ELECTRICAL ENGINEERING SAFETY RISK IDENTIFICATION & MANAGEMENT SYSTEMS (RIMS) REVIEW GUIDE

for the Development of the DPI Strategic Plan for Electrical Engineering Safety in NSW Mines and technical content of workplans for Inspectors of Electrical Engineering and MSO Electrical Engineering.

Introduction

This Guide is based on the "RIMS" that was put together specifically for NSW Department of Mineral Resources Inspectors in order to assist development of Minesite Profiles and Work Plans. This Guide has been put together specifically for NSW DPI Mine Safety Electrical Engineering Staff (Inspectors, MSO's and Test Engineers) in order to assist in the development of Strategic Plans for Electrical Engineering Safety and associated programs, Minesite Profiles and Work Plans. The scope of mining operations is; coal operations, metalliferous mines, extractives operations (dredges, quarries etc.) and processing plants. The intention is to provide an easy-to-use resource to gain a clear understanding of:

- the key risk areas for electrical engineering safety within the whole industry & specific sectors;
- the engineering risk controls that must be implemented to attain a tolerable risk level;
- the electrical engineering safety management practices required to identify, implement and maintain the engineering risk controls, within the industry and at specific sites; and subsequently,
- the priorities for Inspectorate involvement with the industry (mines, service providers and plant designers and suppliers) in the management of electrical engineering safety.

Electrical Engineering Safety Risks

The uncontrolled electrical engineering safety risks are in the highest category. Without the electrical engineering safety risk controls we could expect, on a regular basis:

- multiple fatalities from coal mine explosions;
- many single fatalities from electrocution in any one year;
- multiple fatalities from loss of control of people transport;
- many single fatalities from unplanned movement of production machinery, and
- multiple fatalities from fires.

Of course, this level of risk is not tolerable. In reality, the electrical engineering risk controls are generally well known and if implemented the risk is maintained at a tolerable level.

So, the key to maintaining electrical engineering safety risks to a tolerable level, is to clearly identify the engineering risk controls and make sure that they are implemented with a great deal of "robustness". By robustness, it is meant that if a single particular risk control fails, there are back up risk controls or checks and balances to detect the failed risk controls and restore them to a functioning state. In general, this is achieved by a combination of engineering controls and management system controls, that is:

- the use of well designed engineering risk controls for electrical plant (fit for purpose electrical plant);

- the life-cycle management of electrical plant by, and involving competent electrical workers (engineers, technicians, electricians, linesmen and cable repairers) at the design, verification, install, commission, inspect, maintain, overhaul and modify stages of the life cycle;
- the use of well documented, rigorous, systematic procedures which have been embedded in electrical training programs, and
- all supported by management systems.

All of this is required by Legislation. There are numerous Australian and International standards that support this. Figure 1 summarises the use of engineering risk controls, supported by management systems to manage the risks from electricity from intolerable to tolerable. It should be noted that for the non-mining industry the NSW Electricity (Consumer Safety) Act and Regulation is another key piece of legislation. Other legislation that contributes to electrical engineering safety is the NSW Electricity supply Act and associated regulations. This is all summarized in Figure 1.

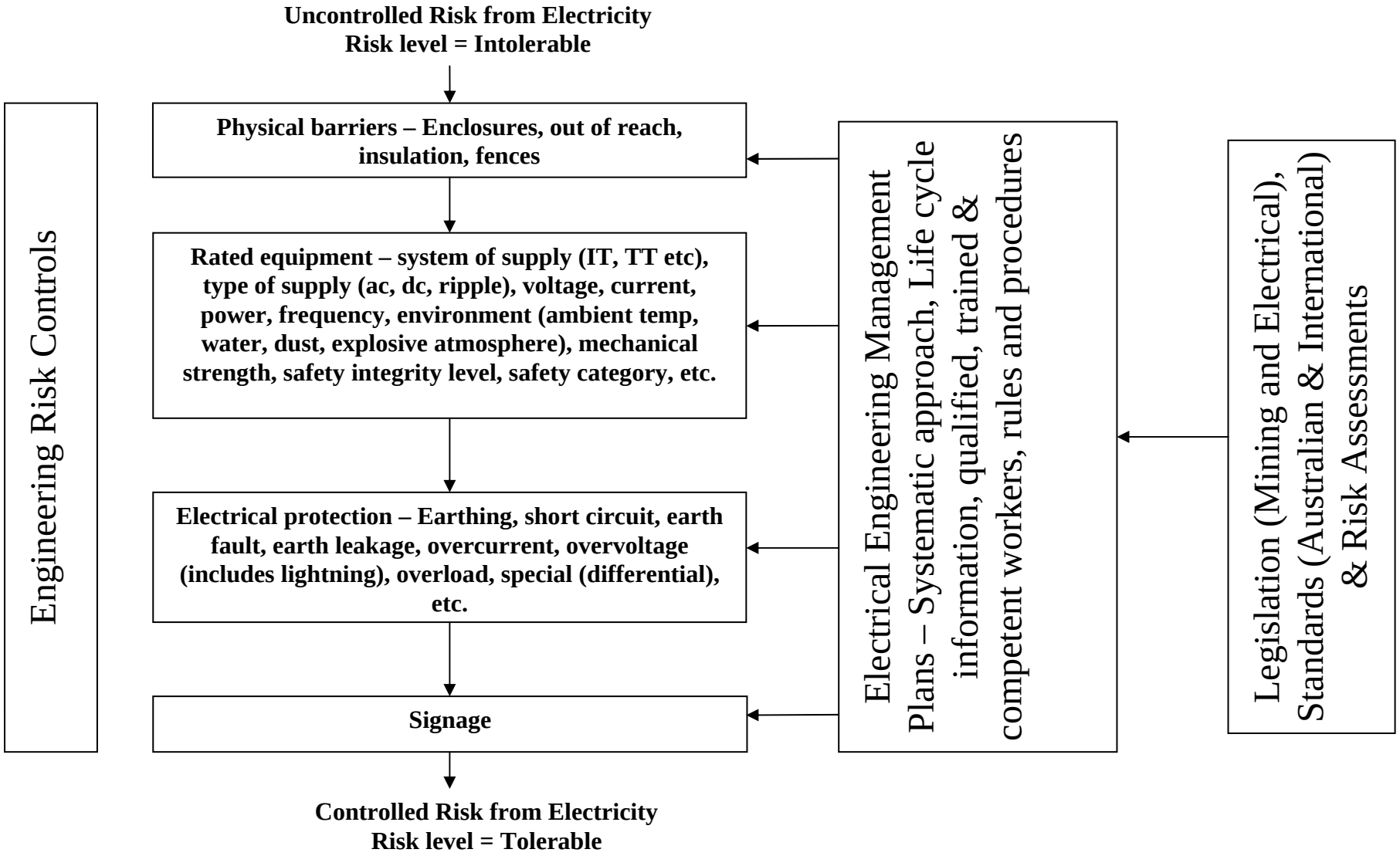
What is a Risk Identification & Management System (RIMS) Review?

