effectiveness of the other layer to enable the plant to be brought to a safe state.

Electrical controls are often provided to control risks associated with hazards other than electricity. A list of other hazards is provided in figure 4 of section 3.2 of the code. The hazards identified in figure 4 will normally be assessed under a different management or control plan where the need for the electrical safeguard will be identified by persons other than electrically competent persons. It is important that where these electrical safeguards are identified as required that they are then analysed, as per any other electrical safeguard in accordance with the requirements of an EECP. This is to ensure that they will adequately control the potential risk and provide the necessary level of reliability. For example, light curtains are used to stop movement of plant if people enter a restricted work space.

To ensure that safeguards are functioning in the manner that was intended, it is crucial that maintenance inspections, including any proof test intervals identified during the design and analysis phases are complied with. Failure to undertake these tests as required by the designer may result in a reduction of the level of reliability and a failure to operate as required.

4.3.3. Electrical engineering and electrical work practices

WHS (MPS) Regulation

Schedule 2 Principal control plans – matters to be addressed (clause 26)

…

3 Electrical engineering control plan

(1) The operator of a mine or petroleum site must, in preparing an electrical engineering control plan, take the following into account in determining the means by which the operator will manage the risks to health and safety from electricity at the mine or petroleum site:

(c) the electrical engineering and electrical work practices to be employed at the mine or petroleum site,

Electrical engineering and electrical work practices are the activities undertaken during the lifecycle of electrical plant and installations to identify, implement and maintain risk controls. These practices include how to work safely with the plant and installations, such as commissioning documentation, isolation procedures, permit to work systems, testing of electrical installations and access to electrical installations by qualified people.

The mine operator must take into consideration the required electrical engineering practices that will be used at the mine to manage the risks to health or safety from electrical aspects of plant and installations, including those of any other PCBUs at the mine. This means considering electrical engineering standards, electrical work practices, electrical competencies and electrical supervision that is needed. For example:

- → electrical engineering standards for the introduction of fit-for-purpose plant and installations to the mine site in a controlled manner ensuring that new plant to the site has the necessary risk controls identified by the mine incorporated in to the design of the plant or installation.
- → electrical engineering standards for the management of change in circumstances where new or different plant or installations are being introduced, or where changing conditions at the mine necessitate changes to the functionality of plant or installations
- → development of appropriate electrical engineering work activities, such as inspection, tests and maintenance strategies that maintain the electrical plant and installations in a fit-for-purpose condition.

4.3.4. Competency of workers

WHS (MPS) Regulation

Schedule 2 Principal control plans – matters to be addressed (clause 26)

…

3 Electrical engineering control plan

(1) The operator of a mine or petroleum site must, in preparing an electrical engineering control plan, take the following into account in determining the means by which the operator will manage the risks to health and safety from electricity at the mine or petroleum site:

(d) the competency required by workers to safely work on electrical plant or electrical installations at the mine or petroleum site.

Performing electrical work requires competent workers who can recognise risks associated with the use of electricity, understand the actions necessary to work safely and have appropriate standards of workmanship.

Note: For a definition of electrical work refer to clause 146 of the WHS Regulation in relation to Part 4.7 of the Regulation.

An EECP should specify:

- → minimum experience, qualifications and skill levels for electrical workers for various types of work, including workers engaged by contractors or other PCBUs at the mine
- → arrangements for supervision for electrical work taking account of experience of the workers and the nature of the task
- → competency requirements to undertake work on hazardous area plant and installations, referring to documents such as AS/NZS 4761
- → qualifications and competency requirements for persons to undertake or supervise electrical work, where a qualified electrical tradesperson is required.

Other matters that the mine operator should consider when developing an EECP are:

- → some tasks may not require electrical trade qualifications, such as refrigeration/air conditioning mechanics or plumbers, but will have to be undertaken under supervision of qualified people and in accordance with management systems for the mine
- → clause 36 of the WHS (MPS) Regulation has specific requirements regarding minimum age of workers, including permitted work activities and supervision requirements for apprentices and trainees
- → competence requirements for positions to be involved in undertaking work activities under an EECP, such as national units of competence (see http://training.gov.au.). This may include competencies for workers such as auto electricians.
- → how the electrical competency requirements for workers, including contractors, are to be determined and checked to ensure workers can work safely e.g. Contract administration, contractor health and safety management plan, pre-assessment etc.
- → refresher training, when activities are undertaken infrequently.
- → that the mine operator must ensure each worker is trained and competent in basic risk management techniques used at the mine (refer to clause 104(3) WHS (MPS) Regulation)
- → how the mine operator will satisfy themselves that suppliers have workers that are sufficiently competent to ensure the plant or service is fit for purpose eg. PLC programmers, specialist service technicians, etc.

4.4. Risks for which controls must be set out in the EECP

An EECP must set out control measures for the following risks to health and safety associated with electricity at the mine, as set out in Schedule 2 clause 3(2) of the WHS (MPS) Regulation:

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

3 Electrical engineering control plan

...

(2) An electrical engineering control plan must set out the control measures for the following risks to health and safety associated with electricity at the mine or petroleum site taking into account the matters set out in subclause (3):

(a) injury to persons caused by direct or indirect contact with electricity,

(b) injury to persons caused by working on electrical plant or electrical installations,

(c) the unintended initiation of gas or dust explosions,

(d) the unintended operation of plant,

(e) the occurrence of uncontrolled fires.

…

Electrical risks include:

- → Electric shock causing injury or death
  - o may be by direct contact with an energised conductor
  - o may be through indirect contact, such as tracking through or across a medium, or by arcing, i.e, a part that is not normally energised becomes energised due to a fault or through capacitive or magnetic coupling effects (for example metal frame covering of a welding machine, fence, double insulated tools that are damp or wet, fences that run parallel to, and are close to, high voltage power lines, the sheaths of cables fed from variable speed drives that are not effectively shielded)
  - o from ‘step-and-touch’ potentials resulting either directly from an electrical fault or a lightning strike, or transferred from an electrical fault at a different (remote) location
  - o may be caused by falls from height, for example scaffolding, following an electric shock.
- → Arcing, explosion or fire causing burns or death, resulting from
  - o arcing, explosion or both, occurring when high fault currents are present
  - o plasma and molten metals being ejected from the arc
  - o concussive injuries from the pressure wave associated with an explosion/blast
  - o fire related to an electrical fault.
- → Toxic gases causing illness or death, resulting from

- vaporisation of metals and other materials
- burning and arcing of electrical insulation materials.

→ Unintended operation of electrically controlled plant or equipment may cause crush injuries or entrapment resulting in injury or death, possibly through the incapacity of the operator, defective design, interference from external sources (EMI) or a circuit fault and so on.

Other injuries or illnesses may include muscle spasms, palpitations, nausea, vomiting, collapse and loss of consciousness. There may also be other injuries if these events occur while a person is working at heights e.g. falls.

The degree of risk associated with electricity is related to the level of voltage and to the level of energy that may be released under either normal or abnormal conditions. A reduction in the level of voltage will reduce the likelihood of damage to muscles such as the heart. Quick operating times of protective devices such as earth leakage circuit breakers will reduce the likelihood of disruption to heart rhythms in the event of contact with an energised source. Quick acting fuses and circuit breakers will also reduce energy that can be expended during an arcing fault, reducing consequences of injuries to people and damage to plant.

4.5. Matters to be taken into account when developing control measures

When developing control measures for the risks set out in Schedule 2 clause 3(2)(a)-(e) above in 4.3 to be implemented through an EECP, the matters in Schedule 2 clause 3(3)(a)-(v) set out below must be taken into account:

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(a) the location of the electrical equipment and electrical installations at the mine or petroleum site,

Electrical plant and installations at the mine should be located so that they are not prone to damage. Damage may result from impact, ingress of water, chemicals or dust, temperature extremes, vibration or radiation and so on.

Consideration should also be given to minimising the requirements for people to access these electrical installations to minimise the likelihood of injury in the event of catastrophic equipment failures. Locations should also provide for adequate room to enable people to work safely on the plant and installations.

An EECP should identify the requirements to be considered in determining the location for electrical plant or installations that will minimise the likelihood of damage. An EECP should also identify requirements for electrical installations to ensure that personnel can work safely around electrical plant and installations.

Refer to the mine survey plans or mine plans (Part 5 clauses 122-123 of the WHS (MPS) Regulation) for details (as applicable) of other services, workings and facilities at the mine that may impact on where electrical equipment electrical installations are located at the mine.

In developing controls in relation to this matter, reference should be made to the following:

- → AS/NZS 3000 *Wiring Rules*,
- → AS/NZS 3007 *Electrical equipment in mines and quarries – Surface installations and associated processing plant*, and
- → AS 2067 *Substations and high voltage installations exceeding 1 kV a.c.*

For underground operations, there are no published Australian or international standards relating to fixed electrical installations. However, the above principles can be applied in an underground situation.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(b) the rating and design of plant for the prospective electrical fault level, electrical load, operating frequency, operating voltages and arc fault control,

The purpose of providing switchgear and other electrical plant and installations that is rated and designed appropriately is to minimise the possibility of injury to switchgear operators and other workers, and minimise the catastrophic failure of the switchgear from fires caused by overheating or arcing that results in arc flash or blast.

An EECP should identify the design requirements for electrical plant and installations and provide for:

- → switchgear and cables that are capable of carrying the maximum prospective fault current for appropriate time durations. Ratings should be based on the settings of the backup protection devices and not the primary protection devices.
- → the rating of various components being suitable for the required operating conditions, including ambient temperatures, relative humidity, dust and so on.
- → selection of cables that are designed and installed to minimise the effects of higher order frequencies associated with harmonics and switching frequencies associated with variable speed drives.
- → electrical plant and installations having appropriate voltage ratings, including switching transients and under fault conditions.
- → switchgear being suitably designed and rated to eliminate, so far is reasonably practicable, the risk of injury associated with arcing faults (arc flash or arc blast) to personnel that may be required to operate or work in proximity to the switchgear

- → the placement of overpressure vents that will:
  - o direct the force of an arc blast away from locations where persons may be present, and
  - o minimise the likelihood of combustible dusts being blown into suspension in proximity of the hot gasses and molten metals ejected by the arc blast,
- → control of electromagnetic emissions to within acceptable limits.

An EECP should also identify the methods for determining appropriate types and levels of PPE where the risk of injury associated with arc flash has not been eliminated.

In developing controls in relation to arcing faults additional guidance and information is contained in the following:

- → AS/NZS 3000 *Wiring rules*
- → IEEE 1584 *Guide for Performing Arc-Flash Hazard Calculations*
- → NFPA 70E *Standard for Electrical Safety in the Workplace*

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(c) the design and operation of any electrical equipment that contains flammable liquid,

Flammable liquids used in association with electrical equipment may create other hazards that will require the development of additional specific controls. For example, insulating and cooling fluids may present the risk of fire and potential for noxious gases to be given off during combustion.

An EECP should detail the safety measures required for the safe installation, use and handling of any flammable liquids in and around electrical plant and installations. Considerations should include measures to control:

- → the likelihood of a fire occurring
- → the consequences if a fire occurs, including management of noxious and toxic gases that result from overheating or fires
- → direct contact with fluid as these may also contain contaminants such as PCBs
- → environmental contamination.

In developing controls in relation to this matter for surface electrical installations, additional guidance and information is contained in the following:

- → AS/NZS 3000 *Wiring rules*
- → AS/NZS 3007 *Electrical equipment in mines and quarries – Surface installations and associated processing plant*
- → AS 2067 *Substations and high voltage installations exceeding 1 kV a.*c.

The principles contained in the above standards should also be considered for underground operations.

For additional information, refer to the Queensland *Recognised Standard 01. Underground electrical equipment and electrical installations.*

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(d) the carrying out of the selection, installation and use of electrical cables and electrical cable accessories at the mine or petroleum site,

For underground coal mines, there are additional requirements in relation to cables, particularly in a hazardous zone. See 5.2.6 ‘Cables’ of this code.

The selection and installation of different types of cables can have significant impact on the safe operation of plant and installations at the mine. The method of installation and the characteristics of the electrical supply network will greatly impact the types of cables required to be selected. Refer to element (b) above for guidance on rating factors to be considered.

An EECP should identify the criteria for the selection of cables and accessories, including plugs and receptacles that are suitable for use with the plant and installations at the mine. This selection criteria should include factors such as:

- → the type and capacity of the supply network at the mine
- → current ratings of the cables and the associated cable accessories under both normal and fault conditions
- → the use of reeling, trailing and flexible feeder cables with individual conductor screening and the use of phase barriers in associated cable accessories

  Note: This has proven to be a reliable risk control at underground coal mines.
- → reeling and trailing cables that conform to AS/NZS1802 or to AS/NZS 2802
- → the use of symmetrical cables to minimise any sparking issues between machines in hazardous zones and potential touch voltages at the machine end of the cable

  Note: Where load currents exceed 20 amps, starting and/or normal running conditions may result in the voltages being induced in earthing conductors of non-symmetrical cables. This is a particular issue for mobile equipment, such as shuttle cars and electrical boggers that are rubber tyre mounted and may not have other forms of earthing.
- → voltage rating of cable insulation to withstand transient voltage rise associated with earth faults on earth fault current limited systems

Note: Phase voltage will rise to line voltage when an earth fault occurs in an earth fault current limited system.

- → cable accessories for use with reeling, trailing or flexible feeder cables that comply with AS/NZS1299 or AS/NZS1300
- → general use cables in mine installations.

Guidance in the selection of cables can be found in:

- → AS/NZS 3000 *Wiring rules*,
- → AS/NZS 3007 *Electrical equipment in mines and quarries – Surface installations and associated processing plant*,
- → AS 2067 *Substations and high voltage installations exceeding 1 kV a*.c., and
- → AS/NZS 3008 part 1.1 *Electrical installations—Selection of cables Part 1.1: Cables for alternating voltages up to and including 0.6/1 kV—Typical Australian installation conditions*

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(e) the control of static electricity at the mine or petroleum site, including preventing the ignition of flammable gas,

Where flammable gases may be present at a mine (which may create an explosive gas atmosphere), it is essential that control measures be implemented to minimise the generation of static electricity, which can act as a potential ignition source.

All non-metallic compressed air equipment or pipe should be considered as likely to develop an unacceptable static electrical charge unless testing shows this is not the case. Conveyor belting and accessories may also create a static electricity risk. Metallic compressed air equipment and pipes will also accumulate a static charge unless effectively bonded to earth.

Ventilation equipment such as ducts associated with auxiliary ventilation fans are a source of significant static. Any appliances or fittings used in association with ventilation ducts and auxiliary fans must be suitably rated and tested to demonstrate that static charges will not accumulate to levels that may cause sparking. The repair of these appliances and devices must also be done in a manner that maintains the original designed anti-static properties. Methods of installation must provide for effective earthing of the equipment, as failure to earth the equipment will affect the ability of the ventilation ducts to dissipate any accumulated charges.

Static charges also represent a significant risk for dry drilling operations, i.e. drilling rigs that use compressed air rather than liquids to remove drill fines from the drill hole. This risk is present in both surface and underground drilling operations. While the risk of ignition of flammable gasses is high if flammable gasses are present, so is the risk of injury to people working with or around the drilling

operations where the charges that build up on materials can cause immediate and severe pain when contacted by a person and potentially cause reactions that lead to further injuries such as falls.

Some items of clothing may also create a static electricity risk.

An EECP should provide for, or link to other control plans such as a ventilation control plan or an MECP, to provide for the identification and assessment of the potential of static charges and the identification of suitable methods for preventing the accumulation of a static charges. Measures will include:

- → earthing and bonding of plant
- → the use of items of plant with proven antistatic properties
- → testing of items of plant to establish anti-static properties.

