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Recognised Standard 01

Underground electrical equipment and electrical installations

Coal Mining Safety and Health Act 1999

Resources Safety & Health Queensland

Contents

Recognised Standards may be updated from time to time. To ensure you have the latest version, check the website: https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/legislation-standards or contact your local office.

This publication has been compiled by the Resources Safety and Health Queensland.

Interpreter statement:

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Recognised standards

This document is issued in accordance with PART 5—RECOGNISED STANDARDS and section 37(3) of the *Coal Mining Safety and Health Act 1999*.

PART 5 - RECOGNISED STANDARDS

71 Purpose of recognised standards

A standard may be made for safety and health (a "recognised standard") stating ways to achieve an acceptable level of risk to persons arising out of coal mining operations.

72 Recognised standards

(1) The Minister may make recognised standards.

(2) The Minister must notify the making of a recognised standard by gazette notice.

(3) The CEO must publish on a Queensland government website each recognised standard and any document applied, adopted or incorporated by the standard.

(4) In this section—

Queensland government website means a website with a URL that contains 'qld.gov.au', other than the website of a local government

73 Use of recognised standards in proceedings

A recognised standard is admissible in evidence in a proceeding if—

(a) the proceeding relates to a contravention of a safety and health obligation imposed on a person under part 3; and

(b) it is claimed that the person contravened the obligation by failing to achieve an acceptable level of risk; and

(c) the recognised standard is about achieving an acceptable level of risk.

PART 3 - SAFETY AND HEALTH OBLIGATIONS

37 How obligation can be discharged if regulation or recognised standard made

(3) …. if a recognised standard states a way or ways of achieving an acceptable level of risk, a person discharges the person's safety and health obligation in relation to the risk only by—

(a) adopting and following a stated way; or

(b) adopting and following another way that achieves a level of risk that is equal to or better than the acceptable level.

Where a part of a recognised standard or other normative document referred to therein conflicts with the *Coal Mining Safety and Health Act 1999* or the Coal Mining Safety and Health Regulation 2017, the Act or Regulation takes precedence.

Issued under the authority of the Minister for Resources and Critical Minerals.

Gazetted 21 June 2024

1.0 Purpose

The purpose of this standard is to establish the minimum standards for the selection, installation, maintenance and operation of electrical equipment and electrical installations in an underground coal mine. It provides a managed approach to achieve an acceptable level of risk to persons in relation to Chapter 2 Part 4 All coal mines – Electrical activities, equipment and installations, Chapter 4 Part 5 Underground mines of the Coal Mining Safety and Health Regulation 2017. It also provides guidance in relation to the control of undesirable static electricity.

2.0 Scope

This standard applies to electrical equipment and electrical installations in an underground coal mine and electrical equipment and electrical installations on the surface directly associated with the underground operations of a coal mine. This standard also applies to equipment or installations that may be impacted by electrical energy e.g. Lightning strike, static electricity, voltage surges and other transient voltages to within acceptable limits. This standard does not apply to the general surface of an underground coal mine.

3.0 Application Framework

The electrical equipment and electrical installations in an underground coal mine require high standards of design, installation, and maintenance, particularly in the hazardous areas of the mine – referred in this standard as “explosion risk zones”. To this end reliance on standard or normal electrical equipment and electrical installations is not sufficient to achieve the necessary levels of risk. This standard indicates the additional requirements that may be necessary to achieve an acceptable level of risk.

4.0 Technical Guidance

4.1 General

Electrical installations should be of a design and standard in accordance with AS/NZS 3000:2018 Electrical Installations (known as Australian/New Zealand Wiring Rules) where applicable.

4.2 Hazard Identification

Identification of the potential hazards of the operation of electrical equipment and installations must be taken into account to ensure that the risk to the safety and health of persons is to an acceptable level.

4.3 Isolation of Equipment

Electrical equipment and cable connectors, other than intrinsically safe (IS) and extra low voltage (ELV) circuits, must be provided with facilities for locking the electrical supply in a safe or isolated position.