A RIMS Review is a structured analysis covering three key aspects of mining and quarrying electrical engineering safety.

1. Identification & control of the largest risks to electrical engineering safety in the industry
2. Identification & control of the largest risks to electrical engineering safety in individual operations
3. Management of the safety concerns using a system safety engineering approach

Points 1 & 2 are critical if we consider the general principle of "if you don't know the risks that exist within a business then you can't expect to manage them". The latter is critical from our knowledge that even well identified controls can easily fail without the systems approach to ensuring the quality of the work process (people, procedures , plant / materials and the work environment), as well as methods to implement requirements, monitor, audit and control change.

Figure 1: Electricity and Risk Controls



How Do I Use This Guide?

Strategic Planning

The tables in this guide that deal with EES key risk areas are reviewed on an industry wide basis for identification of technical content to specific programs and the development of targeted programs to address emerging issues or specifically identified problems.

It is a given, that to maintain a tolerable risk level there needs to be in place an auditable electrical technology management system that is supervised by competent electrical people. The electrical technology management system must incorporate the following elements:

A management system based on AS4801 and AS4804 that includes:

Risk management practices consistent with MDG1010, AS4360, IEC61508, IEC61511, IEC62061 & AS4024

Electrical Engineering Management Plan consistent with EES001

The full life-cycle of the mine and plant

Electrical work is either done by, or supervised by competent electrical workers

Electrical work practices are documented and prevent live line work

The purpose of the EEMP is to minimise the risk of:

Injury from electrical energy

Ignition of flammable atmospheres from electrical ignition sources

Initiation of fires from electrical ignition sources

Unplanned movement (including failure to stop) of machinery

Failure of electrical safeguards for electrical and non-electrical hazards

The above are the “givens” and only appear as risk controls in the risk assessment table to emphasise specific issues.

Individual Workplans And Mine Specific Risk Profiles

The Guide is intended to drive a step-by-step analytical approach. At each step the process reviews the mine or quarry operation. The format encourages the recording of the specific hazards, possible problems and risks that are identified.

There are 6 steps in developing a mine specific risk profile and a workplan using the EES RIMS Review. These are;

Stage 1. Identification of EES key risks

- ***Review the mine or quarry operation using the EES key risk area and decide if the key risk area exists.***

Stage 2. Identify known problem areas in general (things that can go wrong) – include particular issues that need specific attention.

- ***Review the problem areas the mine or quarry has against the industry problem area.***

Stage 3. Identify the known risk controls

- ***Review the effectiveness of the risk controls at the mine or quarry against the industry risk controls.***

Stage 5 Profile the mine or quarry

- ***Prioritise on effectiveness of DPI interventions – the rectification of which problem area will have the most effect***
- ***Target deficient risk controls***
- ***Note: Deficient risk controls may encompass a number of key risk areas and addressing this may be more effective than targeting one specific key risk area and multiple risk controls.***

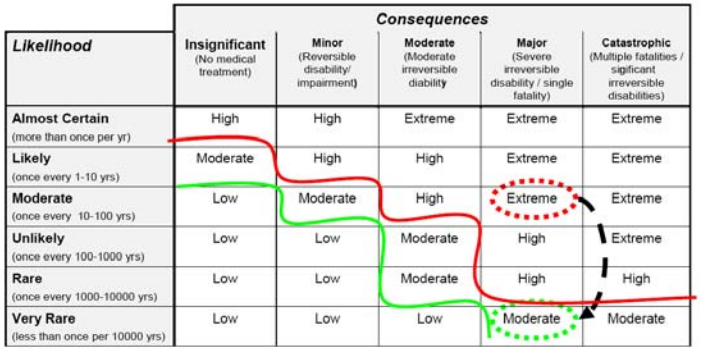
Stage 6 Develop a particular improvement program for the individual mine as part of the workplan.

- ***Set achievable targets:***
  - ***Eg***
    - ***quarry "xxx"to have implemented an overhead line management plan within six months***
    - ***Review implementation of the management plan within nine months***
- ***Note: If an industry wide targeted program is being implemented that addresses the particular mine issue, the required work should be integrated with that program.***

Note: If a key risk control or key risk area appears as an area requiring DPI intervention consistently across a number of mines, further review is required to consider the implementation of an industry wide targeted program.