Guidance on this assessment and possible control measures is given in:

- → IEC TS 60079-32-1 *Explosive Atmospheres – Part 32-1 Electrostatic hazards, guidance*
- → MDG 3608 *Non-metallic materials for use in underground coal mines*.
- → AS 2660 *Hose and hose assemblies – Air/water – For underground coal mines*

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(f) the impact of lightning on the mine or petroleum site (especially on an underground mine) including the effect on electrical systems,

Due to the risks from lightning including possible presence of flammable or explosive gases in a mine, it is essential that control measures are implemented to minimise the effects of the energy from a lightning strike being transferred to the underground workings.

Lightning also has the potential to create an electric shock hazard. This can occur in the underground parts of a mine as well as the surface parts.

Lightning can also cause unintended operation of equipment due to overvoltage on electronic components or by overcurrent and overvoltage surges. Overvoltage can also result in damage to insulation of both power systems and electronic components.

An EECP should identify the methods that will be used to prevent or minimise the effects of lightning being transferred to any underground workings or to the supply systems.

In developing controls in relation to the impact of lightning on the mine, additional guidance and information is contained in the following:

- → AS 1768 *Lightning protection*

  Note: This standard includes guidance for the undertaking of risk assessments associated with lightning.

- AS/NZS 3007 *Electrical installations – Surface mines and associated processing plant*.
- ACARP Report C22003 *Investigation of the Potential Lightning Impacts on Underground Coal Mines*

  Note: This report contains information pertaining to the transfer of the effects of lightning in to an underground coal mine.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(g) the need for reliable circuit interruption for all points in electrical distribution system at the mine or petroleum site when faults occur taking into account the operating time and tripping current of circuit protection devices,

Electrical circuits at a mine may be subject to electrical faults at some time during their lifecycle. An electrical fault can be considered an uncontrolled release of electrical energy. Reliable detection of this uncontrolled release and the automatic disconnection of the electricity supply is essential to minimise the risk to people and damage to plant and installations.

Reliable circuit interruption (which includes switchgear and the means of detecting a fault) must be fitted to all circuits to interrupt the supply when a fault occurs on any circuit or sub-circuit at the mine (refer to clause 32(n) of the WHS (MPS) Regulation).

An EECP should identify protection equipment and switchgear specifications and ratings to achieve reliable circuit interruption under normal operating conditions and under fault conditions that may occur in the different circuits and sub-circuits in the mine's electrical distribution system.

Circuit fault detection and protection devices should include:

- short circuit protection on all circuits and sub-circuits
- over current protection on all circuits and sub-circuits
- earth leakage protection on all final sub-circuits
- earth fault protection on all circuits other than final sub-circuits

  Note: Earth fault protection may be provided through correctly rated fuses on solidly earthed supply systems, where earth fault currents significantly exceed the electrical load on the protected circuit. Earth leakage protection cannot be provided through the use of fuses.

- earth continuity protection on circuits that supply mobile or transportable plant fed via reeling or trailing cables
- RCD protection should be provided on all low voltage (LV) circuits and sub-circuits where suitably rated RCDs are available. (refer to clause 32(2)(o) below for more details).

Note: AS/NZS 3190 for RCDs is applicable to devices that have rated load currents not exceeding 125 A ac.

Circuits that are isolated from earth (isolated circuits) provide safety only in respect of the first fault that occurs on that circuit. Subsequent faults will still present a significant risk to personnel through electric shock or unintended operation of plant where sections of a circuit may be bypassed or defeated by the multiple faults in the circuit. Where an isolated circuit is used, the EECP should require that consideration be given to the use of insulation monitoring systems to detect if there has been a reduction in the required level of insulation resistance (the first fault) on that circuit and the removal of power prior to the second fault occurring.

An EECP should also address what protection is required on different circuit types and the settings required for the different protection devices being used. Where earth leakage protection on an IT supply network is provided by a protection device other than an RCD, the earth leakage protection device should comply with AS/NZS 2081. Devices constructed in accordance with the AS/NZS 2081 standard are intended for use on IT supply networks.

For additional information, refer to:

- → WHS Regulation, and
- → AS/NZS 3000 *Wiring rules*.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(h) the type of earthing system used, including levels of earth fault limitation,

The method of connecting a power supply to an earthing system can be done in different ways:

- → The transformer may be solidly connected to the earthing system.
- → The power supply may be connected via a current limiting device, normally a resistor, so that the earth fault current is limited to a maximum value.
- → The power supply may be isolated from the earthing system.

Different configurations have their own particular benefits and their own particular drawbacks. One advantage of current limited systems is the significant reduction in the likelihood of arc blast incidents. Another is a reduction in prospective touch voltages during earth faults.

In managing risks in accordance with section 3 of this code, an EECP will require that an engineering review of the power supply system be conducted to identify and analyse the risks that need to be controlled. A specific risk control exists in clause 32(2)(l)(i) of the WHS (MPS) Regulation requiring the magnitude of earth fault currents to all electrical plant in an underground mine, and all mobile plant fed via flexible reeling or trailing cables in any other mine to be limited in order to control step and touch potentials.

For other situations, the review will identify the most appropriate earthing technique to be used. Where it is identified that an earth fault current limited system is required to be used, the review must identify the level of current limitation. Values of current limitation should be as low as reasonably practicable. The tripping setpoints for both current and time should also be identified. Guidance in determining the value of current limitation and the tripping setpoints is contained in AS/NZS 3007 for surface of mines and in AS/NZS 4871 for underground mines.

It is important to maintain the ratio between the maximum fault current and the tripping current to ensure reliability of the earth leakage tripping system. A decrease in the tripping ratio below the designed value may result in a failure of the earth leakage protection device to detect and clear a fault.

For all earthing systems, the review should also identify the maximum value of earth conductor impedance so that during an earth fault, the maximum allowable touch potentials are not exceeded.

Note: Either earth fault currents or earth conductor impedance in excess of the designed value will result in increased touch potentials under fault conditions that may exceed the allowable values of voltage.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(i) the potential for persons to contact electricity indirectly,

Indirect contact may be caused by water or other conductive substances entering electrical equipment and providing a path across the surface of insulating materials that conducts the electricity to places and objects that are not normally energised. This path may be along a cable sheath to ground or to other equipment or across multiple layers of insulation. Common sources are light switches, motor isolators, double insulated hand-held tools and so on, that are exposed to water.

Preventative control measures include protection from the weather and sources of contamination, insulation, IP ratings, and effective maintenance practices. Mitigation controls include earth leakage protection and effective earthing of metallic enclosures of electrical equipment

An EECP should identify:

- → suitable locations for the installation of electrical plant (refer to sub clause 3(a) above)
- → IP ratings for electrical plant and installations. This is dependent on the locations selected for installation.
- → suitable locations for the use of portable tools. These should not be permitted in wet environments or where perspiration may impact on the safe use of the tool
- → earthing requirements for electrical enclosures
- → earth fault settings on circuits supplying switch boards

- earth leakage settings on equipment fed from switch boards
- the maintenance practices necessary to maintain the electrical equipment in the designed condition. This will include visual inspections, along with detailed internal inspections and electrical circuit testing.

Examples of the above include:

- equipment installed in a location exposed to the weather and high levels of dust will require a higher IP rating than equipment installed inside a sealed and air conditioned switchroom. Equipment in the exposed and less protected location will also require a higher level of maintenance to ensure the protective properties are maintained.
- Double insulated power tools depend on the double insulation to achieve the required levels of safety. Liquids, whether from rain, condensation or sweat, or other chemicals will bridge the double insulation creating a current path to the outside of the tool and create an electric shock risk. Battery powered tools will eliminate this source of electric shock, although the battery charger itself must still be correctly managed.

For additional information, refer to:

- AS/NZS 3000 *Wiring rules*
- AS/NZS 3007 *Electrical equipment in mines and quarries – Surface installations and associated processing plant*
- AS/NZS 4871 series *Electrical equipment for mines and quarries*
- AS/NZS 3760 *In-service safety inspection and testing of electrical equipment*

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(j) the prospective touch, step and transfer voltage,

Prospective touch, step and transfer voltages are governed by several factors. These factors include fault currents that can range in magnitude of several amps in current limited earth fault systems to tens of thousands of amps in direct earthed supply systems. The resistance of the earthing systems will also impact these voltages.

Effective earthing must be provided, so far as is reasonably practicable, so that the risk from touch, transfer and step potentials are minimised, and lightning effects are not transmitted into an underground operation. The mine operator must also ensure earth fault currents to mobile plant (fed by flexible reeling or trailing cables) at any mine and underground plant are limited (clause 32(2)(l)(i) WHS (MPS) Regulation).

The power systems analysis that is done will identify requirements for the design of the earthing system to achieve certain touch, step and transfer potentials under fault conditions (refer to clause 32(2)(i) WHS (MPS) Regulation). The design of the earthing system will include the design of earth grids to achieve the appropriate resistance and to minimise the transfer of potentially hazardous voltages between earthing systems and especially to underground workings of underground mines. This may require that the underground earthing system should or should not be connected to an earthing system at the surface of the mine.

A generic design of earth grid will not achieve the same level of performance in different situations.

Each earthing installation requires its own design as step, touch and transfer potentials are governed by multiple variable factors such as:

- → soil resistivity
- → fault currents
- → the layout and positioning of the buried conductors.

All earthing conductors should be electrically continuous and in effective electrical connection with an earthing system and the apparatus that they are intended to earth.

An EECP should identify:

- → the methods of determining maximum allowable prospective touch, step and transfer voltages for the mine
- → the processes to be followed as part of the design phase of electrical installations to identify appropriate measures to control touch, step and transfer potentials
- → the processes to be followed to assess the earthing requirements of conductive structures associated with, or that are in close proximity to, electrical installations – to control touch and transfer potentials
- → maintenance practices required to ensure that the earthing systems continue to perform in the same manner that they were designed to perform
- → the processes for determining electrical protection device settings to minimise the duration that faults currents may flow, thereby limiting the duration that elevated touch, step and transfer voltages may be present for
- → the requirements for review of the power supply system, or parts of the supply system, including electrical protection settings when there are changes to the power supply system or to the incoming supply network.

Where mobile plant (fed via reeling or trailing cables) is used, the EECP should identify specifications for earthing that include the levels of earth fault limitation required to enable the required levels of touch or transfer voltages to be achieved. It should also provide for reliable operation of any electrical protection systems associated with the mobile plant.

For additional information, also refer to:

- → AS/NZS 3007 *Electrical equipment in mines and quarries – Surface installations and associated processing plant*
- → AS/NZS 3000 *Wiring rules*

- → AS 2067 *Substations and high voltage installations exceeding 1 kV a.c.*
- → AS/NZS 4871.1 *Electrical equipment for mines and quarries Part 1: General requirements*

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(k) variations in operating conditions,

Variations or fluctuations in electricity supply can result in unintended operation of electrical equipment or in the failure of insulation systems or switchgear. These effects may be caused by voltage instability associated with long runs of cables, frequency changes, switching transients or load fluctuations and may also result from weak supply networks or from undersized or faulty generators.

Consideration should also be given to variations in environmental conditions such as high or low temperatures or excess humidity that may be outside the rating of electrical plant.

An EECP should consider the effects of variations in electricity supply such as:

- → voltage rise
- → voltage instability
- → voltage droop/sag.

  Note: This may result from problems within the supply authority network, as a function of motor starting or short circuit/overload condition at the mine or a high resistance occurring along a phase conductor.
- → loss of phase.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(l) preventing persons inadvertently contacting energised parts of electrical plant and electrical installations,

It is essential that physical barriers and/or electrical safeguards are put in place to protect people coming into contact with electricity, which can cause injury or death through electric shock.

An EECP should nominate the control measures to be used to prevent the inadvertent contact with energised electrical components and electrical plant and installations. This may include a combination of guarding, interlocking and IP rating of equipment, locating items out of reach, along with effective signage.

Examples of such devices or features include:

- → electrical enclosures
- → shielding
- → double insulation
- → electrical or mechanical interlocking devices.

Note: any modifications to electrical plant and installations should comply with the relevant standards and should not result in a lower standard than that originally provided, in particular safe access to and within electrical enclosures.

For further information refer to:

- → WHS Regulation, clause 208 *Guarding*
- → AS 2067 *Substations and high voltage installations exceeding 1 kV a*.c.
- → AS/NZS 3000 *Wiring rules*
- → AS/NZS 3007 *Electrical equipment in mines and quarries – Surface installations and associated processing plant*
- → AS/NZS 4871 series *Electrical equipment for mines and quarries*
- → AS 60529 *Degrees of protection provided by enclosures (IP code).*

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(m) the consultation, co-operation and co-ordination of activities between persons conducting businesses or undertakings at the mine or petroleum site (including the operator) and persons conducting businesses or undertakings installing, maintaining or carrying out work on an electricity supply authority's infrastructure,

Electrical transmission and distribution systems often cross mining operations. Where these do not directly supply electricity for mining activities, they often supply the community or are part of the state transmission system. Electricity supply authorities will need safe access to undertake work on this infrastructure.

Under WHS laws, the mine operator must consult, cooperate and coordinate with other PCBUs who have a duty in relation to the same WHS matter. This should include relevant electricity supply

authorities (and/or any other PCBU involved) in relation to persons who work on an electricity supply authorities' infrastructure who may be affected by the mining operations or the effects of the work undertaken by the supply authority impacting the mine.

An EECP should specify provisions to provide for the safe access for supply authority workers undertaking work on the supply authority's infrastructure. This is to help ensure means supply authority workers are not being put at risk from the mine's activities. The mine operator and supply authority and/or other PCBU may also agree procedures to be followed when accessing infrastructure.

Communications and protocols should be established for access to and from the work site, including the development of emergency plans that are understood by all, and provisions for the supply authority to report any incidents that are notifiable under WHS laws.

Note: the plan may also cover the safe access for other utilities that may need to have access to their infrastructure at the mine, for example, electrified railways or telecommunications towers.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(n) the procedures for the following:

(i) the use of electrical welding plant,

Welding operations are often carried out at mines, where the environment increases the risk of electric shock, explosion, fire or electrocution. Selection of the most appropriate welding machines and hazard reduction devices are critical to control the risks that are created or exacerbated due to the environment. These factors may include elevated temperatures, humidity, moisture, working while in contact with the work piece or structure and so on.

An EECP, in conjunction with an MECP, should identify the minimum requirements for welding plant suitable for use at the mine. These should include be developed having regard to the following:

- → AS 60974.1 specifies requirements for arc welding power sources designed for professional and industrial use
- → AS 60974.6 specifies requirements for limited duty arc welding and allied process power sources

The EECP and/or MECP should also include requirements relating to the use and maintenance of welding plant. See AS/NZS 1674.2 for guidance on the safe use and maintenance of welding plant, including guidance on selection of welding plant suitable for a particular environment.

Where welding is to be conducted in the hazardous zone of an underground coal mine, a high risk activity (HRA) notification be submitted to the regulator (clause 33 and Schedule 3 clause 11 of the WHS (MPS) Regulation). The EECP and/or MECP may set out arrangements to support this obligation. Due to

the risks involved with welding in underground coal mine hazardous zones, consideration should be given to whether there are safer alternative methods of equipment repair, such as moving the item to a safer location for welding.

For additional guidance information on the use of electric welding equipment refer to:

- → MDG 25 *Guideline for safe cutting and welding at mines*
- → TN 22 *Welding Electrical Safety*, Welding Technology Institute Australia.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(n) the procedures for the following:

(ii) the use of electrical test instruments,

Test instruments should not cause the circuit being tested to become a source of electric shock, arc flash/ blast, cause unintended operation of plant or compromise any explosion protection properties. The exception to this is for the use of insulation test instruments, which by nature of the test performed, will energise circuits to voltages greater than the nominal circuit voltage. Where these test instruments are used, it is important to follow any instructions and warnings provided with the instrument.