4.4 Electrical Equipment in an Explosion Risk Zone (ERZ)

Fixed, mobile, portable and transportable, electrical equipment, other than electrical equipment associated with hot work or live testing, installed or operated in an ERZ must be suitably certified by a nationally accredited testing station as listed in Clause 4.6 and constructed, installed and operated in accordance with the relevant standards listed in Clause 6 References – Normative Standards.

Note 1: Portable electrical equipment is covered under section 4.13

Note 2: Simple apparatus, AS/NZS 60079.11, need not be certified by a nationally accredited testing laboratory but compliance with the requirements of AS/NZS 60079.11 shall be demonstrated by the manufacturer or intrinsically safe system designer in accordance with the requirements of AS/NZS 60079.11. Also refer to AS/NZS 60079.14

Note 3: Cables must comply with the applicable standards listed in clause 6 references normative standards but do not need to be certified.

Note 4: Explosion protected electrical equipment that is only Queensland Mines Department (QMD) approved will no longer be allowed to be used in an ERZ 1 after 1 September 2028.

The equipment must be suitable for use in an underground coal mine.

4.5 Protection Techniques

Protection techniques for electrical equipment and electrical installations in ERZ		
Type of Protection	**Relevant Australian Standard and symbol**	**Remarks**
ERZ0		
Intrinsic safety "i"	AS/NZS 60079.11 Ex ia	Or equivalent IEC standard
Special protection “s”	AS/NZS 60079.33 Ex sa AS/NZS 1826 Ex s	In accordance with Zone 0 classification
Encapsulation “m”	AS/NZS 60079.18 Ex ma	**Current Regulations do not permit this technique.**
Caplights for use in mines susceptible to firedamp	AS/NZS 60079.35.1 Ex l	
Protection of equipment and transmission systems using optical radiation	AS/NZS 60079.28 Ex op is	**Current Regulations do not permit this technique.** In accordance with Zone 0 classification
ERZ1		
Intrinsic safety "i"	AS/NZS 60079.11 Ex ia or Ex ib	Or equivalent IEC standard
Special protection “s”	AS/NZS 1826, AS/NZS 60079.33 Ex sa or Ex sb	In accordance with Zone 1 classification
Equipment protection by flameproof enclosures ‘d’	AS/NZS 60079.1 Ex da or Ex db	
Encapsulation “m”	AS/NZS 60079.18 Ex ma or Ex mb	
Pressurized enclosure ‘p’	AS 2380.4 / AS/NZS 60079.2 Ex px	
Increased safety "e"	AS/NZS 60079.7 Ex ea or Ex eb	
Oil immersion ‘o’	AS/NZS 60079.6 Ex o	
Powdered filling 'q'	AS/NZS 60079.5 EX q	
Protection of equipment and transmission systems using optical radiation	AS/NZS 60079.28 Ex op is or Ex op pr or Ex op sh	In accordance with Zone 1 classification. See 4.25
Negligible-Explosion Risk Zone (NERZ)		
Ex protected equipment and maintained or at least IP55	AS 60529 or IEC 60529 or equivalent	IP rated equipment to IP55 or IP56
Pressurized room "p"	AS/NZS 60079.13 Ex pb	

Equipment suitable for use in ERZ0 can also be used in ERZ1. Equipment suitable for use in an ERZ1 can also be used in a Negligible-Explosion Risk Zone (NERZ).

ERZ0, ERZ1 and NERZ are as defined in the Coal Mining Safety and Health Regulation 2017. AS/NZS or equivalent IEC standards are acceptable for all standards listed in section 4.5.