Method To Classify Risk

The classification of risk is based on the Connell Hatch risk matrix, shown below. The risk matrix has been calibrated for an industry wide perspective. The worst case uncontrolled risk has been taken in certain areas, for example failure of transport systems for people safety has considered mine winders in determining the uncontrolled risk. Further, some of the risk areas have been deemed as concentrated outside the scope of Electrical Engineering Safety, eg shotfiring, which is a mining risk, however there are interfaces with Electrical Engineering Safety; these have been identified as requiring input from Electrical Engineering Officers.



Likelihood	Consequences				
	Insignificant (No medical treatment)	Minor (Reversible disability/ impairment)	Moderate (Moderate irreversible diability	Major (Severe irreversible disability / single fatality)	Catastrophic (Multiple fatalities / significant irreversible disabilities)
Almost Certain (more than once per yr)	High	High	Extreme	Extreme	Extreme
Likely (once every 1-10 yrs)	Moderate	High	High	Extreme	Extreme
Moderate (once every 10-100 yrs)	Low	Moderate	High	Extreme	Extreme
Unlikely (once every 100-1000 yrs)	Low	Low	Moderate	High	Extreme
Rare (once every 1000-10000 yrs)	Low	Low	Moderate	High	High
Very Rare (less than once per 10000 yrs)	Low	Low	Low	Moderate	Moderate

Maximum Reasonable Consequences:

Catastrophic - multiple fatalities (full site or over 10 deaths)
Major several fatalities (local event or 2 to 10 deaths)
Moderate - single fatality or permanent disability
Minor - lost time injury (LTI)
Insignificant - medical treatment injury (MTI) or less

Calibrated risk matrix

Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain (> 10 / yr)	High (A5)	Extreme (A4)	Extreme (A3)	Extreme (A2)	Extreme (A1)
Likely (1 – 10 / yr)	Medium (B5)	High (B4)	High (B3)	Extreme (B2)	Extreme (B1)
Moderate (0.1 – 1/ yr)	Low (C5)	Medium (C4)	High (C3)	Extreme (C2)	Extreme (C1)
Unlikely (0.01 – 0.1 yr)	Low (D5)	Low (D4)	Medium (D3)	High (D2)	Extreme (D1)
Rare (0.001 – 0.01 / yr)	Low (E5)	Low (E4)	Medium (E3)	High (E2)	High (E1)
Very Rare (0.0001 – 0.001 / yr)	Low (F5)	Low (F4)	Low (F3)	Medium (F2)	Medium (F1)

RISK IDENTIFICATION & CLASSIFICATION SHEET

EES Key Risk Area	Electrical Engineering Safety Element	Problem area	Risk Controls implemented by mines	DPI actions to facilitate risk control implementation **(seminars, safety alerts, toolbox talks, competency development, mine site assessment of problem areas and risk controls, investigations of incidents, development of standards/codes/guidelines, development of third party test/assessment/audit/certification schemes)**
Explosion or fire caused by electrical plant in a gas or dust hazardous area **Uncontrolled risk** U/G coal mines = EXTREME (A1) Surface installations = HIGH (C3) **Controlled risk** U/G coal mines = MEDIUM (F1) (Note non electrical risk controls bring the risk to low) Surface installations = LOW (F3)	Prevention of electrical arcing and surface temperatures that have sufficient energy to ignite gas and/or dust. Prevention of fires caused by the malfunction of electrical plant.	1. Legislation does not specify hazardous area requirements 2. Lack of competence 3. Incorrect identification & classification of hazardous areas 4. Incorrect plant in area. 4.1 Plant not Ex • Failure of an Ex technique. • Over temperature of plant. • Accumulation of electric charge on the surface of plant/people in hazardous areas.	2. Identify and ensure competent personnel used at address each element of plant life-cycle 3. Hazardous areas are identified & classified (it is recognized that coal dust is treated) 4 Portable apparatus scheme developed and implemented. 4.1 Electrical plant in hazardous areas, is: 4.1.1 designed to a set specification 4.1.2 verified to a set specification 4.1.3 verified in accordance with set procedures 4.1.4 correctly selected 4.1.5 installed & maintained to a set specification 4.1.6 overhauled to set specification 4.1.7 All plant used in hazardous areas is anti-static and/or properly earthed	1 Legislation to specify hazardous area requirements – U/G coal specific and via AS/NZS3000 2 Participate in Australian Standard committees relevant to competencies for explosion protection. • Competency criteria development for mine electrical staff, Ex plant overhaulers and repairers and cable repairers. • Development of technical reference for control and supervision of electrical work 3 Participate in Australian Standard committees for classification of hazardous areas. 4 Development of portable plant practice technical reference 4.1 Implement programs to give a high degree of certainty about Ex properties throughout the life-cycle • IEC Ex and ANZ Ex management committees for plant and Ex workshops • Participate on Ex Australian Standard committees relevant to mining • Participate on Australian Standard committee for static electricity • Assessment of the management of Ex at All underground mines annually. • Development of Technical reference for electrical engineering management plans • Development of Ex management technical reference – include dusts and IP ratings • Development of Ex plant specification technical reference • Standardize DPI's current requirement and test procedures for anti-static properties