An EECP should specify procedures to ensure:

- → the safe use of electrical test instruments, which should include measures to eliminate or control the risk of inadvertent contact with electricity. Reference should be made to AS/NZS 4836 *Safe working on or near low-voltage electrical installations and equipment* for guidance in procedures for fault finding or testing of circuits
- → that appropriate test equipment is only provided to and used by competent persons (refer to the Standards Australia Handbook 187 '*Guide to Selecting a Safe Multimeter*' and the NSW *Code of practice: Managing electrical risks in the workplace*, if necessary)
- → that appropriate personal protective equipment is used by the people conducting the tests
- → the maintenance of test equipment in a safe condition
- → the calibration requirements for identified items.

Additionally, when undertaking testing on an energised circuit, testing must be conducted in the presence of a safety observer, where required, as per the requirements for live electrical work under clause 161 of the WHS Regulation. The safety observer must be competent to implement control measures in an emergency and rescue the worker if necessary. This should include competency in cardio-pulmonary resuscitation. Clause 161 also specifies situations where a safety observer may not be

required. The *NSW Code of practice: Managing electrical risks in the workplace* provides guidance on clause 161 and how to comply with it.

Where tests are routinely carried out as part of maintenance, calibration or fault finding, the plant and equipment should be designed with appropriate diagnostics and/or suitably protected test points that are only accessible to competent electrical people.

Where electrical test equipment is used in a hazardous zone of an underground coal mine, an EECP should provide for the use of electrical test equipment that complies with the requirements of clauses 78-80 and 82-83 of the WHS (MPS) Regulation (see 5.9 'Testing' in code for more information).

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(n) the procedures for the following:

(iii) work near overhead power lines and cables,

Contact with overhead power lines is a source of electrocution. SafeWork Australia has a range of guidance materials on working safely near overhead power lines.

An EECP should require:

- → site plans showing the location of all overhead power lines and cables at the mine, which is readily accessible to workers where relevant to their work
- → procedures for work near overhead power lines and cables
- → provision of signs warning of overhead power lines and cables
- → periodic checking of travel clearance around overhead power lines and cables.

An EECP should also require management systems that restrict work activities and approach distances to the overhead lines in accordance with Section 7 of AS/NZS 3007.

Note that clause 166 of the WHS Regulation has specific requirements in relation to working near overhead and underground electrical lines – see 4.7 below. The *NSW Code of practice: Managing electrical risks in the workplace* provides guidance on this requirement and how to comply with it.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(n) the procedures for the following:

(iv) the treatment of electric shocks and electric burns,

When contact is made with electrically energised objects, current flows through the body and can affect the rhythm of the heart. If current levels are high enough this can also cause damage to muscles including the heart, which can cause respiratory distress and cause burns to internal parts of the body and to skin. The effect of electric shock can also result in altered states of consciousness and in some instances may also result in broken bones.

Arc blast injuries can result in burns due to thermal energy, concussive injuries due to pressure shock waves, hearing damage, injuries due to flying particles and objects, and damage to airways due to hot gases and vapourised metals.

Contact with high voltage may also result in additional effects. The effects of this may be temporary but may also be irreversible, resulting in the death of cells affected. These effects are determined by factors such as the voltage level and the exposure time.

Where an earth leakage protection device has tripped following contact by a person with energised conductors or plant, the values of tripping current and voltages should be documented and provided to the persons undertaking medical assessments.

An EECP should identify, or link to other management plans, the protocols necessary for the effective management of electric shock, electrical burns and arc blast injuries. These should require that any person that has received an electric shock be referred for immediate medical assessment. This assessment may include the person undergoing an electrocardiogram (ECG) so as to detect any irregular heart rhythms. This may be appropriate even where the person who received the electric shock does not feel unwell.

It is recommended that testing should be conducted, and the results assessed, by competent medical personnel. If the mine has its own ECG equipment, then arrangements should be put in place to ensure its results can be relied upon.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(n) the procedures for the following:

(v) accessing and working on high voltage electrical installations,

For high voltage installations to be operated safely throughout their lifecycle, procedures for switching and access should be established and implemented, along with procedures for safe removal and restoration of power in other circumstances.

Workers undertaking high voltage switching and access should be trained in the principles used for safe access and be assessed as competent, and authorised by the operator to undertake these switching and access activities at that mine.

An EECP should identify the competency requirements for workers, and the procedures required when switching high voltage for the purposes of accessing and working on electrical conductors. As a minimum, these procedures should require the use of switching and access permits and provide for:

- → safe operation of switchgear
- → testing for de-energised
- → issuing and receipt of the permits, for the purposes of undertaking work and for undertaking testing of circuits and plant
- → application of locks to isolation points and operator earthing facilities to prevent inadvertent energisation
- → the application of permit earths and working earths.

For high voltage equipment that is installed underground, reference should be made to Australian Standards handbook HB242 *High voltage mining equipment for use underground*

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(o) signage and notices in relation to the risks arising in relation to particular electrical plant and electrical installations such as electrical switchgear,

Even though signs are a low-level risk control, they are an important reminder of hazards and provide information that is essential to effectively manage risks associated with plant and installations.

An EECP should identify what signs are to be displayed for electrical plant and electrical installations and where they are to be displayed. The signs may need to provide for one or more of the following considerations:

- → clearly identify the plant and the source of supply
- → warn of the presence of electricity and if necessary restrict access
- → provide advice on what to do in the event of a fire on electrical plant and installations, including items such as emergency contact numbers
- → provide advice on what to do in the event of an electric shock and other electrical injuries

- → provide advice on the isolation point for the electrical plant or installation
- → for electrical switchgear, provide advice on what electrical plant and installations the switchgear supplies.

For general guidance on signs refer to:

- → AS/NZS 3007 *Electrical equipment in mines and quarries – Surface installations and associated processing plant*
- → AS/NZS 4871 series *Electrical equipment for mines and quarries*.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(p) the security and maintenance of the mine's electrical control system software and control circuits,

Modifications to electrical control systems, whether the control circuits wiring or the software that forms part of the control circuits, may lead to catastrophic failure of plant if not managed in a systematic manner. For example, unintended operation of plant may lead to serious injuries to persons operating or working in proximity to the plant.

An EECP should require the use of change management procedures that provides for control system changes to be authorised by a competent person, before modification work begins. The modifications, and other functions that may be impacted by the modification, must be commissioned, documented and verified as achieving the intended outcomes.

Where access to plant control software may result in unintended operation of plant, including the defeating of safety and interlocking systems, an EECP should require the use of controls that puts the plant in a safe state before any alterations can be made. These controls may entail the placing of a PLC in a dedicated programming state by operation of a key switch rather than by a software command, or requiring a switch to be operated local to the plant to be affected that stops the affected plant before the software alteration can be implemented.

Note 1: A person with the management or control of plant has a duty to ensure, as far as is reasonably practicable, that there are no unauthorised alterations or interference with plant (clause 205 of the WHS Regulation).

Note 2: Modification to safety related systems may invalidate SIL rating.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(q) the use of lasers and fibre optic equipment at the mine or petroleum site,

Lasers pose a hazard to people's vision and can also initiate an explosion due to the heating of dust particles. The risks can be associated with direct exposure to the laser light source or as a result of damage to fibre optic cables.

An EECP should address the following:

- → the use of lasers in accordance with AS 2397 *Safe use of lasers in the building and construction industry* (except for Class 3B and Class 4 lasers which are prohibited for use in construction work under the WHS Regulation clause 223).
- → potential ignition hazards pertaining to equipment using optical radiation in explosive atmospheres, refer to AS/NZS 60079 Part 28 *Explosive atmospheres – Protection of Equipment and Transmission Systems using optical radiation*.
- → maintenance, inspection and testing of lasers.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(r) the construction, installation, and maintenance of battery powered vehicles and battery charging stations at the mine or petroleum site,

Battery vehicles and battery charging stations, in particular where lead acid batteries are utilised, generate explosive gasses during charge and discharge cycles. The construction and the operation of battery vehicles and charging stations must minimise the likelihood of sparking and thermal effects that may ignite these explosive gasses.

Battery vehicles

An EECP should identify the minimum requirements for the construction of battery powered vehicles and machinery to minimise the likelihood of explosions or fire. In determining these requirements, reference should be made to AS/NZS 4871 Parts 1 and 5.

Battery charging stations

An EECP should provide for the design and construction of battery charging stations.

Surface charging stations

Where the charging stations are installed on the surface of a mine, this should include:

- → reference to the appropriate parts of AS/NZS 3000 and AS 3011 parts 1 and 2 for the layout and construction, and
- → arrangements to ensure the identification and assessment of hazardous areas in accordance with AS/NZS 60079.10.1 due to the explosive gasses that may be given off during the battery charging operations, and
- → requirements for the selection and installation of explosion protected electrical equipment in accordance with AS/NZS 60079.14 where hazardous areas are identified, and
- → identify fire alarm and fire extinguishing arrangements for the gasses given off by the types of batteries that are installed.

Note: Most lithium batteries do not contain lithium in metallic form. Batteries that contain lithium metals require special fire suppression techniques.

Underground charging stations

Where charging stations are located underground at the mine, an EECP should make provision for:

- → the removal of power in an emergency (for example in an underground coal mine, an emergency stop on the intake side of the charging station)
- → ensuring charging stations are located outside a hazardous zone (in underground coal mines),
- → ventilation air to flow direct into a return airway to minimise the impacts of gasses given of during charging
- → providing suitable locations for installation, such as a designated room, an enclosure or a cut-through set aside and specifically designed for that purpose.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(s) the supply of electricity in hazardous atmospheres and, in the case of underground coal mines, in hazardous zones,

Electricity presents a significant hazard as an ignition source when used in a hazardous atmosphere (explosive gases, combustible dusts and so on) and in the case of underground coal mines, hazardous zones. Where it is necessary to use electricity in a potentially hazardous environment, controls such as electrical protection systems, earthing systems, explosion protected equipment and monitoring of the environment must be correctly designed and implemented to ensure the safety of workers and the installation.

Electrical protection and earthing design will have significant impact on the overall safety of the electrical installations at the mine. A change in one part of the mine can impact all aspects of the mine power supply. It is essential that people who are competent in these areas are involved in the design and any subsequent reviews of the protection system or earthing system.

An EECP should make provision for the assessment of explosion risks in potentially hazardous areas on the surface of a mine in accordance with the wiring rules and require the installation of electrical plant and installations in these areas to be undertaken in accordance with the *Wiring Rules*.

An EECP should require that any electrical protection and earthing design for hazardous atmospheres is carried out by competent, qualified workers familiar with the constraints imposed by the particular hazardous environment.

An EECP should also detail competencies required of the workforce that will be required to install or maintain electrical plant and installations within the hazardous area.

For hazardous zones of underground coal mines, refer to 4.6 and Chapter 5 below for additional information.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(t) the use of electrical plant in hazardous atmospheres and, in the case of underground coal mines, in hazardous zones,

Electrical plant and installations in hazardous atmospheres and, in the case of underground coal mines in hazardous zones, should be fit for purpose and used in a safe manner and under competent supervision to prevent them becoming a source of ignition. Preventative measures include the use of equipment that is certified as explosion-protected. This includes portable electrical equipment.

Electrical equipment on the surface of a mine is required to be installed in accordance with the requirements of AS/NZS 3000:2007 (refer to clause 32(2)(a) WHS (MPS) Regulation). The wiring rules require that locations be assessed for explosion risk in accordance with AS/NZS 60079.10.1 (gasses) and AS/NZS 60079.10.2 (dusts). Suitable equipment for the environment must be selected and installed in accordance with AS/NZS 60079.14.

For hazardous zones of underground coal mines, additional requirements exist. Refer to chapters 4.6 and 5 for further information.

Workers must also be suitably trained and competent to install and maintain electrical plant and installations in hazardous environments. This ensures that all special requirements and conditions of use of certified plant and of the installation standards are identified, understood and implemented correctly.

An EECP must address the particular requirements of the wiring rules in relation to plant and installations in hazardous areas and include arrangements to ensure the plant is used in accordance with any conditions of certification.

An EECP should also detail competencies required of the workforce that will be necessary to install or maintain electrical plant and installations within the hazardous area. These competencies should be consistent with AS/NZS 4761 or with the IECEx Scheme for Certification of Personnel Competence.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(u) safe work systems for persons dealing with electrical plant and electrical installations including the isolation, dissipation and control of all electrical energy sources from the electrical plant or electrical installation,

Safe systems of work identify how work activities should be done so the activity can be undertaken safely, particularly in relation to hazardous work processes and the control of hazardous energies. They include the instructions given to workers to enable them to perform the tasks in a safe and consistent manner.

In developing safe systems of work, a mine operator should consider all sources of hazardous energies and the associated risks relating to the proposed activity to determine the level of competence required of workers to be permitted or authorised to undertake the work activity. The competence of workers the complexity of the work activity and the consequence of errors being made will determine the level of detail required in procedures or work instructions that will enable the task to be performed safely.

Sources of electrical energy not only originate from mains supplied systems, but can also be from stored energy systems such as capacitors, inductors and storage batteries, and generation sources such as rotating electric motors and generators, and photovoltaic panels. Capacitive coupling from high voltage or high frequency systems and inductive coupling associated with high current systems also present significant risks if not properly controlled. The failure to isolate sources of electrical energy before undertaking electrical work exposes workers to a high level of risk from electrocution, electric shock, burns and/or injuries resulting from ignition of flammable gas or dust, unintended operation or movement of plant.

Reference should be made to figure 3 in section 3.2 above for guidance in identifying potential risks for associated with electrical energy to figure 4 in section 3.2 above for potential risks associated with other forms of energy.

It is important to note that while the activities of operating an isolation point, or multiple isolation points, dissipation of stored energy sources and implementing correctly the necessary tests for de-energised will eliminate a hazard and create a safe environment for workers, these acts are procedural. A hazardous energy source can only be regarded as having been controlled when all the required actions have been implemented correctly. Operation of an electrical isolation point only isolates electrical energy and other

isolation and dissipation mechanisms may need to be implemented as well. Errors made during these processes mean that an energy source has not been made safe.

An EECP should detail the arrangements for the development of safe systems of work for activities relating to electrical aspects of plant or installations. These should relate to:

- the nature of the task
- all hazardous energies involved
- the potential for human error
- the complexity of the task and its frequency
- type of plant or installation and the particular hazards associated with the work environment at those locations
- electrical competencies, training and supervision needs
- provision of notices and warning signs
- resources required such as special tools and other plant
- communication needs such as between work areas and shifts
- available information, such as information from the designer manufacturer or supplier .
- Identification and operation of isolation points relating to electrical plant
- be developed or checked by a person with appropriate electrical engineering competence
- describe how the work is to be carried out
- identify the work activities and associated hazards
- describe the control measures that will be applied
- identify specific equipment requirements, as applicable
- identify core competency requirements and any additional training needs
- involve detailed risk assessment methods where complex tasks and hazardous energies are involved
- involve work permit systems where higher levels of overarching control are required, such as for high voltage switching and access or complex isolations involving multiple isolation points.

Reference should be made to:

- MDG 40 *Guidelines for hazardous energy control (isolation or treatment),* and
- AS 4024.1 *Safety of machinery* series of standards for further guidance on energy isolation and dissipation.

Schedule 2 Principal control plans – matters to be addressed (Clause 26)

…

3 Electrical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2)

(v) the use of switchgear and electrical protection devices that can automatically detect an electrical fault in a circuit and disconnect the supply of power to the circuit.