4.6 Nationally Accredited Testing Stations

The following organisations are currently nationally accredited testing stations for certification of Explosion Protection Electrical Equipment (EPEE):

Simtars
2 Robert Smith Street
REDBANK QLD 4301

TestSafe Australia (TSA)
919 Londonderry Road
LONDONDERRY NSW 2573

Ex Testing and Certification Pty Ltd (ExTC)
30 Kennington Drive
TOMAGO NSW 2322

The following organisations were previously nationally accredited testing stations for certification of EPEE:

- Londonderry Occupational Safety Council (LOSC)
- International Testing and Certification Services (ITACS)
- TUV Rheinland Australia (TRA)
- Mine Safety Technology Centre (MSTC)

4.7 Location of Electrical Equipment

The installation of underground electrical equipment, other than portable or mobile equipment, signalling equipment or telephones and accessories, should be subject to the following requirements:

4.7.1 The equipment should be housed in a room, recess or area set aside for the purpose.
4.7.2 The room, recess or area should be constructed to provide adequate height and working space.
4.7.3 Flammable material should not be stored in any location adjacent to electrical equipment.
4.7.4 The room, recess or area should be constructed so as to protect the equipment from damage by falls of ground and must be kept clean of all debris.
4.7.5 The room, recess or area should be adequately ventilated, having regard to the type of equipment and its use.
4.7.6 The room, recess or area should have adequate lighting.
4.7.7 The room, recess or area should be constructed so as to protect against contact with mobile equipment.
4.7.8 The room, recess or area should be constructed to protect against water ingress or pooling of water around the equipment.

4.7.9 Active gas drainage outlets and piping must not be in the room or recess where electrical equipment is located.

4.7.10 Coal mine workers accessing electrical operating areas must be made aware of the electrical hazards.

4.8 Liquid Filled Electrical Transformers, Magnets and Switchgear

4.8.1 Installation

4.8.1.1 A formal risk assessment must be undertaken prior to the installation and operation of liquid filled electrical transformers, magnets and switchgear.

4.8.1.2 Electrical transformers, magnets and switchgear containing liquid must not be installed within 25 metres of any shaft bottom, or within 25 metres of where any roadway, drive, drift or other passage opens into the shaft.

4.8.1.3 A transformer of the liquid immersed type should be placed in or above a specially prepared sump or container capable of containing the liquid content of the transformer. Refer **AS 1940:2017** The storage and handling of flammable and combustible liquids for guidance.

4.8.1.4 There must be no combustible material exposed or stored in any roadway, room or recess that is used for housing electrical equipment containing combustible liquid.

4.8.1.5 The location of electrical transformers, magnets and switchgear containing combustible liquid should be ventilated with a provision for short-circuiting to return airway the products of combustion if a fire occurred.

4.8.2 Operation

4.8.2.1 Over-temperature protection should be provided on liquid immersed transformers and magnets for liquid and windings. In the event of a high temperature being detected the power to the transformer must be automatically disconnected.

4.8.2.2 The liquid contained in electrical equipment should be such that infrequent contact will not result in long-term health problems.

4.9 Maintenance of Explosion Protected Equipment

The maintenance of electrical equipment installed and/or operated or intended to be installed and/or operated in an ERZ0 or ERZ1 should be in accordance with the relevant Australian Standards.

The overhaul and repair of electrical equipment installed in an ERZ0 or ERZ1 must be conducted by an Australian recognised service facility or an IECEx Certified Service facility (refer to ANZEx or IECEx websites).

Like for like replacement of components is not considered a repair.

The pre-overhaul audit of electrical equipment installed in an ERZ0 or ERZ1 must be conducted by an Australian recognised service facility or an IECEx Certified Service facility (refer to ANZEx website or IECEx websites).

4.10 Maintenance of Electrical Equipment and Electrical Installations

A system of planned maintenance, including the maintenance of relevant records, must be implemented, and maintained for all electrical equipment and electrical installations.

4.11 Inspection and Testing

4.11.1 Routine testing

4.11.1.1 The frequency with which the routine inspections and tests of the electrical equipment and electrical installations at the mine are to be carried out, must be developed and recorded.

4.11.1.2 Routine testing of the electrical equipment and electrical installations including earthing and lightning protection systems must be carried out by competent persons using appropriate testing equipment.