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		4.2 Abuse of plant.	4.2 Failure of Ex plant investigated	4.2 All failure of Ex plant investigated
		4.3 Arcing external to cable	4.3 Cable arcing incidents investigated	4.3 Analyse Cable damage stats – monthly 4.3.1 Cable arcing investigations
		4.4 Cable management systems for hazardous zones.	4.4 Cable management plans developed and implemented 4.4.1 Cables repaired to a set specification	4.4 Cable management plans reviewed as part of incident investigation 4.4.1 Licensing and annual review of cable repair facilities.
		5. Failure of removal/restoration of power procedures, including purging, resetting onto a fault, working on energised conductors, Electrical testing.	5. Procedures for removal/restoration of power in hazardous areas includes purging of enclosures, electrical testing and isolation, reset after a fault trip, no compromising of Ex properties whilst testing and fault finding, no live line work	5 Development of technical references for removal and restoration of power.
		6. Failure of mine earthing systems.	6. Earthing systems are designed, verified and maintained to a set specification	6 Development of protection and earthing technical reference
		7. Failure of electrical protection	7. Electrical protection is designed, verified and maintained to a set specification	7 Development of protection and earthing technical reference • Participate on Australian Standard Committees for electrical protection plant at mines
		8. Failure of lightning protection systems • Lightning strikes	8. Lightning / overvoltage protection is designed, verified and maintained to a set specification	8 Development of protection and earthing technical reference • Review SAGO outcomes
		9. High energy electrical systems	9. High energy electrical systems are used in accordance with risk management plans	9 Participate and monitor research and development of high voltage explosion protected plant for mining.
		10. VVVF Drives	10. VVVF drives are correctly earthed and protected and used in accordance with risk management plans	10 Develop a position on VVVF drives
				11 Develop handbook on HV practices at U/G mines.

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		11. HV continuous miners	11. HV continuous miners are used in accordance with risk management plans and HV practices are used.	• Develop a position on HV continuous miners
		12. 11Kv longwalls	12. HV face longwall plant are used in accordance with risk management plans and HV practices are used	12 develop a position on 11kV longwall face plant • Develop a position on 11kV longwall face plant
		13. Failure of ventilation system interlocks, trip systems and alarms	13. Functional safety approach to alarm and trip systems such that they have an appropriate safety integrity level. Proof testing is incorporated in inspection and maintenance schemes	13 Facilitate Functional safety standards adoption by industry • DPI officers participate in Australian Standard committee relevant to functional safety of machines.
		14. Failure of ventilation • the main ventilation system (including main fan and booster fans) • Failure of auxiliary ventilation fans • Failure to manage electrical plant associated with ventilation in a safe and functional manner	14 Ventilation fans have a high reliability and redundancy built in as required Mines ventilation plant which is: • designed to a set specification; • calibrated to a set specification; • maintained to a set specification; • designed, installed, maintained and calibrated	14 Review current design practices of auxiliary fans and review MDG3
		15. Failure of fixed methane monitoring. • Failure of portable methane monitoring. • Failure of fixed other gas monitoring • Failure of portable other gas monitoring • Failure to manage electrical plant associated with gas monitoring in a safe and functional manner	15 Mines have atmospheric monitoring plant which is: • designed to a set specification ; • installed to a set specification; • calibrated to a set specification; • maintained to a set specification; • designed, installed, maintained and calibrated	15 DPI officers participate in all Australian Standard committees relevant to ventilation appliances and gas monitoring and detecting plant.
		16. Introduction of new technology into hazardous areas i.e. diesel engine electronic management systems.	16 New technologies to fulfill the requirements of Chapter 5 of OHS Regulations 2001, e.g. electronic management systems to be suitable for use in hazardous zone. Risk based approach to introduction of new and novel technology into hazardous zone.	16 Monitor application of this technology

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Electrocution, electric shock and electric burns **Uncontrolled risk** ALL mines = EXTREME (A3) **Controlled risk** ALL mines = LOW (F3)	Prevention of electrocution. Prevention of injury or death from electric shock. Prevention of electrical burns, including electrically induced radiation burns. Prevention of arc blast injuries	1. Legislation does not provide for electrical engineering safety that is better than non-mining industry		1. Legislation provides for a level of electrical engineering safety that is better than general industry. AS/NZS3000 and AS3007 compliance is an absolute minimum
		2. Electricity not recognized as a hazard by the mine.	2 Mines to recognize electricity has a hazard	2. Review mine site risk assessments to see that electricity is recognized as a hazard
		3. Failure of electrical plant • Failure of insulation and / or barriers. • Incorrect rating and guarding of electrical plant. • Damaged plant	3. Only plant that conforms to set specifications is used at mines. • Electrical plant, - designed to a set specification; - installed to a set specification; - maintained to a set specification; - overhauled to set specification designed	3. Development of Technical reference for electrical engineering management plans • Development of a technical reference for design principles of electrical plant and installations • Competency criteria development for mine electrical engineers. • Only electrically qualified people do electrical work • Development of a Technical Reference for the Control and Supervision of electrical work. • Participate on Australian Standard Committees for electrical plant and installations at mines
		4. Failure to install and commission electrical plant properly	4. Plant installed and commissioned properly and in accordance with AS/NZS3000 • Electrical work done by or supervised by qualified electrical people • Electrical work tested by qualified electrical people • Electrical work notified to responsible persons	4. Assessment of mines against AS/NZS3000 and EEMP's • Competency criteria development for mine electrical engineers. • Development of a Technical Reference for the Control and Supervision of electrical work. • Develop handbook on HV practices at U/G mines.
		5. Failure of earthing systems.	5. Earthing systems are designed, verified and maintained to a set specification	5. Development of protection and earthing technical reference
		6. Failure of electrical protection.	6. Electrical protection is designed, verified and maintained to a set specification	6. Development of protection and earthing technical reference • Participate on Australian Standard Committees for electrical protection plant at mines
		7. Failure of lightning protection systems.	7. Lightning protection is designed, verified and maintained to a set specification	7. Development of protection and earthing technical reference