Fault conditions associated with electrical power systems can expend significant quantities of energy in extremely short periods of time and have the capacity to cause significant injuries to workers.

To minimise the possibility of injury to workers, including risks from damage to plant and installations, it is important that the sources of electrical energy are disconnected as quickly as possible. This can be achieved by using protection systems that are capable of detecting the different types of faults that may occur on a circuit and automatically initiating the tripping of the associated switchgear. This switchgear must be capable of safely disconnecting the faulted circuit from the supply system without causing or exposing workers to other risks.

An EECP should identify the types of electrical protection devices required to be used at the mine to detect and initiate clearing of electrical faults that have potential to cause injury to workers. The EECP should also identify the types of switchgear that are to be used to provide safe interruption of electrical faults once identified by the protection devices.

4.6. Specific risk controls – WHS (MPS) Regulation

There are specific controls required under the WHS (MPS) Regulation for all mines that apply to electrical plant and electrical installations at mines. A specific risk control is a mandatory requirement that must be complied with if that type of plant or installations exists at the mine.

Clause 32 contains many specific controls for electrical safety. An EECP for a mine should detail the arrangements that are required for the mine to achieve compliance with these specific risk controls.

WHS (MPS) Regulation

32 Electrical safety

(1) In complying with clause 9, the operator of a mine or petroleum site must manage risks to health and safety associated with electricity at the mine or petroleum site.

(2) In managing risks to health and safety associated with electricity at the mine or petroleum site, the mine operator must ensure:

(a) that electrical installation work at the surface is carried out in accordance with the Wiring Rules, and

The *Wiring Rules* (AS/NZS 3000) have developed over many years and provides minimum standards of electrical installations that will minimise the likelihood of electric shock, electrocution and fires associated with electrical installations.

Part 1 of the *Wiring Rules* identifies the essential elements that constitute the minimum requirements for a safe electrical installation and provides a mechanism for acceptance of alternative design and installation practices that are not addressed, or are inconsistent with, those given in the 'deemed to comply' Part 2. Part 2 provides prescriptive requirements for installation practices that achieve certainty of compliance with the essential safety requirements of Part 1.

An EECP should provide for the design of any new electrical installations, or the modification of existing installations, at the surface of the mine to comply with the *Wiring Rules*. This may allow for the use of either Part 1 or Part 2 and should give guidance as to circumstances under which the relevant parts should be used.

(b) that before a circuit is first energised at the mine or petroleum site, or is first energised following the circuit being recommissioned:

(i) the circuit is tested in accordance with the Wiring Rules by a competent person, and

(ii) there is a process in place whereby the operator (or an individual nominated to exercise the statutory functions of electrical engineering manager or electrical engineer at the mine or petroleum site) can be adequately notified about that testing as soon as is reasonably practicable after the testing occurs, and

Before power is turned on to a new installation, or a recommissioned installation, it must be verified that it is safe for use. The notification process confirms that appropriate commissioning and testing has been done.

An EECP should specify:

- → all electrical installations are inspected and tested after they are installed and prior to being put into service, to demonstrate they are safe for use. As a minimum, these tests must include the mandatory tests identified in Section 8 of the *Wiring Rules*,
- → the training, skills and experience required of a person that is to be deemed competent to undertake the tests required above. This would normally be a qualified electrical tradesperson. An EECP may also permit the undertaking of these testing activities when conducted under the supervision of a person competent for this purpose.
- → the notification process to be used to provide information to the mine operator or to an individual nominated to exercise the statutory functions of electrical engineering manager or electrical engineer at the mine done in compliance with the regulation and EECP requirements.
- → a record is made and kept of all commissioning tests and/or tests resulting from a modification.

Commissioning and test reports should be kept by the operator throughout the life of the plant (whether in a digital form or hardcopy).

(c) that adequately rated switchgear is provided that permits power to be safely switched off and safely restored and that does not permit automatic restoration of power if there is a risk of electric shock, fire, explosion or unplanned operation of plant, and

Adequately rated switchgear is switchgear that has:

- → voltage ratings suitable for the maximum operating voltage of the system that it is required to switch, including transient conditions
- → current ratings suitable for the maximum current that it is required to switch. Where required, this may include the ability for the switchgear to safely open a load or fault condition (fault-break), and may also require the ability to safely close onto a load or fault condition (fault-make). This may include motor starting, overload and/or overcurrent situations, and arc fault control capabilities where energy levels are high enough.

There are further requirements for switchgear in hazardous areas and hazardous zones that are explained in chapter 5 – Additional requirements for underground coal mines.

An EECP should provide guidance and instruction for the selection of switchgear with the following functionality:

- → switchgear should not be able to automatic reclose where re-closure may present a risk of electric shock or fire. Such risks usually arise as result of damage to cabling systems and equipment where insulation has been compromised.
- → under-volt or no-volt trip facilities should be incorporated in to the switchgear to automatically open the switchgear and prevent the automatic restoration of electrical power into a hazardous location where a risk of explosion exists (for example, if the loss of ventilation in a hazardous zone or hazardous area may lead to an accumulation of explosive gases or dusts). The switchgear should be designed so that power can only be restored once the location has been inspected and shown to be clear of explosive gases or dusts.
- → switchgear should automatically switch off when there is a loss or interruption of supply, or a brown out condition (a condition where there is an excessive voltage dip in the supply, but not a total loss). where there is a risk of an unplanned operation of electrical plant, the switchgear should be fitted with facilities that cause the This may require the use of under-voltage trip units where a brown out condition may cause erratic operation of plant.

In addition, the electrical distribution system should be sectionalised so that:

- → action can be taken in cases such as emergency
- → removal of power to one part of a mining operation does not unnecessarily affect other parts of the mining operations that are not involved or at risk.

These arrangements should be reflected in the mine electrical drawing plans, as appropriate, for uses such as identifying where power can be isolated.

(d) that arrangements are in place for switching the power off or restoring power as part of normal operations in the event of a fault or an emergency, and

In addition to the provision of suitably rated switchgear in strategic locations throughout a mining operation, facilities should be provided to allow for the operation of that switchgear in an emergency situation. These facilities may include emergency stop buttons placed at strategic and accessible locations, such as outside a switch room or in a control room so that anyone can remove power.

Procedures should be developed and workers trained in the correct operation of these emergency shutdown facilities.

In addition, communication facilities (such as telephones) should be provided at the switchgear locations. Protocols for communication with operators of switchgear at these locations should be developed and implemented in accordance with the emergency plan for the mine.

Procedures should also be developed and workers trained in the correct manner for restoration of electrical power. These procedures should detail competency requirements for workers that are to be permitted to operate switchgear for the purposes of power restoration, along with any inspection requirements that are necessary prior to the reintroduction of power to equipment or location. These include inspections for explosive gases, testing and inspection prior to resetting of electrical protection trips such as earth leakage, overload or short circuit faults, and are applicable to all types of protection systems including RCDs fitted to lighting and power circuits in office facilities through to mobile face machinery and to high voltage reticulation systems.

Each of these matters should be addressed in an EECP by including or linking to the procedures, specifications or other arrangements in which this is managed in practice.

(e) that, for electrical plant at the mine or petroleum site (other than plant connected, and in close proximity, to a wall socket with a switch):

(i) an isolation facility is provided, and

(ii) the equipment is clearly identified as being isolated from electricity by the facility, and

(iii) the facility is clearly identified as the isolator for the electrical plant, and

(iv) persons required to work with the electrical plant are competent in the correct use of the facility, and

An isolation facility may also be known as an isolation switch or isolator.

To ensure that there is no confusion when isolating plant, signs should clearly identify the plant that is supplied through the isolator.

The requirements for the signs (minimum size of printing, material of construction etc) should form part of the EECP arrangements (see 4.5 above).

Training must be provided to all workers that may be required to work with the plant to ensure that they know how to identify the correct isolation facility for the plant and how to operate the isolation facility correctly. In some instances, having workers switching isolation equipment may expose those workers to an increased level of risk, in particular where the isolations relate to very large (high current) plant, high voltage plant and installations, or where multiple isolations need to be implemented to establish a safe state. In these instances, permit systems should be used requiring isolations to be implemented by trained workers. The workers should be following previously identified work instructions authorised by suitably qualified supervisors.

See 4.5 Schedule 2 clause 3(3)(u) for more information on isolation, dissipation and control of all energy sources that must be considered in developing controls under an EECP.

(f) that plans of the electrical installations at the mine or petroleum site showing the following matters are kept and maintained as required and are easily accessible by each worker required to access them:

(i) the location of each main electricity reticulation line,

(ii) the location of all high voltage cables, aerials and switchgear,

(iii) the location, rating, identifying label and purpose of each main isolator, substation and high voltage switchboard

(iv) any information required to perform switching programs,

(v) the location of all known buried electrical services at the mine or petroleum site, and

(vi) in the case of a mine or petroleum site (other than an underground mine), the general location of each item of high voltage mobile plant supplied with electricity by a trailing cable,

(vii) in the case of an underground mine, the location of each fixed communication device at the mine, and

Refer to guidance in 4.5 (above) for Schedule 2 clause 3(3)(a).

Notes:

1. High voltage electrical installations must be shown on a mine survey plan (if installed at the mine).
2. Fixed communication devices may include telephones (e.g. DACS) and WIFI if it used in this capacity only. The plan should be updated as required whenever changes have been made to enable workers to carry out their work safely.
3. See also clause 122 of the WHS (MPS) Regulation for requirements for mine survey plans and locations of electrical items.

The nature and types of plans should be determined by the mine operator according to the mine operations and risk, and may range from single line diagrams to detailed site plans showing buried services.

In addition to showing the main isolators, the plans should include details of all points of isolation available on the electrical distribution system for voltages greater than 1000V.

The plans should be easily accessible for workers when they require them, and should be available at all electrical switchgear such as at electrical substations and switchrooms.

(g) that arrangements are in place so that mobile electrical plant fed by a flexible reeling or trailing cable:

(i) is not connected with power if there is an earth fault in the cable, and

Flexible reeling or trailing cables feeding mobile plant are exposed to arduous conditions and are regularly damaged. These cables presently supply equipment with voltages up to 22kV. Energising a damaged cable may cause arcing, with the potential to cause burns to people in the vicinity of the cable damage, along with ignition of gas, dust, or other flammable materials. It may also result in electric shock if contact is made with the damaged section of the cable, equipment connected to the cable, or if the earthing system has been compromised.

Earth fault lockout protection is provided to detect damaged power conductor insulation by applying a low energy test voltage and measuring leakage currents while the cable is not connected to the main supply. The test is performed automatically immediately prior to the restoration of power.

An EECP should provide for the use of these devices to provide protection to flexible reeling and trailing cable circuits. Earth fault lockout systems associated with mobile plant and fed via flexible reeling and trailing cables should be compliant with AS/NZS 2081.

(g) that arrangements are in place so that mobile electrical plant fed by a flexible reeling or trailing cable:

(ii) has its power interrupted automatically if the continuity of the connection to earth is interrupted, and

The earth conductors in a reeling or trailing cable are often the only return path for fault currents in the event of an earth fault. To ensure the earth integrity of trailing/reeling cables and their associated coupling devices, the plan should provide for earth continuity monitoring systems on trailing or reeling cable circuits and any associated extension cable.

An EECP should provide for the use of earth continuity systems in association with mobile plant fed via flexible reeling and trailing cables. Where provided these protection devices should be compliant with AS/NZS 2081.

For more information refer to:

→ MESHCM/2006/9, ILO *Code of practice on safety and health in underground coalmines.*

(h) that arrangements are in place to ensure that mains-powered hand-held electrical equipment used at the mine or petroleum sites operates at no more than 250 volts and have an earth leakage of not more than 30 milliamperes sensitivity, and

Limiting voltage to no more than 250 volts reduces risks a person may be exposed to such as arc blast and burns, and using quick acting earth leakage devices minimises the duration of exposure in the event of a fault occurring on the hand-held equipment, or the cable supplying that equipment. The 30 milliamperes (mA) sensitivity minimises the likelihood of a person going into ventricular fibrillation.

A residual current device (RCD) provides earth leakage protection with quick operation to reduce potential consequences associated with contact with energised plant. These units operate to disconnect the supply of electricity to protected circuits, socket-outlets or equipment in the event of a current flow to earth, which exceeds a predetermined level, normally 30mA. In higher risk circumstances, consideration should be given to the use of RCDs with 10mA sensitivity.

If mains powered hand held equipment is used, arrangements must be in place to ensure that equipment is not supplied at voltages greater than 250 volts and that the circuit supplying the equipment is protected by an earth leakage device with sensitivity of no more than 30mA.

An EECP should include or link to the arrangements through which compliance with this requirement is managed. For example, an EECP may link to procurement processes for purchase of equipment requiring RCDs or to the introduction to site processes to verify that equipment being brought to site by the mine or others is fitted with RCDs where required.

(i) that an effective earth system is provided at the mine or petroleum site to minimise, so far as is reasonably practicable:

(i) touch, transfer and step potential, and

The earthing system is comprised of the soil, the conductors that are buried in the soil, the conductors that are reticulated with power conductors and conductive structures at the mine. These may include the reinforcing metalwork associated with footings and concrete slabs associated with coal handling plants, concentrator mills, conveyor structures, workshops and so on.

To be effective, an earthing system must be considered as a single entity. A current flowing in one part of the earthing system will impact all other parts of the system.

Also refer to 4.5 above for additional information and guidance on Schedule 2 clause 3(3)(h) and Schedule 2 clause 3(3)(j).

(i) that an effective earth system is provided at the mine or petroleum site to minimise, so far as is reasonably practicable:

(ii) the effects of lightning causing the ignition of methane, the ignition of explosives or detonators or the creation of dangerous touch voltages, and

Energy associated with lightning can transfer to the underground workings of a mine either through direct or indirect methods and has the capacity to cause the ignition of methane.

Coupling effects associated with lightning also have potential to initiate the firing of electrical detonators used with explosives. This may occur on the surface as well is in an underground mine.

Lightning events can also create dangerous touch voltages on cables, exposed metal work and conductive objects that are not connected to electrical supply systems, such as winder headframes and overland conveyor structures.

An EECP should provide for controls to minimise the effects of lightning on personnel and plant on the surface of a mine as well as provide controls to minimise the effects of lightning being transferred into the underground workings and causing ignition of gas explosion or dangerous touch voltages on plant and equipment. For example, controls may include lightning spires connected to dedicated earthing electrodes above electrical switchyards or explosives magazines to try to divert lightning strikes away from critical plant and infrastructure, and lightning conductors attached to structures and buildings to give a low impedance path to ground and away from more critical infrastructure.

An EECP should also link to the explosives control plan to provide controls for capacitive and inductive coupling effects that may cause initiation of detonators.

Also refer to 4.5 above for further guidance on Schedule 2 clause 3(3)(f).

(j) that all electrical installations (other than isolated circuits) have a continuous and effective connection to the earth system, and

The earthing systems of electrical supply networks perform several functions. These include:

- → providing a low impedance path that provides for the reliable operation of circuit protection devices to clear faults resulting from an insulation failure to earth
- → limiting touch, transfer and step voltages to a level that does not present a significant risk (this is often termed ‘protection against indirect contact’)
- → providing overvoltage protection and voltage stabilisation
- → providing dissipation of electrostatic charge.

An EECP should identify the methods to be used to provide a secure and reliable connection to the earthing system of the mine. This will entail the use of integrated earthing conductors within supply cables. It may also require the use of supplementary earthing conductors and equipotential bonding conductors.

(k) that all isolated circuits comply with section 7.4 of the Wiring Rules

In special applications, it may be necessary to use electrical supplies that are isolated from the earthing system. Protection by electrical separation is a recognised alternative method to prevent electric shock through contact with exposed conductive parts, whether through direct contact or indirect contact. It is intended for use in individual circuits and not for general installations.