4.11.1.3 The following routine inspections and tests of electrical equipment and electrical installations must be carried out:

4.11.1.3.1 An inspection of all electrical equipment including the enclosure, doors and covers of all electrical switchgear used at the mine, and all earthing conductors.

4.11.1.3.2 A test of the insulation of every electrical lighting and power circuit below ground, including all electrical equipment forming part of, or in connection with such circuits, either collectively or in parts. Double insulated and Intrinsically Safe equipment does not require this insulation test, but a visual inspection must be conducted.

4.11.1.3.3 A test of the electrical conductance of all earthing and bonding conductors and metallic coverings if used as an earth path.

4.11.1.3.4 Inspections of electrical equipment in explosion risk zones must be carried out in accordance with **AS/NZS 2290.1:2021** Electrical equipment for coal mines – Introduction, inspection and maintenance – Part 1: For hazardous areas.

4.11.1.3.5 Earth leakage and earth continuity protection functionality tests should be conducted on ERZ1 equipment daily, Transformers supplying ERZ1 equipment weekly, NERZ equipment monthly and diesel machine alternators weekly.

Note: Refer to clause 4.26 for IS Circuit information and testing

4.11.2 New and Overhauled Equipment

All new and overhauled electrical equipment and electrical installations, including equipment relocated in a new position in the mine, must be examined and tested before being put into service.

4.11.3 Recording of tests

The results of the tests and examinations prescribed in 4.11 must be recorded and maintained by the site.

4.12 Routine Testing of High Voltage Installations

Routine testing of all high voltage apparatus and cables should be carried out at intervals not exceeding 12 months. Variance to this frequency must consider the following factors including:

- the history of previous faults and failures.
- equipment usage.
- age
- history of operation of protection systems
- manufacturer's recommendations; and
- backup protection.

4.13 Operation of Portable Electrical Equipment

Portable electrical equipment should be effectively managed and tracked whilst underground (e.g. managed via a register or by tracking tag). This is to ensure that equipment is not inadvertently left underground and is adequately maintained and stored appropriately if left for an extended period.

4.13.1 The use of certified portable electrical equipment in an ERZ

Portable electrical equipment operated in an ERZ should be suitably certified by a nationally accredited testing station and constructed and operated in accordance with the certificate of conformity.

4.13.2 The use of uncertified portable electrical equipment in an ERZ

4.13.2.1 Uncertified portable electrical equipment must not be operated in an ERZ0.

4.13.2.2 Uncertified portable electrical equipment must not be used in an ERZ1 if certified electrical equipment is available that is suitable for the task. Even then, the use of portable uncertified electrical equipment in an ERZ1 is only be undertaken where the use of the equipment does not create an unacceptable level of risk.

4.13.2.3 A formal risk assessment must be undertaken prior to the use of uncertified portable electrical equipment in an ERZ. The results of the risk assessment must be documented, and an operating procedure developed there from. Hazards that must be considered for the risk assessment include:

- voltage levels
- power
- chemical compositions (refer to Safety Data Sheet)
- battery propensity for thermal runaway (Maximum battery operating temperature)
- environment
- operating temperature
- loss or misplacement of UPEE device
- emergency response in the event of fire or damage
- removal of all uncertified portable equipment in the event of evacuation from that part of the mine
- possible failure modes of the equipment.

A Risk management process for each individual item must be undertaken prior to use underground.

4.13.2.4 Only persons authorised in writing by the underground mine manager and the electrical engineering manager (EEM) are permitted to operate the equipment.

4.13.2.5 Prior to taking the equipment underground it must be inspected by appropriately qualified electrical personnel authorised by the EEM and must not be dismantled for adjustment of internal circuitry or repaired underground.

4.13.2.6 After use the equipment must be withdrawn from the mine.

In NERZ, electrical test equipment may, when not in use, be securely stored until the end of the shift in a location approved by the EEM.