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		8. Failure of removal/restoration of power procedures.	8. Mines have rules for the removal and restoration of power to all electrically powered plant to a set specification	8. Development of technical references for removal and restoration of power. • Development of Isolation Guidelines • Participate on Australian Standard for safe work on low voltage plant
		9. Failure of electrical testing procedures.	9. Mines have rules for electrical testing, to a set specification	9. Development of portable plant practice technical reference • Participate on Australian Standard for safe work on low voltage plant
		10. Failure of PPE.	10. Mines have rules for electrical testing, including the use of PPE to a set specification	10. Development of portable plant practice technical reference
		11. Failure of signage	11. Mines have set specifications for signage. and oversighted by a person with set competencies	11. Development of a technical reference for EEMP's
		12. Failure of welding plant & procedures.	12. Welding systems and plant: - designed to a set specification; - maintained to a set specification; - used to a set specification;	12 Assess welding plant at mines on a routine basis
		13. Failure of Hand held power tools	13. Portable power tools meet set specifications and are life-cycle managed - Hiearchy of controls, eliminate for ELV, battery, air powered tools, etc, environment assessment, correctly IP rated power tools, compliance with manufacturer's rating.	13. Development of portable plant practice technical reference
		14. Cables and overhead lines underrated, overloaded or poorly located	14 Overhead cables and lines - designed to a set specification; - installed to a set specification; - maintained to a set specification;	14. Assessment of OHL management on a routine basis.
		15. Cables and overhead lines damaged by moving traffic.	15 Procedures for working near overhead lines - Signage and barriers	15. Promote Safe Mining Guidelines and Workcover CoP - All incidents of contact with HV overhead lines or HV cables investigated.
		16. Underground cables dug up	16. A procedure to locate underground cables before excavation commences and supervised. Procedures for excavating near buried cables	16. Development of technical references for rEEMP's.

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			Signage	
		17. Failure to treat people receiving an electric shock.	17. Mine emergency systems include an electric shock protocol for the proper treatment and observation of electric shock	17. Investigate all electric shocks above ELV
		18. Catastrophe failure of batteries	18. Accumulation of gases diluted to a safe level, short-circuiting of terminals prevented, and use of correct PPE (insulated tools and gloves, goggles/face shields).	18. Investigate all incidents involving injury from battery failures.
		19. Arc blast from switch gear/electrical apparatus	19. Fault level controlled, arc blast areas defined, arc fault containment specified in apparatus, remote switching, authorized access / limitation of personnel, no-reclose on fault without proper investigation, high voltage PPE	19. Investigate all incidents involving injury from battery failures • Develop technical reference for use of portable apparatus
		20. Generators not installed correctly	20. Installed to a correct standard	20. Develop technical reference for generator installations
		21. Security of electrical infrastructure (from thief, inappropriate operation)	21. Applicable security of electrical system / control	21 Awareness campaign
		22 Lightning strikes • Plant explosions • People struck	22. Lightning protection systems are: - designed to a set specification; - maintained to a set specification; - procedures for approaching thunderstorms	22 Development of protection and earthing & EEMP technical references
Failure of transport systems for people safety	Prevention of injury and death from unintended operation, failure to stop	1. Legislation does not provide for high risk plant		1. High risk plant such as winders to be registered

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Uncontrolled risk ALL mines = EXTREME (A2) **Controlled risk** ALL mines = MEDIUM (F2) Non-electrical risk controls reduce the controlled risk to LOW	or failure to operate of electrically powered or controlled plant.	2. Failure of electrical control of winders • shaft winders • drift winders	2. Shaft and drift manwinders are: - designed to a set specification; - maintained to a set specification - maintained, tested, inspected by competent people - winder management plan implemented to include Emergency preparedness (IS plant at pit bottom) and software management; - electrical protection systems to a set specification. - A functional safety approach is taken; - Incidents of loss of control on shaft and drift winders are investigated and remedial action taken.	2. Competency criteria development for mine electrical engineers to include winders • Development of technical references for registration of powered winding systems. • Design registration of all powered winding systems • Development of technical references for life-cycle management of powered winding systems. • Development of Technical reference for electrical engineering management plans • Mentoring plan for DPI Inspectors • Develop software management technical reference • Participate on Australian Standard Committees for functional safety of machines. • All Incidents of involving unplanned movement are investigated
		3. Failure of electrical control of locomotives.	3. Locomotives are: - designed to a set specification; - maintained to a set specification; Locomotives have electrical protection systems to a set specification A functional safety approach is taken. Incidents of loss of control on locomotives are investigated and remedial action taken	3. Participate on Australian Standard Committees for electrical wiring of machines, functional safety of machines and mining machines. • All Incidents of involving unplanned movement are investigated
		4. Failure of electrical control of rubber tyred vehicles.	4. Rubber tyred vehicles are: - designed to a set specification; - maintained to a set specification; Rubber tyred vehicles have electrical protection systems to a set specification A functional safety approach is taken. Incidents of loss of control on rubber tyred vehicles are investigated and remedial action taken	4. Participate on Australian Standard Committees for electrical wiring of machines, functional safety of machines and mining machines. • All Incidents of involving unplanned movement are investigated
		5. Traffic control	5. Block light system, reliable communications, zone control/exclusion	5. Assessed by mining inspectors as part of transport management plans
Failure of Machine Control electrics.	Prevention of injury and death from unintended operation, failure to stop	1. Legislation does not provide for a functional safety approach		1. Legislation to provide for a functional safety approach and mobile plant