An EECP should provide for circuits that are intended to be isolated from earth to comply with the requirements of section 7.4 of the Wiring Rules.

(l) that the electricity supply to all electrical plant at an underground mine, and all mobile plant fed via flexible reeling or trailing cables in any other mine or petroleum site, is designed so that:

(i) the magnitude of earth fault currents to the plant is limited (in order to control step and touch potentials), and

Underground electrical installations are often supplied by long runs of cable with variable earthing conditions. The only earthing provided to mobile and transportable equipment, both on the surface and underground, that can have an acceptable level of surety is through the earthing conductors of the cables feeding back to the respective supply transformers.

Limiting the maximum value of earth fault current minimises the prospective touch, step and transfer potentials that can occur during an electrical fault to earth. Factors that will influence the maximum level of earth fault currents for a supply system include:

- → allowable step and touch potentials
- → system operating voltage
- → resistance of earthing conductors from the fault location to the point of supply.
- → operating times of protection relays and associated circuit opening devices, design and construction of the cables, that is, armoured, individually or collectively screened.

An EECP should identify the allowable levels of step, touch and transfer potential for different environments at the mine. Reference should be made to AS/NZS 3007 and AS/NZS 4871 for guidance in determining acceptable levels of voltage.

An EECP should identify the value(s) of earth fault current limitation necessary to control step and touch potentials to within the identified limits for different operating systems at the mine. This will have been determined during the power supply engineering review discussed in 4.5 above for Schedule 3 clause 3(3)(h).

For guidance, including recommendations for the magnitude of earth fault current limitations, reference should also be made to:

- → AS/NZS 3007 *Electrical equipment in mines and quarries – Surface installations and associated processing plant*, and
- → AS/NZS 4871.1 *Electrical equipment for mines and quarries Part 1: General requirements*.

Also refer to 4.5 above for further guidance on Schedule 2 clause 3(3)(h) and (j).

(l) that the electricity supply to all electrical plant at an underground mine, and all mobile plant fed via flexible reeling or trailing cables in any other mine or petroleum site, is designed so that:

(ii) so far as is reasonably practicable, the most likely type of electrical fault is a low energy earth fault (in order to minimise the amount of energy released), and

Energy levels associated with earth faults are lower than those where faults occur between phases. This is particularly so on earth fault current limited networks where correctly engineered insulation co-ordination and suitable creepage and clearances distances will mean arcing damage associated with earth faults is virtually non-existent.

For electrical installations in hazardous environments, this also minimises the risk of compromising explosion protection properties of electrical equipment.

An EECP should require that for earth fault current limited systems, earth screens should be provided on power circuit conductors of both single phase and multi-phase power cables, where reasonably practicable. Where it is not reasonably practicable, the EECP should require the use of correctly engineered insulation co-ordination, along with suitable creepage and clearance distances.

(m) that the reliability of any electrical safeguards provided to control the risk from both electrical and non-electrical hazards is sufficient for the level of risk being controlled, and

Refer to 4.3.2 above for guidance on how an EECP is to address electrical safeguards.

Electrical control systems are often used to either:

- → provide a safeguard against something going wrong with a piece of plant or an installation
- → or
- → to monitor a non-electrical safeguard to ensure that the non-electrical safeguard is functional

The mine operator must consider the reliability of safeguards used. For example, is guarding prone to fail? Could workers forget or ignore safe operating procedures? To understand the reliability of a safeguard it helps to consider:

i. the magnitude of the hazard
ii. the potential level of residual risk (harm and likelihood), should the safeguard not be in place or fail
iii. the required reliability of a safeguard to minimise risk where it is not possible to eliminate the risk, having regard to the residual risk
iv. the assessment and validation of the actual safeguard installed to provide the required reliability and level of protection.

Many safeguards are developed by the designer before the mine operator's involvement. When acquiring any item of plant, the mine operator may ask how the considerations above have been addressed. The mine operator should then consider each of these items as they implement appropriate safeguards or risk controls.

The integrity, or reliability, of the safeguard is essential if the safety function is to provide the level of risk control that has been determined as necessary to eliminate or minimise the likelihood of injury to persons. A reliability assessment of safeguards may be undertaken. Consideration should be given to systematic failures that could occur and the potential for reasonably foreseeable human behaviour that may adversely affect the safeguard's performance.

Where a safeguard has a failure mode that cannot be detected except through specific testing programs, additional independent safeguards should be implemented in parallel with the system that has the undetectable failure mode. Consideration should also be given to the provision of monitoring systems to identify when a fault has occurred with a safeguard. The monitoring system may initiate alarms or initiate automatic actions to bring the plant to a safe state.

In developing these safeguards, guidance on required risk reduction, required safeguard integrity and assessment (functional safety) may be sought from the following functional safety standards:

- → AS 61508 *Functional safety of electrical/electronic/programmable electronic safety-related systems*

- → AS 62061 *Safety of machinery – Functional safety of safety-related electrical ,electronic and programmable electronic control systems*
- → AS 61511 *Functional safety – Safety instrumented systems for the process industry sector*
- → AS 4024 *Safety of machinery* series of standards
- → AS/NZS 4024.1503 *Safety of machinery Part 1503: Safety-related parts of control systems—General principles for design*

An EECP should detail what processes are to be used to verify that electrical safeguards provided for plant or installations, whether for electrical or non-electrical hazards, provide an acceptable level of risk reduction.

It is important to note that safeguards will remain effective only if they are inspected, tested and maintained. If 'functional safety' techniques are used, inspection, testing and maintenance activities should be reflected in the EECP through a functional safety management (FSM) approach.

(n) that short circuit protection and over current protection is provided on all circuits (including sub-circuits), and

Short circuit protection is provided to identify conditions where very high levels of current may flow as a result of a circuit insulation fault. This protection may be achieved through the use of fuses or circuit breakers. In either situation, the fuses or the circuit breaker must be rated to interrupt a higher value of short circuit current than can flow in circuit under a worst case scenario.

Overcurrent protection includes overload protection, which is used to identify when the load current of the circuit has increased beyond what the circuit is designed to carry. This occurs as a result of too much load being connected to the circuit. To prevent damage to the controlling switchgear and to cabling systems through excessive heat generation, overload protection is provided to automatically trip the power from the circuit.

An EECP should identify what types of protection are to be provided on all circuits and sub-circuits, to detect and clear both short circuit and overload conditions. An EECP should also identify requirements for determining settings that achieve effective fault discrimination across circuits.

(o) that, except for circuits that are isolated from earth, or that have a supply voltage that is extra-low voltage:

(i) earth leakage protection is provided on sub-circuits, and

Earth leakage is a fault condition where low levels of current flow from the energised conductors of a circuit to the earthing system. These leakage currents may be an indication of a fault condition such as a person receiving an electric shock when they make contact with an energised conductor, or by the degradation of circuit insulation which may lead to a fire or a person receiving a shock. Earth leakage protection devices detect these low level leakage currents and disconnect the supply voltage from the faulty circuit.

An EECP should provide for earth leakage protection to be fitted to all sub-circuits and provide guidance for the types of earth leakage protection devices to be used on different types of circuits, such as high-power motor circuits or protection on a power outlet in an office building. An EECP also identify factors to be considered in determining the required operating set points for current and time.

In identifying the types of earth leakage detection to be provided (refer to clause 2.6.3.2.1 of AS/NZS 3000), the following outcomes should be required and set out or referenced in the EECP:

- → protection by an RCD with a maximum rated residual current of 30 mA for final sub-circuits supplying socket-outlets where the rated current of any individual socket-outlet does not exceed 20 amps (A)
- → final sub-circuits supplying lighting where any portion of the circuit has a rated current not exceeding 20 A
- → final sub-circuits supplying directly connected hand-held electrical equipment, should do so in accordance with the Wiring Rules.

Where these socket outlets are provided in a hostile operating environment the EECP should contain details of requirements to use RCD protection in accordance with WHS Regulation clause 164 *Use of socket outlets in hostile operating environment.*

Clause 32(2)(d) requires that the mine have procedures for the restoration of power. Refer 4.6 above for guidance.

The EECP should provide for earth leakage protection devices used on earth fault current limited systems, other than RCDs, to be compliant with AS/NZS 2081. RCDs should be compliant with AS/NZS 3190.

Earth leakage protection fitted to earth fault current limited supply networks should have trip levels set to provide for at least a 10 to1 tripping ratio against the value of earth fault limitation current.

For additional information and guidance with tripping ratios, refer to:

- → AS/NZS 3007 *Electrical equipment in mines and quarries – Surface installations and associated processing plant*, and
- → AS/NZS 4871.1 *Electrical equipment for mines and quarries Part 1: General requirements*.

(o) that, except for circuits that are isolated from earth, or that have a supply voltage that is extra-low voltage:

(ii) earth fault protection is provided on all distribution and control circuits.

Earth faults on control circuits may result in electric shock or unintended operation of plant. They may also create a sparking risk if the circuit is used in a hazardous zone.

The intent of this subclause is that that earth fault protection is to be provided on all distribution and control circuits except for circuits that are isolated from earth or operate at a voltage that is extra low voltage.

An EECP should identify the types of earth fault protection devices to be used for different types of circuits, for example fuses or ground fault protection relays, and provide guidance in the selection of these devices.

In some circumstances, the earth fault protection devices may be fuses provided by a supply authority and are outside the control of the mine operator. In these situations, an EECP should require that the effects of an earth fault occurring are identified and assessed and additional controls provided where necessary.

See guidance above in 4.5 regarding Schedule 2 clause 3(3)(g).

WHS (MPS) Regulation

Clause 27 Communication between outgoing and incoming shifts

An EECP should identify communication requirements between outgoing and incoming shifts so far as the communication relates to electrical work on plant and installations. The EECP may provide for this or link to elsewhere in the safety management system.

WHS (MPS) Regulation

Clause 34 Prohibited items and substances

For underground coal mines, the EECP may provide or link to elsewhere in the safety management system for the management of electrical plant containing exposed light metal alloys or aluminium.

WHS (MPS) Regulation

Clause 36 Minimum age to work at mine or petroleum site

An EECP may provide or link to elsewhere in the safety management system to ensure a person under the age of 18 years is not engaged to carry out work in an underground mine, unless the person is over the age of 16 years and is an apprentice or trainee under direct supervision in relation to the work.

WHS (MPS) Regulation

Clause 37 Inspections

An EECP should link to the inspection arrangements developed under clause 37, insofar as it relates to risks associated with the electrical aspects of plant and installations.

In the case of underground coal mines, this should extend to the additional inspection program requirements under clause 85 such as in cl 85(5)(c) regarding inspection for the presence of flammable gas prior to the supply of electric power to any underground part of the mine.

WHS (MPS) Regulation

Clause 60 Monitoring and testing of ventilation system

An EECP should link to the ventilation control plan in relation to the provision of monitoring systems for the operation of the main ventilation fans of the mine and that an alarm is triggered on the surface if any such fan stops.

WHS (MPS) Regulation

Clause 71 Ventilation

For underground coal mines, the EECP should link to the ventilation control plan in relation to the removal of the supply of power to electrical plant (other than electrical plant referred to in clause 78(4)). The EECP should require the power to be cut off by the quickest means available and not be restored before the supply of ventilated air is above that minimum quantity.

WHS (MPS) Regulation

Clause 72 Control and monitoring of methane levels

Clause 72 requires methane monitoring plant to be installed on specified plant and locations to provide an alarm or remove power when certain levels of methane are detected in the atmosphere. For example, a monitor should be located at the head of the continuous miner. An EECP should link with the ventilation control plan to provide methane detection systems and power trip interlocks with a suitable level of reliability for the control of risks associated with elevated levels of methane.

WHS (MPS) Regulation

Clause 104 Duty to provide information, training and instruction

An EECP may provide for, or link to elsewhere in the safety management system, to ensure workers are provided with information and instruction in relation to the electrical aspects of plant and installations. Consideration should be given not only to the competencies of workers who will work on electrical plant or installations as discussed in this code but also the information training and instruction needed by others such as plant operators.

WHS (MPS) Regulation

Clause 105 Duty to provide induction for workers

An EECP may provide or link to elsewhere in the safety management system to ensure that anyone involved with electrical works is appropriately inducted before starting work, in accordance with clause 105. This should include reviewing and assessing skills, and permitting people to undertake electrical work only in their areas of competence.

WHS (MPS) Regulation

Clause 128 Duty to notify regulator of certain incidents

An EECP may provide or link to elsewhere in the safety management system to ensure the correct reporting of both high potential and other incidents so far as they relate to electrical aspects of plant and installations.

Note: section 15 of the WHS (MPS) Act also requires reporting of ‘notifiable incidents’, which includes those resulting in ‘serious injury or illness’ and ‘dangerous incidents’ within the meaning of clauses 178-179 of the WHS (MPS) Regulation.

For further guidance on reporting incidents see the *Notification of incident and injury guide*.

WHS (MPS) Regulation

Schedule 1 Principal mining hazard management plans – additional matters to be considered

Clause 4 Roads and other vehicle operating areas

The movement of high loads and tall equipment has resulted in contact with energised overhead cables that cross roads and operating areas. The use of graders to maintain roads and vehicle operating areas

may result in a reduction of depth of cover for any buried cables and other services. These events can result in injury to workers from electric shock and arc blast, damage to cables and associated infrastructure.

An EECP should link to principal mining hazard management plans for roads and other vehicle operating areas so far as it relates to the monitoring and control of traffic movements, such as block lights or traffic signals. This may also include the use of collision avoidance systems to assist with the management of vehicle interactions with people, other vehicles or infrastructure, and where overhead or underground power lines cross roads or operating areas.

See guidance in 4.7 below regarding clause 166 of the WHS Regulation.

WHS (MPS) Regulation

Schedule 1 Principal mining hazard management plans – additional matters to be considered

Clause 6 Fire and explosion

Burning of electrical insulation materials produces toxic fumes and may leave corrosive residues on surfaces affected by smoke, fire or explosion. Damage to some high voltage switchgear may also result in highly toxic residues that require correct handling and management, such as powders formed through the decomposition of SF_6 insulating gas during arc quenching. These are normally contained within the sealed switching chamber of the circuit breaker or contactor but can be released if the housing is damaged.

An EECP should link with any principal mining hazard management plan for fire and explosion so far as it relates to electrical matters. This should include the nomination of suitable fire extinguishing and suppression agents that are non-conductive, and requirements for the removal of power prior to attempting to extinguish a fire. Where fire detection and suppression systems are associated with electrical switchrooms, consideration should be given to the automatic disconnection of electrical power to the switchroom on the detection of fire.

WHS (MPS) Regulation

Schedule 2 Principal controls plans – matters to be addressed

Clause 2 Mechanical engineering control plan

The EECP should link with the MECP in relation to the electrical aspects of plant covered under that plan. For example, electrical control systems used in mechanical plant, such as diesel engine management systems, and electrical safeguards used to control risks associated with mechanical plant, such as guard interlocking and emergency stop systems.

4.7. Other specific risk controls – WHS Regulation

There are specific controls required under the WHS Regulation that can apply to electrical aspects of plant and installations at mines. Where these controls are required and/or used to manage electrical risks, they must be set out in the EECP. The following controls may be relevant, but are not an exhaustive list.

WHS Regulation

151 Untested electrical equipment not to be used

A person conducting a business or undertaking must ensure, so far as is reasonably practicable, that electrical equipment is not used if the equipment:

(a) is required to be tested under clause 150, and

(b) has not been tested.

(details of penalties omitted)

WHS Regulation clause 150 requires that electrical equipment fed via an electrical socket outlet is regularly inspected and tested when used in an environment that exposes the equipment to conditions that are likely to result in damage or a reduction in its lifespan. These conditions include exposure to moisture, heat, vibration, mechanical damage, corrosive chemicals or dust.