4.13.2.7 The Underground Mine Manager must ensure that the equipment is not to be used in any location where the percentage of methane in the general body of air exceeds 0.5% by volume.

4.13.2.8 Any batteries used by the equipment must not be replaced underground.

4.13.2.9 When not securely stored as per 4.13.2.6 the equipment must be always accompanied by a person trained in the use of, and must have in their possession, a certified continuously reading portable gas detector with its methane alarm pre-set to activate at 0.5% by volume. The ERZ controller must be advised of the presence of the equipment in their district.

4.13.2.10 Should any defect on the equipment or the portable gas detector be detected at any time, the equipment must be immediately withdrawn from underground.

4.13.2.11 Persons authorised under subclause 4.13.2.4 of this standard must make a record on the use of this equipment. The record must be kept at the mine and must include as a minimum the name of persons, date, time the equipment was underground, and a statement confirming that subclauses 4.13.2.1 to 4.13.2.9 have been fulfilled.

4.13.2.12 Upon failure of the mine ventilation system in the area where the equipment is being used or stored, the equipment must be withdrawn from that area of the mine immediately.

4.13.3 The storage of automated external defibrillators (AEDs) in a NERZ

4.13.3.1 A formal risk assessment must be undertaken prior to the storage of AEDs in a NERZ. The results from the risk assessment must be documented and an operating procedure developed there from.

4.13.3.2 The equipment must be transported and stored in an IP66 container or enclosure (i.e. rugged transport case).

4.13.3.3 Stored equipment have a routine weekly inspection as part of the maintenance management system.

4.13.3.4 Should any defect on the equipment be detected at any time, the equipment must be immediately withdrawn from underground.

4.13.3.5 Stored equipment must be in a secure location (e.g. cribroom).
4.13.3.6 Battery lifecycle replacement of the equipment must meet manufacturers specifications and replaced on the surface of the mine.
4.13.3.7 Upon failure of the mine ventilation system in the area where the equipment is being stored, the equipment must be withdrawn from that area of the mine immediately.
4.13.3.8 The equipment must only be energised and used in the case of an emergency.

4.14 Selection, Installation and Use of Cables

The selection, installation and use of cables in an underground coal mine should be in accordance with the following Australian Standards:

AS/NZS 1747:2022 Reeling, trailing and feeder cables used for mining – Repair, testing and fitting of accessories.

AS/NZS 1802:2018 Electric cables – Reeling and trailing – For underground coal mining purposes.

AS/NZS 1972:2006 Electric cables – Underground coal mines - Other than reeling and trailing.

Cables selected and installed outside the above standards will be assessed against hazards associated with their expected use. Cables incorporated with certified equipment are deemed to have satisfied the electrical parameters however, assessment for mechanical protection should be considered.

4.15 Selection, Installation and Use of Cable Plugs, Receptacles, Couplings and Glands

The selection, installation and use of cable plugs, receptacles, couplings and glands in an underground coal mine should be in accordance with the following Australian Standards:

AS/NZS 1299:2022 Electrical equipment for mines and quarries – Explosion-protected three-phase plugs and receptacles for working voltages up to and including 3.3 kV

AS/NZS 1300:2009 Electrical equipment for mines and quarries – Bolted explosion-protected three-phase cable coupling devices

All cable plugs, receptacles, couplings and glands must be suitably certified in accordance with the relevant Australian Standard.

Note: AS 1299:2022 has been published and has combined AS/NZS 1299 & AS/NZS 1300.

AS 1147.1 – 1989 Electrical equipment for coal mines – Insulating materials – Materials for insulating power conducting components may be used to show compliance for filling compound used in plugs, receptacles, couplings and glands.

4.16 Protection of Circuits on Mobile Diesel Equipment

The design, installation and maintenance of electrical circuits on mobile diesel machinery at the mine must provide for the reliable circuit interruption under fault conditions.