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Uncontrolled risk ALL mines = EXTREME (A3) **Controlled risk** ALL mines = LOW (F3)	or failure to operate of electrically powered or controlled plant.	2. Unexpected activity/action of radio remote control machines. - Maintainability (designed to maintenance and competency of maintainer to commission and operator in addition to electrical competencies)	2 Functional safety approach taken • Radio remote controlled plant: - designed to a set specification; - maintained to a set specification; • Radio remote controlled plant have associated isolation procedures to a set specification • Radio remote controlled plant have associated operational procedures to a set specification • Remote control LHD's in Line of Sight operations to have personnel detection and shut down systems installed. • Spectrum management • Maintainability designed into the plant • Incidents investigated	2. Development of Technical reference for electrical engineering management plans - Participate on Australian Standard Committees for electrical wiring of machines, functional safety of machines, remote control mining machines. - Facilitate the adoption of functional safety by industry - Competency criteria development for mine electrical engineers - Monitor and advise on remote control through RCEAG - Refine remote control use guidelines - All Incidents of unplanned movements of radio remote controlled machines investigated
		3. Unexpected activity/action of plant, including microprocessor controlled - longwall systems, other mobile machines, conveyors, other fixed plant, automated systems (longwalls and LHD's) - Maintainability (designed to maintenance and competency of maintainer to commission and operator in addition to electrical competencies)	3 Functional safety approach taken - designed to a set specification; - maintained to a set specification; - associated isolation procedures to a set specification - maintainability designed into the plant - Incidents investigated	3. Development of Technical reference for electrical engineering management plans - Participate on Australian Standard Committees for electrical wiring of machines, functional safety of machines and mining machines. - Facilitate the adoption of functional safety by industry - Competency criteria development for mine electrical engineers - All Incidents of involving unplanned movement are investigated
Asphyxiation/poisoning caused by insulation combustion (Fire caused by failure of electrical	Prevention of fires caused by the malfunction of electrical plant.	1. Legislation does not provide for electrical engineering safety that is better than non-mining industry		1. Legislation provides for a level of electrical engineering safety that is better than general industry. AS/NZS3000 and AS3007 compliance is an absolute minimum

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plant) **Uncontrolled risk** ALL mines = EXTREME (A1) **Controlled risk** ALL mines = MEDIUM (F1) Non electrical risk controls reduce the risk to LOW		2. Failure of electrical plant • Failure of insulation • Incorrect rating of electrical plant. • Overloaded plant • Damaged plant • Oil filled transformers • Design of electrical switch rooms, • misuse of switch rooms • switchgear maintenance.	2. Only plant and switch rooms that conforms to set specifications is used at mines. - designed to a set specification; - installed to a set specification; - maintained to a set specification; - overhauled to set specification - Fault level controlled, - arc blast areas defined, - arc fault containment specified in apparatus,	2. Development of Technical reference for electrical engineering management plans • Development of a technical reference for design principles of electrical plant and installations • Competency criteria development for mine electrical engineers. • Only electrically qualified people do electrical work • Development of a Technical Reference for the Control and Supervision of electrical work. • Participate on Australian Standard Committees for electrical plant and installations at mines
		3. Failure to install and commission electrical plant properly	3. Plant installed and commissioned properly and in accordance with AS/NZS3000 • Electrical work done by or supervised by qualified electrical people • Electrical work tested by qualified electrical people • Electrical work notified to responsible persons	3. Assessment of mines against AS/NZS3000 and EEMP's • Competency criteria development for mine electrical engineers. • Development of a Technical Reference for the Control and Supervision of electrical work. • Develop handbook on HV practices at U/G mines.
		4. Failure of earthing systems.	4. Earthing systems are designed, verified and maintained to a set specification	4. Development of protection and earthing technical reference
		5. Failure of electrical protection.	5. Electrical protection is designed, verified and maintained to a set specification	5. Development of protection and earthing technical reference • Participate on Australian Standard Committees for electrical protection plant at mines
		6. Failure of lightning protection systems.	6. Lightning protection is designed, verified and maintained to a set specification	6. Development of protection and earthing technical reference
		7. Failure of removal/restoration of power procedures. - Failure to turn off the power - Ability to disconnect power without entering risk area. - Documented isolating points	7. Mines have rules for the removal and restoration of power to all electrically powered plant to a set specification	7. Development of technical references for removal and restoration of power. • Development of Isolation Guidelines • Development of technical reference for EEMP's
		8. Failure of electrical testing	8. Mines have rules for electrical testing, to a set	8. Development of portable plant practice technical reference

EES Key Risk Area	Electrical Engineering Safety Element	Problem area	Risk Controls implemented by mines	DPI actions to facilitate risk control implementation (seminars, safety alerts, toolbox talks, competency development, mine site assessment of problem areas and risk controls, investigations of incidents, development of standards/codes/guidelines, development of third party test/assessment/audit/certification schemes)
		procedures.	specification	• Participate on Australian Standard for safe work on low voltage plant
		9. Failure of signage	9. Mines have set specifications for signage. and oversighted by a person with set competencies	9. Development of a technical reference for EEMP's
		10. Failure of welding plant & procedures.	10. Welding systems and plant: - designed to a set specification; - maintained to a set specification; - used to a set specification;	10 Assess welding plant at mines on a routine basis
		11. Cables and overhead lines underrated, overloaded or poorly located	11. Overhead cables and lines - designed to a set specification; - installed to a set specification; - maintained to a set specification; - Procedures for working near overhead lines - Signage and barriers	11.Assessment of OHL management on a routine basis. - Promote Safe Mining Guidelines and Workcover CoP
		12. Failure to respond properly to fires on electrical plant.	12. Mine emergency systems include provisions for fire on electrical plant	12.Development of technical references for rEEMP's. - Investigate all electric fires
		13. Catastrophe failure of batteries	13. Accumulation of gases diluted to a safe level, short-circuiting of terminals prevented, and use of correct PPE (insulated tools and gloves, goggles/face shields).	13.Investigate all incidents involving injury from battery failures.
		14. Failure of fire detecting and fighting plant	14. Fire detection and suppression is designed, verified and maintained to a set specification Incidents investigated	14.Investigate all incidents involving injury from battery failures
		15. Lightning strikes • Plant fires and explosions due to failure	15. Lightning protection systems are: - designed to a set specification; - maintained to a set specification;	15. Development of protection and earthing technical reference
Electrical Shotfiring U/G coal Surface & metals	Prevention of injury and death from unintended operation, failure to stop or failure to operate of electrically powered or controlled plant.	1. Premature ignition of shots and explosives. - Misfire - Use of electronic firing systems - Effects of lightning	1. Electrical shotfiring plant, is: - designed to a set specification; - overhauled to set specification; - maintained to a set specification; - electronic systems use a functional safety approach	1. Develop registration criteria for electric shotfiring plant • Registration of underground coal mining shotfiring plant. • Participate on Australian Standard Committees for functional safety of machines. • Facilitate the adoption of functional safety by industry