An EECP should require that electrical equipment is not used if requirements of clause 150 have not been satisfied.

WHS Regulation

154 Electrical work on energised electrical equipment—prohibited

Subject to this Division, a person conducting a business or undertaking must ensure that electrical work is not carried out on electrical equipment while the equipment is energised.

(details of penalties omitted)

WHS Regulation Part 4.7 clause 154 prohibits live electrical work unless permitted under other provisions.

The WHS Regulation clause 146 defines electrical work as connecting electricity supply wiring to electrical equipment or disconnecting electricity supply wiring from electrical equipment, or installing, removing, adding, testing, replacing, repairing, altering or maintaining electrical equipment or an electrical installation.

The WHS (MPS) Regulation, Schedule 3 clause 2 identifies that live electrical work (excluding 'testing for de-energised') is a high-risk activity and must be notified to the regulator prior to the work being undertaken.

Further guidance on high risk activity notifications is available from the regulator.

WHS Regulation

157 Electrical work on energised electrical equipment – when permitted

(1) A person conducting a business or undertaking must ensure that electrical work on energised electrical equipment is not carried out unless:

(a) it is necessary in the interests of health and safety that the electrical work is carried out on the equipment while the equipment is energised, or

Example. It may be necessary that life-saving equipment remain energised and operating while electrical work is carried out on the equipment.

(b) it is necessary that the electrical equipment to be worked on is energised in order for the work to be carried out properly, or

(c) it is necessary for the purposes of testing required under clause 155, or

(d) there is no reasonable alternative means of carrying out the work.

(details of penalties omitted)

(2) The electrical work that may be carried out under subclause (1) (a), (b) and (d) may include testing of the energised electrical equipment.

An EECP should clearly identify what types of work may be permitted to be undertaken while equipment is still energised (live) at the mine. For work on energised systems, other than testing as identified in WHS clause 157(1)(c) or 157(2), the EECP must require that notification is made to the regulator as a high risk activity (HRA) in accordance with clause 33 of the WHS (MPS) Regulation before the work is undertaken.

The EECP should also identify requirements for the development of procedures relating to testing of energised electrical plant. Refer to Sch 2 3(3)(n)(ii) above for guidance.

Note: Requirements for testing include testing of intrinsically safe circuits (also refer to WHSMP clause 82) and extra low voltage circuits in addition to low voltage circuits.

WHS Regulation

Division 5 Electrical equipment and installations and construction work – additional duties

163 Duty of person conducting a business or undertaking

(1) A person conducting a business or undertaking that includes the carrying out of construction work must comply with AS/NZ 3012:2010 (*Electrical installations – Construction and demolition sites*).

The EECP must require that the design, construction and testing of electrical installations that supply electricity to appliances and equipment associated with construction work at the mine comply, as a minimum, with AS/NZS 3012:2010 *Electrical installations—Construction and demolition sites*. The EECP must also require the in-service testing of portable, transportable and fixed electrical equipment used for construction work comply, as a minimum, with AS/NZS 3012:2010.

WHS Regulation

Division 6 Residual current devices

164 Use of socket outlets in hostile operating environment

(1) This clause applies in the following circumstances:

(a) electrical equipment is used in an environment in which the normal use of electrical equipment exposes the equipment to operating conditions that are likely to result in damage to the equipment or a reduction in its expected life span, including conditions that involve exposure to moisture, heat, vibration, mechanical damage, corrosive chemicals or dust,

(b) electrical equipment is moved between different locations in circumstances where damage to the equipment or to a flexible electricity supply cord is reasonably likely,

(c) electrical equipment is frequently moved during its normal use,

(d) electrical equipment forms part of, or is used in connection with, an amusement device.

(2) In a circumstance set out in subclause (1), a person conducting a business or undertaking at a workplace must ensure, so far as is reasonably practicable, that any electrical risk associated with the supply of electricity to the electrical equipment through a socket outlet is minimised by the use of an appropriate residual current device.

(details of penalties omitted)

(3) Without limiting subclause (2), the residual current device must have a tripping current that does not exceed 30 milliamps if electricity is supplied to the equipment through a socket outlet not exceeding 20 amps.

(4) Subclause (2) does not apply if the supply of electricity to the electrical equipment:

(a) does not exceed 50 volts alternating current, or

(b) is direct current, or

(c) is provided through an isolating transformer that provides at least an equivalent level of protection, or

(d) is provided from a non-earthed socket outlet supplied by an isolated winding portable generator that provides at least an equivalent level of protection.

Notes.

1 This clause commences on 1 January 2013 (see clause 2 (2)).

2 Residual current devices are also regulated under the *Electricity (Consumer Safety) Act 2004.*

165 Testing of residual current devices

(1) A person with management or control of a workplace must take all reasonable steps to ensure that residual current devices used at the workplace are tested regularly by a competent person to ensure that the devices are operating effectively.

(details of penalties omitted)

(2) The person must keep a record of all testing of a residual current device (other than any testing conducted daily) until the earlier of the following occurs:

(a) the device is next tested,

(b) the device is permanently removed from use.

(details of penalties omitted)

Where electrical equipment fed from a socket outlet is used in a hostile environment, that is an environment in which the normal use of electrical equipment exposes the equipment to operating conditions that are likely to result in damage to the equipment or a reduction in its expected life span, the circuit supplying the equipment is required to be protected by an RCD or the equipment should be fed from an isolated (isolated from earth) source.

Portable electrical tools should not be used in damp environments as moisture readily bridges multiple layers of insulation. This often occurs with double insulated power tools where the moisture, whether from damp ground or from perspiration of the operator ingresses the tool and creates a current path to the operator.

Where an RCD is fitted, it should have of a residual current operating value that does not exceed 30mA. Where there is an elevated risk of electric shock due to the environment, consideration should be given to the use of 10mA RCDs. RCDs also need to be suitable for the supply source. Some supply sources such as some inverters units which may be integral to newer types of generators, do not have pure sinusoidal current waveforms. A RCD designed for a pure AC waveform may not operate at the intended values of residual current, or may fail to operate with pulsating DC or non-sinusoidal waveforms.

Where an isolated circuit is used to supply a portable tool, only one supply cable and tool should be connected to that isolated source at any one time. Isolated supplies provide an increased level of safety because the first fault that occurs does not create an electric shock risk. If a second fault occurs, this may create a short circuit fault. If the worker forms a part of these fault paths there is no protection that trips at low current values (30mA or less). It is therefore critical that the worker ensures that there is no damage to any of the supply cables or tools before the use of this equipment and that regular inspections are undertaken during the use of the equipment. The use of multiple supply cables and multiple tools increases the shock risk to an operator and should not be permitted.

An EECP should detail the requirements for the use of RCDs and for isolated power supplies, and the circumstances in which these may be used. An EECP should also detail inspection requirements for electrical equipment prior to use and the periodic testing requirements of the equipment at regular intervals. An EECP must detail the procedures for the testing of any RCD and the recording of the results of such tests.

For guidance information on the inspection and testing of portable electrical equipment, including testing of RCDs, reference should be made to: AS/NZS 3760 *In-service safety inspection and testing of electrical equipment.*

Note: While AS/NZS 3760 provides guidance for inspection and test frequencies, these should be reviewed against the potential risks associated with the proposed use. Where there is an elevated risk associated with the use of electrical tools then inspection and test frequencies should be undertaken more often. This should be based on risk assessments of the work activities and the environments in which they are to be undertaken.

WHS Regulation

Division 7 Overhead and underground electric lines

166 Duty of person conducting a business or undertaking

(1) A person conducting a business or undertaking at a workplace must ensure, so far as is reasonably practicable, that no person, plant or thing at the workplace comes within an unsafe distance of an overhead or underground electric line.

(details of penalties omitted)

Clause 166 requires that, so far as is reasonably practicable, that no person, plant or thing at the workplace comes within an unsafe distance of an overhead or underground electric line.

In assessing whether a safe distance can be maintained, consideration should be given to response and reaction times of a spotter in realising that contact is about to occur, raise the attention of the machine operator and the machine operator to stop the movement of the machine while still maintaining a safe distance from the lines. If a safe distance cannot be maintained, the lines should be de-energised and earthed. Before re-energising the lines, inspections to verify the lines are undamaged should be undertaken.

For electricity supply authority lines, any work must be in consultation with the supply authority and in accordance with the supply authority requirements.

For overhead lines, the EECP should provide for procedures that restrict work activities and approach distances to the energised overhead lines (see 4.5 above in relation to Schedule 2 clause 3(3)(n)(iii) of the WHS (MPS) Regulation) and Section 7 of AS/NZS 3007.

An EECP should require that before excavation work is carried out in proximity of buried electrical cables that all available information concerning the position of the cables should be obtained and disseminated to the people doing the work. To assist in the provision of necessary information, an EECP should identify that:

- → site plans should be maintained showing the location of all buried cables
- → these plans should be readily accessible to supervisors
- → procedures should be developed for work near buried cables
- → safe distances should be maintained between temporarily exposed buried cables and machinery
- → signs should be provided warning of buried cables and their buried depth.

Additional information and guidance can be found in the SafeWork NSW code of practice *Work Near Overhead Power Lines* and the code of practice *Work Near Underground Assets.*

WHS Regulation

213 Maintenance and inspection of plant

(1) The person with management or control of plant at a workplace must ensure that the maintenance, inspection and, if necessary, testing of the plant is carried out by a competent person.
(details of penalties omitted)

(2) The maintenance, inspection and testing must be carried out:

(a) in accordance with the manufacturer's recommendations, if any, or

(b) if there are no manufacturer's recommendations, in accordance with the recommendations of a competent person, or

(c) in relation to inspection, if it is not reasonably practicable to comply with paragraph (a) or (b), annually.

For plant to remain in a safe condition, it is necessary for regular inspections to be undertaken on the plant. The person undertaking these inspections must have the knowledge and understanding of the protective controls incorporated in the design and manufacture of the plant.

For example, (IP ratings) must be maintained to the designed level. Door catches that are not engaged result in dust and moisture entry that will cause failures of insulation, resulting in electric shock risks and possible arcing faults. Warning signs and notices that are illegible, damaged or missing may cause workers to make incorrect decisions about allowable access or inherent dangers.

An EECP should include maintenance strategies appropriate to each item of plant at the mine. This should include the external and internal inspection requirements, along with testing requirements for electrical protection devices installed within each item of plant. Maintenance strategies must be in accordance with manufacturers recommendations but additional maintenance may be required to take account of the operating environment. An EECP should also identify the competencies required of people that will be undertaking the maintenance activities on the plant.

WHS Regulation

222 Industrial robots

(1) This clause applies to a person with management or control of an industrial robot or other remotely or automatically energised plant at a workplace.

(2) The person must not direct or allow a worker to work in the immediate vicinity of the plant if it could start without warning and cause a hazard, unless suitable control measures are in place to control the risks to health and safety.

(details of penalties omitted)

(3) If the remote or automatic energising of the plant could lead to risks to health and safety, the person must ensure that access to the area in the immediate vicinity of the plant is controlled at all times:

(a) by isolating the area, or

(b) by:

(i) providing interlocked guards, or

(ii) if a risk remains, providing presence-sensing devices, or

(iv) if a risk then remains, providing permit to work systems.

(details of penalties omitted)

The use of automated and remote-controlled equipment presents a risk to people when a person is in proximity to the equipment and the equipment is not isolated.

Levels of automation and remote control vary, but normally fit into one of the following categories:

- Direct remote control - where the remote controls are located with the operator who is in close proximity to the equipment and able to directly observe the equipment and the environment around the equipment.
- Tele-remote – where the operator is located remote from the equipment and relies on video links from the equipment to enable the operator to control the movements and actions of the equipment. Depending on the placement of the cameras, the operator may have limited visibility of the environment around the machine. The operator control station may be local to

the equipment working location, at a remote location at the mine site or remote from the mine site.

- → Autonomous (fully automatic) – where the equipment starts or initiates actions as the result of an action by another piece of equipment, such as a conveyor belt starting in sequence, longwall roof support advance as a function of shearer position, blast hole drill rigs that move, position themselves and drill blast holes in accordance with a pre-programmed sequence. In many cases, the only action required by an operator is to initiate the operation of the equipment.
- → Semi-autonomous – where the operator is required to initiate actions during the operating cycle of the equipment. This may include taking control of the equipment through tele-remote operation for specific actions such as mucking out from a stope, or for controlling the discharge of product or reject from a truck loading facility.

Each of these automatic or remote-controlled activities presents different risks to operators and other persons that may be required to work in proximity to, or pass through, areas where the automated or remote-controlled equipment operates.

Where electrical safeguards are identified to eliminate or minimise the risks to workers by this equipment, an EECP should provide guidance for the development of these safeguards. In developing the safeguards, consideration must be given to all lifecycle activities associated with the equipment, including commissioning, operation, inspections, repairs and maintenance activities required to be undertaken on or near the equipment,

AS/NZS **4240** series of standards provide guidance for the design, construction, testing, installation, commissioning and modification of remote controlled mining equipment and machinery. This series of standards also recommends safeguarding practices and the provision for training of personnel associated with the operation and maintenance of such equipment.

4.8. Hazardous atmospheres

The requirements for identifying hazardous atmospheres apply to all mines:

WHS Regulation

51 Managing risks to health and safety

(1) A person conducting a business or undertaking at a workplace must manage risks to health and safety associated with a hazardous atmosphere at the workplace, in accordance with Part 3.1.

Note WHS Act—section 19 (see regulation 9).

(2) An atmosphere is a ***hazardous atmosphere*** if:

(a) the atmosphere does not have a safe oxygen level; or

(b) the concentration of oxygen in the atmosphere increases the fire risk; or

(c) the concentration of flammable gas, vapour, mist or fumes exceeds 5% of the LEL for the gas, vapour, mist or fumes; or

(d) combustible dust is present in a quantity and form that would result in a hazardous area.

A common hazard in mining is an atmosphere that increases the risk of explosion. To properly manage a potentially hazardous atmosphere, the mine operator must identify the type and extent of the hazardous atmosphere. This should involve appropriate testing to confirm if explosive elements such as gas and dust are present in the atmosphere.

Explosive elements that may be present at mines may include:

- → all types of mines – hydrogen sulphide, LPG, various process chemicals such as ammonia, hydrogen, fuel (such as petrol and ethanol) and dusts such as coal dust or sulphide dusts
- → underground coal mines – methane and coal dust (see further details in the next chapter).

Clause 5 of the WHS Regulation defines a hazardous area as an area in which:

- → an explosive gas is present in the atmosphere in a quantity that requires special precautions to be taken for the construction, installation and use of plant, or
- → a combustible dust is present, or could reasonably be expected to be present, in the atmosphere in a quantity that requires special precautions to be taken for the construction, installation and use of plant

For electrical installations on the surface of a mine, people must also refer to AS/NZS 3000:2007 for the identification and classification of hazardous areas. See 5.2 below in relation to hazardous zones in underground coal mines.

Note: AS/NZS 3000 uses the term ‘hazardous areas’, whereas clause 51 of the WHS Regulation (set out above) refers more broadly to managing the risks of ‘hazardous atmospheres’, which although it includes atmospheres that are explosive, also includes other atmospheric hazards. Hazardous areas may be viewed as a subset of hazardous atmospheres so the requirements of clause 51 for hazardous atmospheres apply to them.

An EECP or other plans should include arrangements to ensure that areas with a potentially explosive atmosphere are identified in mine plans, section plans and emergency plans. These plans should be readily available to electrical workers and mining supervisors. An EECP should also identify the competency requirements of people that will work on electrical installations within the identified hazardous areas and any procedures that those competent people must use (refer to 4.3.4 above).