Diesel machinery requires:

- A detailed inspection schedule must be formulated with reference to relevant standards and must ensure that cables are secure and free from damage. Particular focus should be given to machine articulation points and areas where cables are exposed to risk of damage.
- Mobile machines require the use of enhanced over-current and earth fault protection devices. On explosion protected diesel vehicles, electrical circuits to provide reliable circuit interruption under fault conditions, including where fault current and load current are difficult to distinguish between.
- Testing of the functionality of protection circuitry must be conducted with the test point at the end of the longest cable run.

Note: Replacement of lower wattage equipment may cause protection circuitry to not function as designed due to the reduction in power load (e.g. lower wattage non intrinsically safe LED lights have caused protection circuits not to work in some circumstances).

4.17 Prevention of Ignition of Flammable Gas, Combustible Dust, Explosives or Combustible Material

The design, construction, installation and use of cables must be such as to reduce the risk of causing an ignition of any flammable gas, combustible dust, explosives or material within the mine or initiating detonators due to the effects of electromagnetic or electrostatic fields. Where explosives are involved, consideration should be given to: AS/NZS 2187.2: 2006 Explosives storage and use.

4.18 Protection of Cables in Shafts and Boreholes

All cables used in shafts and boreholes must be adequately supported, protected, and restrained.

Measures to prevent the build-up of static charges on such cables should be considered.

4.19 Protection Against Extraneous Voltages

4.19.1 Electrical systems, metallic and non-metallic piping arrangements and structures must be designed to prevent the conductance of the adverse effects of lightning and/or voltage surges into the mine. Consideration should be given to AS 1768:2021 Lightning protection.

4.19.2 Electrical systems, metallic and non-metallic piping arrangements and structures must be designed to prevent the build-up of static electricity.

4.19.3 Electrical systems, metallic and non-metallic piping arrangements and structures entering the mine must be designed to prevent any adverse effects from electrical faults on incoming electrical circuits and any electrical circuits traversing the mine, and any touch potential rise must be limited to acceptable levels. Where VSD drives are used in an underground mine or connected to underground workings, risk controls must be verified by a suitably qualified electrical engineer and in place to ensure the effectiveness of:

- earth leakage system operation.
- earth fault limitation.
- touch and step potential.
- interference with other electrical systems.
- prevention of an arcing fault where faults occur.
- adequate control of functional earthing (circulating currents).
- detection, indication or interlocking in the event of harmonic filter failure.

4.19.4 Electrical cables that have been withdrawn from service must be decommissioned and the exposed conductors managed as per AS/ NZS60079: 17 clause 4.6. Where explosives mixtures of gases may accumulate in unventilated, abandoned workings and sealed areas, consideration should be given to the removal of all conductive cables, pipes and other metallic structures.

4.20 The Control of Undesirable Static Electricity

Fire Resistance and Anti-Static (FRAS) Management

The control of static electricity in an underground mine should ensure that the following conditions are met, refer to AS/NZS 60079.14.

The control of undesirable static electricity in an underground coal mine should be in accordance with SA TS 60079.32.1:2022. Note that AS/NZS 1020: 1995 has been revised and is applicable to non-hazardous areas.

4.20.1 Nonferrous and non-metallic air/gas pipelines and venturis.

- Refer to AS/NZS 60079.14 for guidance and a procedure must be in place for the installation of such pipelines and venturis and be part of the safety and health management system.
- A positive restrained method of bonding an earth to the coupling of each pipe or venturi must be in place.
- A drawing showing the bonding method must be included in the procedure.
- A drawing showing where the pipelines are installed throughout the mine is to be maintained up to date.
- The effectiveness of each earth bond is to be tested and recorded at regular intervals for fixed pipelines.
- The effectiveness of the earth bond on venturis must be identified in the mine's inspection regime
- An inspection regime is to be in place that ensures earth bonds on fixed pipelines are correctly installed and maintained.
- A maintenance regime is to be in place that ensures that each earth bond remains effective for the length of time the pipe is in service.
- A record of the results of regular testing of the earth bonds is to be kept in the mine record.
- For venturis that are regularly moved, strata and roof support resistivity checks should be part of the maintenance / inspection schedule.