EES Key Risk Area	Electrical Engineering Safety Element	Problem area	Risk Controls implemented by mines	DPI actions to facilitate risk control implementation (seminars, safety alerts, toolbox talks, competency development, mine site assessment of problem areas and risk controls, investigations of incidents, development of standards/codes/guidelines, development of third party test/assessment/audit/certification schemes)
This is seen as a mining issue. However, there are particular electrical issues that arise		- Stray currents (ground fault) - EMR sources 2. Damage to electrical plant from shotfiring	Magazines are: • designed to a set specification; • maintained to a set specification; Earthing systems are: • designed to a set specification; • maintained to a set specification; Lightning protection systems are: • designed to a set specification; • maintained to a set specification; Control of external sources of electricity that may affect electrical shotfiring plant (including PED aerials and other radio signals, isolation procedures of electrical) Use OF electronic type shotfiring systems subject to risk assessment 2. Shotfiring to incorporate removal and restoration of power.	• Advise Mining personnel on electrical requirements for magazines, earthing and potential electrical shotfiring initiation sources (stray currents etc) • Advise mining personnel on electrical matters related to misfires 2. Develop technical reference for the removal and restoration of power.
Radiation energy sources **Uncontrolled risk** ALL mines = HIGH (B4) **Controlled risk** ALL mines = LOW (F4)	Prevention of electrical burns, including electrically induced radiation burns.	1. Failure to manage the electrical safety aspects of radiation energy sources (X-ray, Gamma- ray, Microwaves, EMF) 2. Failure to mange lasers	1. Mines to include radiation management in the OHSMS and to appoint a radiation control officer. 2. Lasers used in accordance with Australian standards	1. Develop technical reference for EEMP's 2. Lasers used in accordance with Australian standards
Carcinogenic substances & Asbestos **Uncontrolled risk** ALL mines = MEDIUM (D3) **Controlled risk** ALL mines = LOW (F3)	OHS General	1 PCB's, Asbestos in old switchboards, Asbestos in old AC welders and SF6	1. PCB's removed from site, Old switchboards replaced, Welders replaced and SF6 switchgear properly maintained	1. Develop technical reference for EEMP's
Chemical sources. This is seen as a general issue. However, there are particular electrical issues that arise	OHS general	1 Solvents, encapsulations, compounds, oils, greases, aerosols, paints, descalers, acids	1 MSDS • Materials register • Procedures of use	Develop technical reference for EEMP's

EES Key Risk Area	Electrical Engineering Safety Element	Problem area	Risk Controls implemented by mines	DPI actions to facilitate risk control implementation **(seminars, safety alerts, toolbox talks, competency development, mine site assessment of problem areas and risk controls, investigations of incidents, development of standards/codes/guidelines, development of third party test/assessment/audit/certification schemes)**
Communications and emergency preparedness This is seen as a mining issue. However, there are particular electrical issues that arise	Emergency response plan including communication support system	1. Deficient electrical infrastructure • IS plant, • backup power supplies (UPS), • systems redundancy, • installation of communications cables to be protected from explosion. • Electrical isolation points in emergency. • Emergency lighting. • Gas monitoring systems.	1.Emergency management system and associated infrastructure to be highly reliable and include the following elements: • IS plant, • backup power supplies (UPS), • systems redundancy, • installation of communications cables to be protected from explosion. • Electrical isolation points in emergency. • Emergency lighting. • Gas monitoring systems	1. Advise mining personnel on electrical engineering aspects. • Assess Mine rescue Service life-cycle management of plant • Technical reference for EEMP's

Electrical Engineering Safety Risk Ranking

Key Risk Areas for Electrical Engineering Safety

Ranking the key risk areas is based on the uncontrolled risk and the number of people exposed to the risk and the industry performance with regard to related incidents. It is also recognised that many of the key risk areas require non-EES risk control and EES risk controls to adequately manage the risk.

Electrical Key Risk Areas in risk ranking order

1. Electrocution, electric shock and electric burns, incorporating failure of distribution systems (reasonable consequence is 1 fatality per event, although multiple fatalities have occurred).
2. Asphyxiation/poisoning caused by insulation combustion (Fire caused by failure of electrical plant). (reasonable consequence is 10 or more fatalities in one event)
3. Explosion or fire caused by electrical plant in a gas or dust hazardous area, incorporating failure of ventilation systems (reasonable consequence is 10 or more fatalities in one event.
4. Failure of transport systems for people safety – Mine winders. (reasonable consequence is 10 or more fatalities in one event – much larger numbers could occur at some mines with shaft winders)
5. Failure of Machine Control electric's. (reasonable consequence is 1 fatality per event)
6. Radiation, harmful energy sources. (consequence is generally long term)
7. Carcinogenic substances & asbestos (consequence is generally long term)
8. Chemical sources (General OHS risk area)
9. Electrical Shot firing. (reasonable consequence is 1 fatality per event)
10. Mine emergency system infrastructure (Mining risk area)

Key Risk Controls for Electrical Engineering Safety

The elements required as a minimum to safely manage the use of electricity (These elements were identified via a risk assessment conducted and regularly reviewed by Mine Safety operations electrical engineering staff.)