An EECP should also identify any sign requirements required to inform other people of the hazardous location and any restrictions that are required.

In addition to the guidance provided in this code on risk management of ignition sources, people should also refer to the *NSW code of practice: Mechanical Engineering Control Plan*.

5. Additional matters for underground coal mines

In addition to the requirements outlined in Chapter 4, the EECP should provide for specific requirements that must be met for electrical plant and installations to be used in an underground coal mine (refer to clauses 78-80, 82-83 of the WHS (MPS) Regulation). An EECP for an underground coal mine should include procedures for the immediate removal of plant to a safe location where the plant or the environment is found to no longer meet the requirements or exceptions in clauses 78-82 for use in a hazardous zone.

In the event of the minimum ventilation requirements not being met, clause 71 stipulates that the supply of power to electrical plant must be cut off by the quickest means available (other than explosion-protected plant referred to in clause 78(4)). Additionally, clause 72 requires the use of continuous methane monitors that cut supply of electricity to face machines and the face of any longwall, shortwall or miniwall operation, when certain methane levels are exceeded or the monitor malfunctions or fails.

Clause 73 identifies specific requirements relating to the selection of gas monitoring plant and clause 177 requires that gas monitoring plant be design registered.

5.1. Specific requirements

WHS (MPS) Regulation

83 Electrical safety—static charges

The mine operator of an underground coal mine must ensure that any compressed air equipment, hose or pipe is electrically bonded to earth if it has been risk assessed under clause 9 as likely to develop static electrical charges capable of causing an electric shock to a person or a spark during operation.

(details of penalties omitted)

An EECP should provide for, or link to other control plans such as the ventilation control plan or the mechanical engineering control plan, to provide for suitable methods for static charge dissipation.

Refer to 4.5, schedule 2 clause 3(3)(e) of this code for information and guidance.

5.2. Managing electrical plant in hazardous zones

The WHS (MPS) Regulation has further requirements in relation to methane levels in underground coal mines, including the requirement to determine the location of all hazardous zones and to manage the risks associated with the ignition of methane in such zones:

WHS (MPS) Regulation

3 Definitions

hazardous zone, at an underground coal mine, means each of the

following:

(a) any part at the mine in which the concentration of methane in the general body of the air is 1.25% by volume or greater,

(b) a return airway,

(c) any part of an intake airway that is on the return side of such points that are within 100 metres outbye of:

(i) the most inbye completed line of cut-throughs, or

(ii) any longwall or shortwall face, but only to the extent that the intake airway is on the intake side of that face (but not if the longwall face is an installation face at which the development of the face, and

mining for development coal, have been completed and at which longwall mining has yet to commence).

The primary control of methane levels is through the provision of effective ventilation. An EECP should link with the ventilation control plan in respect of the requirements for methane monitoring.

Under clause 72 the mine operator must ensure that face machines and any longwall, shortwall or miniwall face is equipped with continuous methane monitors that raise an alarm if specified levels of methane are exceeded and, at certain methane levels, remove electrical power from plant. Such monitors must also raise an alarm and cut power supply to any plant it is monitoring if the monitor itself malfunctions or fails.

Explosion protection levels are required for electrical plant when used in a hazardous zone (refer to 5.2.1 below) except in certain circumstances (refer to 5.2.5 below). When certain methane levels are reached power must be removed from all electrical plant that does not meet the required level of explosion protection to prevent it becoming a possible source of ignition.

Cables for use in hazardous zones also need to meet prescribed standards to ensure that they have the electrical properties that will minimise risks of sparking, and mechanical properties that will minimise the likelihood of damage, while being suitable for the required duties of the cables (refer to 5.2.6 below).

In the event of a fan failure, there is a significant potential for methane gas concentrations to exceed prescribed levels in an area of the mine. If the main ventilation system fails, any auxiliary fan must be switched off by the quickest means available.

The mine operator must ensure workers are aware of the location of hazardous zones. Signs detailing the start of the zone should be placed in all intake airways.

An EECP, or other relevant plans, must address all of the above requirements to ensure compliance with the specific requirements of the legislation and the management of risk. . It is important that the arrangements across different plants are implemented and maintained to be effective in practice.

5.2.1. Explosion- protected plant in underground coal mines

The WHS (MPS) Regulation requires electrical plant used in hazardous zones to be explosion protected in accordance with certification requirements discussed in this section and in section 5.2.2. The EECP should include arrangements to ensure those requirements are met.

Under clause 78(4), electrical plant may only be used in a hazardous zone where the concentration of methane exceeds 1.25% in the general body air if the plant has a valid certificate of conformity in one of the following categories:

- → equipment protection level ‘Ma’
- → intrinsically safe category ‘Ex ia’
- → encapsulated – level of protection ‘Ex ma’
- → for gas detectors / monitors, special protection ‘Ex s’ (zone 0)
- → for cap lights, explosion protected for gas group ‘I’, as defined in AS/NZS 60079.35.1:2011 or AS/NZS 62013.1:2001

Note: caplights explosion-protected for gas group 'I' and which are not certified as 'Ex ia' must be withdrawn to a safe area when the flammable gas concentration exceeds 2% in the general body of air by volume.

Under clauses 78(5), other electrical plant may be used in a hazardous zone, but only where the methane level is less than 1.25%, and a valid certificate of conformity exists for them in one of the following categories:

- → equipment protection level 'Mb'
- → explosion-protection of a type suitable for Group I
- → plant that is intrinsically safe for Group II as associated apparatus
- → In the case of restrained plugs and receptacles, the certificate of conformity must also attest to compliance with AS/NZS 1299 *Electrical equipment for mines and quarries—Explosion-protected three phase restrained plugs and receptacles for working voltages up to and including 3.3 kV* or AS 1299—1993 *Electrical equipment for coal mines—Flameproof restrained plugs and receptacles*.

Note: The reference to *plant* in clause 78 does not include cables. See 5.2.6 below regarding cables. There are some exceptions to the explosion protection requirements in relation to certain portable electrical plant – see 5.2.5 below.

5.2.2. Certificates of conformity

Clause 78(9) identifies that only a certificate of conformity issued under the ANZEx scheme, the AusEx scheme or the IECEx scheme is valid for compliance with the WHS (MPS) Regulation requirements.

In addition to the certificates of conformity that are accepted, clause 78(2) allows for plant that has been manufactured prior to 1 October 2015, and holds a MDA as specified in the *Explosion Protected Electrical Apparatus Approvals List* as issued by the Resources Regulator (www.resourcesandenergy.nsw.gov.au/miners-and-explorers/safety-and-health) to continue to be used while ever it continues to be specified in that list.

The mine operator must ensure the use of explosion protected plant in a hazardous area only where the plant has a valid certificate of conformity under the ANZEx scheme, the AusEx scheme or the IECEx scheme, or has a Mines Department Approval (MDA) that is recognised as being valid.

The AUS Ex Certificate of Conformity is being phased out, however currently installed plant that is maintained in accordance with its certificate of conformity is considered to meet the minimum explosion protection requirements.

An EECP should set out arrangement that identify how equipment being brought to the mine will meet this requirement. This may include links to procurement processes for the mine and links to the introduction to site inspection processes. The EECP should also provide for checking of the approvals list prior to the purchase of plant that is covered by an MDA, and that is not also covered by a valid certificate of conformity.

5.2.3. Arcing faults in explosion-protected plant to be controlled

Engineering arrangements should be made and detailed in the EECP to prevent arcing faults compromising explosion-protection properties of plant and installations (including cables). Some points to consider are:

- → limitation of earth fault currents
- → prospective fault levels of the supply to the explosion protected equipment
- → fault rating of the explosion protected equipment
- → protection device settings, including both current and time settings
- → use of current limiting fuses to minimise let through energy during clearance of a fault
- → earth screening of cables to create low energy earth faults rather than high energy phase-to-phase faults
- → insulation coordination to ensure that creepage and clearance distances are suitable for the applied voltages, including transient overvoltages associated with switching.

Further guidance information can be obtained from the Mine Electrical and Mechanical Mining Engineers Society (MEMMES) document on arc fault control – Code Of Practice for the Control of Fault Arcs in Flameproof Enclosures used in Underground Coal Mines. This is not an approved code of practice for the purposes of the WHS laws but provides detailed guidance.

5.2.4. Batteries in explosion protected plant

When ventilation is lost to an area of an underground coal mine (refer to clause 71(2)(e)(ii)) or methane levels exceed prescribed limits in an underground coal mine, electrical power must be removed from electrical plant in that area unless the plant meets certain prescribed criteria (refer to clause 78(4)).

As a battery cannot be turned off, it is not possible to remove electrical power from the equipment connected to the battery itself. Any batteries installed within explosion protected electrical plant, and the circuits that are connected to the battery, must be suitably certified for use in a hazardous zone where methane levels exceed 1.25%.

5.2.5. Appropriate information regarding certification to be supplied

An EECP should link to the procurement systems for the mine so a PCBU at a mine does not purchase explosion protected plant from a supplier unless certain requirements can be satisfied. The EECP should identify all information that the mine operator must obtain from a supplier under WHS (MPS) Regulation clause 78(7).

Additional information may also be required if the plant is to comply with relevant standards such as those for lasers and for remote controlled equipment.

An EECP should identify where information provided for each item of plant can be accessed.

All above supplier provided information should be maintained at the mine, or, where the owner of the plant is not the mine operator, at a location determined as acceptable by the mine operator, to enable the plant to be verified as conforming to the certificate of conformity or registration or approval, when installed, used, maintained, overhauled, and repaired. This information should also comply with the requirements of AS/NZS 2290.1 '*Electrical equipment for coal mines – Introduction and maintenance Part 1 for hazardous areas*'.

5.2.6. Portable electrical plant

Despite the explosion protection requirements in clause 78, certain portable electrical plant may be used in a hazardous zone if the criteria in clause 79 is met.

WHS (MPS) Regulation

79 Exceptions to explosion-protection requirements

(1) Despite clause 78 (1), portable electrical plant may be used in the hazardous zone of an underground coal mine if:

(a) the concentration of methane in the general body of the air is 0.5% by volume or less, and

(b) the plant is powered by internal batteries, and

(c) the temperature of any surface of any component or part of the plant is not greater than:

(i) 150° Celsius, or

(ii) if the surface is wholly internal to the plant and the plant has a level of ingress protection sufficient to prevent coal dust coming into contact with the surface—450° Celsius, and

(d) the plant does not in normal operation produce hot surfaces or sparks that could ignite methane, and

(e) the mine operator has implemented control measures to manage the risk of the plant becoming an ignition source.

(2) Despite clause 78 (1), electrical equipment associated with hot work may be used in the hazardous zone of an underground coal mine if the mine operator has complied with the requirements of clause 33 (Notification of high risk activities).

(3) Despite clause 78 (1), insulation test instruments may be used in the hazardous zone of an underground coal mine if the instruments are used in accordance with the procedures for using those instruments developed under the electrical engineering control plan for the mine.

An EECP should provide for the use of portable electrical equipment to be used in a hazardous zone of an underground coal mine by requiring:

- → the assessment, prior to initial use of the portable electrical plant, against the prescribed conditions in clause 79(1) and any other requirements identified through risk assessment of the proposed use of the plant at the mine
- → inspection of the portable electrical plant immediately before each occasion where the plant is to be used at the mine.
- → linking with the inspection plan of the mine to require the inspection of the hazardous zone environment, in particular methane levels where the plant is to be used, immediately before use, and for the regular reinspection of the environment while the plant continues to be used in the hazardous zone

Note: the Inspection Plan should detail the nature and extent of examinations required to be undertaken immediately prior to the portable equipment being taken into the hazardous zone and the frequency of follow up inspections for the duration of time that the equipment remains in the hazardous zone. It may also require the issue of a dedicated report detailing the results of the inspections and the locations inspected.

- → Immediate removal of the portable plant from the mine, or parts thereof, in the event of a ventilation failure in those parts of the mine
- → Communications protocols with the surface of the mine in the event of an emergency situation

Additional matters to be considered in an EECP for the safe use of this electrical plant include:

- → arrangements needed to ensure that it is fit for purpose and suitable for the work environment
- → what systems are needed to assess and authorise workers as competent to safely operate the plant within the environment of the mine
- → arrangements needed to ensure that plant is in the control of the authorised person at all times while underground
- → measures to ensure that batteries are securely fastened within the apparatus so they cannot inadvertently detach from the apparatus. For example that covers are correctly fitted
- → systems to prohibit charging of batteries in the underground workings of the mine.

See 4.5 regarding Schedule 2 clause 3(3)(t) above for additional guidance on portable electrical equipment.

5.2.7. Cables

For matters to be dealt with in the EECP in relation to cables and cable accessories at all mines, see 4.5 regarding Schedule 2 clause 3(3)(d).

Only electric cables that conform to the requirements of clause 80 of the WHS (MPS) Regulation can be used in a hazardous zone. Among other requirements, only cables that are an integral part of a caplamp, or form part of an intrinsically safe circuit and have been determined as being suitable by the mine operator in conjunction with the Electrical Engineering Manager at the mine, can be used in the hazardous zone

Note: Only caplamps that are certified as intrinsically safe, category ‘Ex ia’ are permitted where the methane level is 2% or greater by volume).

Cables (other than cables that are part of intrinsically safe circuits) in hazardous zones must conform to either AS/NZS 1802:2003 or AS/NZS 1972:2006.

Where methane levels in the general body of the air are 1.25% by volume or greater, only cables where all circuits in the cable are intrinsically safe to category ‘Ex ia’ are used.

5.2.8. Testing

An EECP should set out the arrangements for the testing of circuits in a hazardous zone in accordance with the requirements of clause 82 of the WHS (MPS) Regulation.

Testing equipment must be explosion protected unless it meets a category of exemption under clause 79. For example, clause 79(3) permits the use of insulation test equipment that is not explosion protected if used in accordance with the procedures developed under the electrical engineering control plan for the mine.

See 4.5 Schedule 2 clause 3(3)(n)(ii) above for information and guidance on electrical test instruments.

5.2.9. Licenced activities

An EECP should link with the mine's procurement and work procedures and arrangements to ensure that only persons that hold a current licence for a licensable activity to undertake that licenced activity for the mine (refer to clause 152 WHS (MPS) Regulation). In relation to electricity and electrical work, such as for plant in a hazardous zone with explosion-protection requirements (clause 78) these activities include:

- → any overhauling, repairing or modifying activities that may affected the explosion-protection properties of explosion-protected plant
- → any repairing of flexible reeling, feeding or trailing cables for use in a hazardous zone.

The EECP should provide for, or link to other processes such as procurement, for periodic assessment by the mine to verify that the licensable activities are being carried out under and in accordance with a relevant licence (including that the cable repair work is being certified by a person competent to do so). See clause 157(5) of the WHS (MPS) Regulation.

6. Implementation

6.1. Implementing an EECP

Implementation is not a single step to be completed once only but is an ongoing activity. It involves putting into practice the requirements of the documented EECP that has been developed.

The mine operator is responsible for the ongoing implementation of an EECP.

To implement an EECP, the mine operator needs to ensure that what is set out in an EECP is followed in practice. Implementing an EECP will include ensuring that risk controls are used and maintained, for example:

- → that procurement practices support the acquisition of fit for purpose electrical plant and installations
- → that safe work procedures are provided, understood and followed and required PPE is used
- → that equipment is maintained in its intended condition
- → that there is effective coordination with contractors and their staff
- → that change management arrangements are effective in identifying new or changed risks and managing them
- → that staff know how to raise safety issues relating to electrical aspects of plant and installations.

Implementation may be seen as a similar process to commissioning of plant or installations. It involves putting into practice the documented EECP that has been developed. The implementation process should include verification that actual site practices are following the documented EECP.