4.20.2 Components and equipment identified as FRAS.

4.20.3 All equipment that is required to be FRAS is rated in accordance with the regulations.

4.20.4 FRAS rated equipment and components must be supplied with test results for all its types and variants. Conformation of the accuracy of the test results with ongoing use of the equipment and components is to be undertaken at regular intervals. Testing should be undertaken as per the requirements of MDG 3608.

4.20.5 A dossier of all FRAS rated equipment and components, along with supporting documentation and test results is maintained by the mine.

4.20.6 FRAS rated materials are to be adequately equipotential bonded to earth, where practicable, to ensure that a static charge cannot build up.

4.20.7 Adequate measures, including testing and inspections, are implemented to ensure the required FRAS properties are maintained and have not deteriorated over time.

4.21 Unattended Equipment

A person operating a mobile machine must not leave the controls (local or remote) of the machine while it is working. Before leaving the machine controls a person must ensure it cannot be inadvertently operated.

4.22 Battery Powered Mobile Equipment

4.22.1 General. Relevant equipment must comply with the requirements of AS/NZS 4871.5:2010 Electrical equipment for mines and quarries - Battery powered electrical mobile machines.

4.22.2 Construction of batteries. The construction of the terminal arrangement for batteries other than those classified as intrinsically safe must be in accordance with AS/NZS 60079.7:2016 Explosive atmospheres - Equipment protection by increased safety 'e'.

4.22.3 Construction of battery boxes. Battery boxes and the covers must be so constructed as to minimise accidental or unauthorised interference with the battery. If the batteries produce gas during charging, then the enclosure must be effectively ventilated. The covers must be kept securely locked except when in the charging or repair station.

4.22.4 Control and protection. Every battery-operated vehicle must be provided with suitably enclosed fuses or circuit breakers where required.

4.22.5 An ampere hour meter which must be connected at all times to indicate the condition of charge of the battery.

4.22.6 Earth or chassis Fault protection for the on-board DC battery system and AC systems.

4.22.7 Earth or chassis Fault protection for charging system prior to application of power.

4.22.8 Touch potentials generated as a result of a fault must be demonstrated as controlled and within the levels specified in AS4871.

4.22.9 Appropriate protection handshaking while charging.

4.22.10 Battery Management System monitoring every cell for lithium and other chemistries that are susceptible to charge imbalance.

4.22.11 Appropriate cooling system for the most onerous operating scenario, be that charging or discharge in operation.

4.22.12 Cell temperature monitoring.

4.22.13 Protection against over-charging and/or overheating by regeneration.

4.22.14 Battery operated vehicles in an ERZ1. Battery operated vehicles operated in an ERZ1 must be suitably certified by an accredited certification body (Ex CB) (Refer JAS-ANZ website) and be in accordance with the relevant Australian Standards.

4.22.15 Integrated ignition hazard assessment must be completed and cover electrical and mechanical aspects of the vehicle.

4.22.16 Battery operated vehicles operated in an ERZ0 or ERZ1 Lithium chemistries must be assessed against IEC62133-2, IEC60086-4 or UL1642, in addition to being suitably certified.

4.22.17 Battery operated vehicles in an NERZ. As a minimum shall establish the fundamental safety properties of the cells via assessment against IEC62133-2, IEC60086-4 or UL1642. Where that testing identifies a failure to a specific pass requirement (eg: susceptibility to thermal runaway) additional control measures must be applied, and the design assessed to reduce the probability of that event in an underground environment.

4.22.18 Fire Safety Considerations

4.22.18.1 Several battery chemistries (particularly lithium) are not fundamentally stable and can suffer thermal runaway and may result in a fire that is self-perpetuating or difficult to extinguish. The effects of heating (either self-heating from a short circuit or heating from an external source or fire) must be considered. Battery chemistries that are fundamentally stable are preferred for underground and confined space application. Battery cells that rely on a cooling system to maintain thermal stability must demonstrate reliable controls or safeguards against cooling system failures or where cooling is rendered inoperable.