Note: Where mines do not have hazardous zones or hazardous areas then it can be considered that the risk of explosions from hazardous areas is adequately managed.

- Electrical technology management systems incorporating emergency management and incident investigation
- Competency (of people engaged in electrical plant and systems throughout the life cycle).
- Fit for purpose (FFP) electrical plant.
    - Electrical protection
    - Earthing and lightning protection
    - Electrical plant (cables and apparatus) in non hazardous areas (HV, LV, ELV)
    - Machine (M/C) Control circuits - Functional safety, Field devices = ELV
    - Electrical plant (cables & apparatus) in a hazardous zone (includes gas monitoring) (HV, LV, ELV)
    - Signage
- Safe Procedures
    - Hazardous zone classification and identification
    - Removal/restoration of power procedures
    - Isolation procedures
    - Electrical testing procedures
    - Electric welding procedures
    - Electric shock and burn protocols
    - Use of portable apparatus U/G (underground)
    - Use of remote controlled plant
    - High Voltage procedures
    - Work near overhead lines

Relationship Between Key risk areas & Key Risk Controls

Electrical Engineering Safety Risk controls	Electrical Engineering Safety Key Risk Area
Electrical technology management systems incorporating incident investigation	1,2,3,4,5,6,7,8,9,10
Competency	1,2,3,4,5,6,7,8,9,10
Fit for purpose (FFP) electrical plant.	1,2,3,4,5,6,7,8,9,10
➢ Electrical protection	1,2,3,4,5
➢ Earthing and lightning protection	1,2,3,4,5,9
➢ Electrical plant (cables and apparatus) in non hazardous areas ➢ HV ➢ LV ➢ ELV	1,2,6,7,8,9,10
➢ Control circuits & safeguards (Machine (M/C) Control circuits) ➢ Functional safety ➢ Field devices = ELV	1,2,3,4,5,9,10
➢ Electrical plant (cables and apparatus) in a hazardous zone (includes gas monitoring)	1,2,3,5,9,10
➢ Signage	1,2,3,5,9,10
Safe Procedures	
➢ Hazardous zone classification and identification	3,9,10
➢ Removal/restoration of power procedures	1,2,3,6,10
➢ Isolation procedures	1,2,3,4,5,6,7,8,9,10
➢ Electrical testing procedures	1,3,4,5,6,9
➢ Electric welding procedures	1,2,3,6,9
➢ Electric shock and burn protocols	1,10
➢ Use of portable apparatus U/G	1,3,9,10
➢ Use of remote controlled plant	5,10
➢ High Voltage procedures	1,2,3,10
➢ Work near overhead lines	1,10

Key Risk Controls for Electrical Engineering Safety & Supporting Information

General information is available in: AS/NZS 3000, AS 3007 & Minerals Industry safety Handbook (section 4.8). **Note:** EES documents reference other standards.

Electrical risk controls	Key Supporting Information
Electrical technology management systems incorporating incident investigation	EES001, AS/NZS4801
Competency	EES001, EES002, AS/NZS 4761
Fit for purpose (FFP) electrical plant.	EES001, EES011, AS4871 (U/G Mines), MDG15 (Mobile and Transportable Plant for Use in Mines – Surface applications), AS 4242 (Automotive wiring)
➢ Electrical protection	EES005
➢ Earthing and lightning protection	EES005
➢ Electrical plant (cables and apparatus) in non hazardous areas ➢ HV ➢ LV ➢ ELV	EES001, EES002, HB242 (in draft), EES011
➢ Control circuits & safeguards (Machine (M/C) Control circuits) ➢ Functional safety ➢ Field devices = ELV	MDG2005 (Winders), EES008 (Winders - in draft), EES009 (Winders - in draft), AS4024, AS/NZS4240, AS60204, AS61508, AS62061, EES011, AS61511
➢ Electrical plant (cables and apparatus) in a hazardous zone (includes gas monitoring)	EES003, EES010 (in draft), AS/NZS 60079, AS/NZS2290.1 & 3, AS/NZS2381, AS/NZS3800, AS/NZS 1020, EES007, AS/NZS1747, AS/NZS1802, AS/NZS1972 EES003, EES010 (in draft), AS/NZS 60079, AS/NZS2290.1 & 3, AS/NZS2381, AS/NZS3800, AS/NZS 1020, EES007, AS/NZS1747~~, AS/NZS1802, AS/NZS1972~~
➢ Signage	EES001
Safe Procedures	
➢ Hazardous zone classification and identification	EES003
➢ Removal/restoration of power procedures	EE006
➢ Isolation procedures	MDG40
➢ Electrical testing procedures	EES004, HB187
➢ Electric welding procedures	AS/NZS1674.2, WTIA TN 7-98, MDG25
➢ Electric shock and burn protocols	Development yet to commence.
➢ Use of portable apparatus U/G	EES004
➢ Use of remote controlled plant	AS/NZS4240, MDG5002
➢ High Voltage procedures	EES001, HB242 (In draft)
➢ Work near overhead lines	EES001, Workcover CoP