As part of the safety management system, an EECP must also be maintained to ensure it remains effective.

6.2. Who can implement an EECP?

The mine operator must implement the plan but ensure that an EECP is developed and reviewed by a person who is, or who is under the supervision of:

- → the electrical engineering manager (for an underground coal mine)
- → the electrical engineer (for all other coal mines)
- → a competent person (for mines other than coal mines).

Refer to clause 26(5) of the WHS (MPS) Regulation which is contained in section 1.2 of this code.

Implementation of some aspects of an EECP may be delegated by the mine operator to persons with relevant expertise or in a relevant supervisory role. However some supervisory functions may only be carried out by persons nominated to exercise that function. Refer to 2.2 and 2.3 of the code.

6.3. Resources

The mine operator must provide resources to meet their duty to implement the EECP, under clause 26(5) of the WHS (MPS) Regulation. Resources include people with appropriate skills, adequate time, appropriate equipment, authority and financial delegation.

The mine operator must set out in the SMS the resources allocated to effectively implement and use the SMS (clause 14(1)(u) WHS (MPS) Regulation). As an EECP is part of the SMS, the EECP should state the resources to be provided to meet the legislated requirements or reference the appropriate part of the mine SMS that addresses it.

6.4. Responsibility

The roles and responsibilities for implementing an EECP should be defined, documented and communicated to the relevant people in the organisation. Details of the people in the mine management who are responsible for the implementation of the plan, or parts of it, should be set out in an EECP or the safety management system. This should include the relationships between responsible people in the EECP and other plans, with details of how any interface issues are to be managed.

6.5. Documentation

The implementation process for an EECP should be documented, including the methods used, for example communication activities, training etc. Other details recorded should include those people who implemented the plan, which may be the competent person, electrical engineer or electrical engineering manager who developed the EECP. These people may supervise its implementation and may report at set intervals to the mine operator that the EECP is being implemented and is operating satisfactorily.

7. Monitoring, audit and review

7.1. Monitoring

Monitoring helps determine whether control measures are adequately designed, properly executed and effective at any given time. If controls are not effective for managing the risks, then the EECP should direct how they are to be corrected.

An EECP should detail the frequency and type of monitoring, such as inspections, assessments and audits. For each element addressed in the EECP, including controls, monitoring activities should be identified and incorporated into the plan. Monitoring activities may include:

- → pre-start inspections
- → visual inspections
- → internal inspections
- → function testing.

An EECP should identify the frequency of the different monitoring activities and incorporate these into the plan. Inspections may occur on a frequent basis, per shift, daily, weekly and so on. This is in contrast to a formal audit and review process is less frequent and often to a set schedule (see further details below).

An EECP should also identify the required skills and competencies for people undertaking the different monitoring activities.

For more complex operations, an EECP may reference the maintenance management plan or similar document, if applicable, so that all controls are monitored as determined.

7.2. Review of control measures

The mine operator must review and revise the risk-control measures provided for in an EECP in certain circumstances, as required in clause 38 of the WHS Regulation and clause 10 of the WHS (MPS) Regulation. See *Managing risks in mining* guide for more information about when control measures must be reviewed.

7.3. Periodic review of an EECP

An EECP must also be periodically reviewed by a person who is eligible to develop the plan. (see 1.2 and 2.3 in this code for further explanation and legislative extracts). The purpose of a review is to determine if an EECP is effective in managing the risks posed by electricity at the mine and not just whether the plan is being carried out.

Other circumstances which may prompt a review of an EECP include:

- → The introduction of new plant or significant changes to plant
- → new hazards identified, such as substances found as being hazardous after an incident or research
- → changes in the way work tasks are undertaken
- → changes in conditions.

An EECP must also be reviewed as part of the safety management system for the mine:

WHS (MPS) Regulation

17 Review

(1) The mine operator of a mine must ensure that the safety management system for the mine or petroleum site is reviewed within 12 months of the commencement of mining operations or petroleum

operations at the mine or petroleum site and at least once every 3 years after that to ensure it remains effective.

(details of penalties omitted)

Note. Regular testing of the emergency plan is also required (see clause 93).

(2) In addition, if a risk control measure is revised under clause 38 of the WHS Regulation or clause 10 of this Regulation, the operator must ensure that the safety management system for the mine or petroleum site is reviewed and as necessary revised in relation to all aspects of risk control addressed by the revised control measure.

(details of penalties omitted)

In undertaking a review, the mine's workers and their health and safety representatives (and mine safety and health representatives in coal mines) must be consulted, as required under the WHS laws. The following questions, during that consultation, should be considered by the mine operator and workers:

- → Are all risks posed by electricity adequately managed?
- → Are control measures working effectively in both their design and operation?
- → How effective is the risk assessment process? Are all hazards being identified?
- → Have new work methods or new plant and installations been introduced to make the job safer? What is their impact on existing hazards, risks and control measures?
- → Are safety procedures being followed?
- → Has instruction and training provided to workers been successful?
- → If new legislation or information becomes available, does it warrant a review of current controls?
- → What are the current industry best practices for compliance (and better) and whether any activities have been benchmarked against them?
- → Have there been technological advances that may be of assistance in managing risks posed by electricity?
- → Whether there have been any industry publications or technical reports published that may assist in managing risks posed by electricity?
- → Have there been any relevant incidents and what were the outcomes of investigations?

If problems are found, the mine operator should review current information and make further decisions about risk controls to be implemented through an EECP.

7.4. Audit

The WHS (MPS) Regulation requires the mine operator to carry out audits of an EECP, as part of the safety management system:

WHS (MPS) Regulation

15 Performance standards and audit

The safety management system for a mine or petroleum site must include the following:

(a) performance standards for measuring the effectiveness of all aspects of the safety management system that:

(i) are sufficiently detailed to show how the operator will ensure the effectiveness of the safety management system, and

(ii) include steps to be taken to continually improve the safety management system,

(b) the way in which the performance standards are to be met,

(c) a system for auditing the effectiveness of the safety management system for the mine or petroleum site against the performance standards, including methods, frequency and results of the audit process.

The mine operator must set performance standards and audit against them, such as whether procedures specified are in place and being followed, performance outcomes set are being achieved, and actions (for example corrective actions from an incident investigation) are being taken. Further details on auditing are contained in the *NSW code of practice: Safety management systems in mines.*

The purpose of the audit is to measure the effectiveness of an EECP against set performance standards and may include auditing whether:

- → mine workers understand their responsibilities and carry them out
- → training and testing has been carried out in accordance with the EECP
- → electrical plant and installations required is fit for purpose, available and maintained
- → inspections and tests specified have been carried out
- → corrective actions have been carried out
- → required reports have been completed.

Information from the audit should enable an EECP to be improved and for it to remain effective in managing the risks posed by electricity at the mine.

The audit system must include the frequency, audit methodology and results. It may also include provisions for:

- → scope of the audit
- → name(s) and competency of the auditor(s)
- → person responsible for ensuring the audit is conducted
- → reporting protocol/outcomes for the audit
- → people responsible for acting on the audit report
- → corporate or PCBU requirements for auditing, such as internal versus external auditors.

A mine operator may decide to carry out internal audits with people working at the mine that have the appropriate auditing competence and technical expertise, such as an electrical engineer. Alternatively, it may be decided to have an independent audit undertaken by an external person so as to be potentially more objective and gain external expertise and insights.

An EECP should require that the results of audits are communicated to the mine operator and any other persons that have responsibilities within the SMS or the EECP for the implementation of those control measures.

8. References

8.1. NSW codes of practice

General:

- How to manage work health and safety risks
- How to manage and control asbestos in the workplace
- How to safely remove asbestos
- Managing electrical risks in the workplace
- Managing risks of plant in the workplace
- Managing risks of hazardous chemicals in the workplace
- Excavation work
- Welding processes

www.workcover.nsw.gov.au/lawpolicy/codes-of-practice/Pages/default.aspx

Mining

- safety management systems in mines
- inundation and inrush hazard management
- emergency planning for mines
- mechanical engineering control plan

8.2. Documents that form part of this code

Compliance with the documents listed below, either in whole or in part, is required by either the WHS regulation or the WHMP regulation.

Document	Standard or guideline title
AS/NZS 1299	Electrical equipment for mines and quarries – Explosion-protected three-phase restrained plugs and receptacles for working voltages up to and including 3.3 kV
AS/NZS 1802:2003	Electric cables – Reeling and trailing – For underground coal mining purposes
AS/NZS 1972:2006	Electric cables – Underground coal mines – Other than reeling and trailing
AS/NZS 3000:2007	Wiring Rules
AS/NZS 3012:2010	Electrical installations— Construction and demolition sites

8.3. Documents that do not form part of this code

Below is a list of some published documents that should be referred to in the management of risks associated with electricity and the development of the EECP. These documents, whether or not referred to in the text of this code, do **not** form part of this code.

Please note the list below is not an exhaustive list of references that may be relevant to the management of electrical risks. Complying with any one or more of the following documents does not guarantee compliance with WHS laws.

This list provides details of useful information that persons may refer to so as to possibly support their compliance for WHS laws involving the management of electrical risks in mines.

8.3.1. Australian Standards

Document	Standard or guideline title
AS/NZS 1300	Electrical equipment for mines and quarries – Bolted explosion-protected three-phase cable coupling devices
AS/NZS 1674.2	Safety in welding and allied processes – electrical
AS/NZS 1768	Lightning protection
AS 2067	Substations and high voltage installations exceeding 1 kV a.c.
AS/NZS 2081	Electrical protection devices for mines and quarries
AS/NZS 2290.1	Electrical equipment for coal mines—Introduction, inspection and maintenance Part 1: For hazardous areas
AS 2397	Safe use of lasers in the building and construction industry
AS 2660	Hose and hose assemblies - Air/water - For underground coal mines
AS/NZS 2802	Electric cables – Reeling and trailing for mining and general use (other than underground coal mining)
AS/NZS 3007	Electrical equipment in mines and quarries – Surface installations and associated processing plant
AS/NZS 3008 Part 1.1	Electrical installations—Selection of cables Part 1.1: Cables for alternating voltages up to and including 0.6/1 kV—Typical Australian installation conditions
AS 3011.1	Electrical installations— Secondary batteries installed in buildings Part 1: Vented cells
AS 3011.2	Electrical installations— Secondary batteries installed in buildings Part 2: Sealed cells
AS/NZS 3190	Approval and test specification— Residual current devices (current-operated earth-leakage devices
AS/NZS 3760	In-service safety inspection and testing of electrical equipment
AS/NZS 4024.1 series	Safety of Machinery

AS/NZS 4024.1503	Safety of machinery Part 1503: Safety-related parts of control systems—General principles for design
AS/NZS 4240 series	Remote controls for mining equipment
AS/NZS 4836	Safe working on or near low-voltage electrical installations and equipment
AS/NZS 4871 series	Electrical equipment for mines and quarries
AS/NZS 4871.1	Electrical equipment for mines and quarries Part 1: General requirements
AS/NZS 60079.10.1	Explosive atmospheres— Classification of areas - Explosive gas atmospheres
AS/NZS 60079.10.2	Explosive atmospheres— Classification of areas - Explosive dust atmospheres
AS/NZS 60079.14	Explosive atmospheres— Electrical installations design, selection and erection
AS/NZS 60079.28	Explosive atmospheres— Protection of equipment and transmission systems using optical radiation
AS/NZS 60079.35.1	Explosive atmospheres— Caplights for use in mines susceptible to firedamp - General requirements - Construction and testing in relation to the risk of explosion
AS 60529	Degrees of protection provided by enclosures (IP code)
AS/NZS 60825.1	Safety of laser products Part 1: Equipment classification and requirements
AS 60974.1	Arc welding equipment Part 1: Welding power
AS 60974.6	Arc welding equipment Part 6: Limited duty portable arc welding and allied process power sources
AS 61508 series	Functional safety of electrical/electronic/programmable electronic safety related systems
AS 61511	Functional safety - Safety instrumented systems for the process industry sector
AS 62061	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems

8.3.2. Other technical publications

Document	**Standard or guideline title**
HB 89	*Risk management - Guidelines on risk assessment techniques,* Standards Australia
HB 187	*Guide to Selecting a Safe Multimeter,* Standards Australia
HB 205:2017	*Managing health-and-safety-related risk*, Standards Australia
HB 242	*High voltage mining equipment for use underground*, Standards Australia
IEC TS 60079-32-1	*Explosive Atmospheres – Part 32-1 Electrostatic hazards, guidance*
IEEE 1584	*Guide for Performing Arc-Flash Hazard Calculations,*

	IEEE Standards Association
MDG 25	*Guidelines for Safe Cutting and Welding Operations at Mines,* NSW Resource Regulator
MDG 40	*Guideline for Hazardous Energy Control (Isolation or Treatment)*, NSW Resources Regulator
MDG 3608	*Non-metallic materials for use in underground coal mines*, NSW Resource Regulator
NFPA 70E	*Standard for Electrical Safety in the Workplace,* National Fire Protection Association (USA)
Recognised Standard 01	*Underground electrical equipment and electrical installations*, Qld Department of Natural Resources and Mines
TN 22	*Welding electrical safety,* Welding Technology Institute Australia
wcms_110254	*Safety and health in underground coal mines,* International Labour Office (ILO)
	General Guide for Working in the Vicinity of Overhead and Underground Electric Lines Safe Work Australia

8.3.3. Websites

- NSW Resource Regulator – www.resourcesandenergy.nsw.gov.au/miners-and-explorers/safety-and-health
- WA Department of Mines and Petroleum – www.dmp.wa.gov.au
- Queensland Department of Natural Resources and Mines - www.dnrm.qld.gov.au
- Safe Work Australia – www.safeworkaustralia.gov.au
- Health and Safety Executive, UK http://www.hse.gov.uk and in particular human factors at www.hse.gov.uk/humanfactors/
- MIRMGATE (Minerals Industry Risk Management Gateway) www.mirmgate.com/
- RISKGATE www.mishc.uq.edu.au/Resources/RISKGATE.aspx

Appendix A: Registration

Information on plant registration can be found on the Resources Regulator website: www.resourcesandenergy.nsw.gov.au/miners-and-explorers/safety-and-health

Plant that must be design or item registered if used at a mine

Plant designs that require design registration (refer Schedule 5 WHS Regulation) and are used at mine sites are often powered by or controlled by electricity, and include:

- → lifts
- → hoists with a platform movement exceeding 2.4 metres, designed to lift people
- → boom-type elevating work platform
- → gantry cranes with a safe working load greater than 5 tonnes or bridge cranes with a safe working load of greater than 10 tonnes
- → vehicle hoists
- → mobile cranes with a rated capacity greater than 10 tonnes.

Items of plant that require item registration and which are often used at mine sites include:

- → lifts
- → mobile cranes with a rated capacity greater than 10 tonnes.

Plant that must be design or item registered if used at a mine

The WHS (MPS) Regulation also requires that the design and/or item of certain other plant (as set out below) be registered in accordance with the WHS Act if used in a mine. Clause 177 of the WHS (MPS) Regulation requires that plant that is required to be registered is not used unless it is registered. As commissioning of plant requires the use of the plant, a PCBU must not commission an unregistered item of plant for use in a mine if it is required to be registered. An EECP should make provision to ensure that plant that is required to be registered is not used unless it is appropriately registered.

All mines

The use of a winding system at a mine requires both the registration of the design and the registration of each item of plant.

Underground coal mines

The following types of plant require plant design registration:

- → diesel engine systems
- → booster fans
- → plant or items used to determine or monitor the presence of gases
- → shotfiring apparatus (including exploders and circuit testers)

The following types of plant require plant item registration as well:

- → diesel engine systems
- → booster fans