4.22.18.2 Battery toxicity and by-products of combustion shall be tested and a report listing the chemicals present and relative quantities should be made available to the end user.

4.22.18.3 Firefighting and suppression techniques shall be made available to the end user.

4.22.19 Chargers

4.22.19.1 Switching power electronic equipment typically utilised for EV charging on the surface needs explicit review and consideration for use on earth fault limited networks underground. EMC capacitances as well as transient suppression are commonly installed in common mode on equipment designed for use on MEN (TN-C-S) earthing systems. These components may bypass the earth fault limitation that is fundamental to safe provision of power underground.

4.22.19.2 Electrical equipment contained on the vehicle or in associated equipment (chargers) used underground must limit the energy delivered in event of an earth fault for the ERZ it is in.

4.23 Power Transformers

4.23.1 General. The equipment must comply with the requirements of **AS/NZS 4871.3:2010** Electrical equipment for mines and quarries - Substations.

4.23.2 Power transformers in an ERZ1. Power transformers operated in an ERZ1 should be suitably certified by an accredited certification body (Ex CB) (Refer JAS-ANZ website) testing authority and be in accordance with the relevant Australian Standards.

4.24 Control of Electromagnetic Radiation

Australian Standard AS/NZS 60079.14 contains guidance for the design of electrical installations in managing radio frequency transmissions into the ERZ.

4.25 Fibre Optic Equipment

Fibre optic equipment should meet at least one of the following criteria:

- Exception from the scope of AS/NZS 60079.28:2016

Note: A Class 1 laser under AS/NZS IEC 60825.1 for use in a NERZ or ERZ1 meets the criteria.

- The requirements of AS/NZS 60079.28:2016
- The requirements of AS/NZS 60079.0:2019

4.26 Intrinsically Safe Power Circuits

4.26.1 Australian Standard AS/NZS 60079.14 contains the specific requirements for the design, selection and erection of electrical installations in hazardous areas associated with explosive atmospheres, this includes intrinsically safe equipment.

4.26.2 Australian Standard AS/NZS 60079.17 covers factors directly related to the inspection and maintenance of electrical installations within hazardous areas.

4.26.3 Australian Standard AS/NZS 60079.25 contains the specific requirements for construction and assessment of intrinsically safe electrical systems, type “i”.

4.26.4 Australian Standard AS 2290.1 contains guidance in relation to resistive type faults.
Note: AS/NZS 60079.14 states that a fundamentally different type of protection philosophy has to be recognised in the installation of intrinsically safe circuits. In comparison with all other types of installations, where care is taken to confine electrical energy to the installed system as designed so that a hazardous environment cannot be ignited, the integrity of an intrinsically safe circuit has to be protected from the intrusion of energy from other electrical sources so that safe energy limitation in the circuit is not exceeded, even when breaking, shorting or earthing of the circuit occurs. Because of this principle, the aim of the installation rules for intrinsically safe circuits is to maintain separation from other circuits. It also states that, in relation to section 7 Electrical Protection, the requirements of this clause are not applicable to intrinsically safe circuits. One of the requirements of section 7 is that short-circuit and earth fault protection devices shall be such that auto-reclosing under fault conditions is prevented.
Intrinsically safe power supplies typically do not have earth fault detection nor do they have a function to require a manual reset if an overload condition occurs.

4.26.5 In relation to intrinsically safe circuits at underground coal mines, the following should be considered as part of the sites risk management processes.

- 4.26.5.1 Ascertain the energy levels available from intrinsically safe electrical circuits.
- 4.26.5.2 Ascertain the electrical protection systems in place for intrinsically safe electrical circuits.
- 4.26.5.3 Review the energy levels and protection systems and determine if additional controls are required for intrinsically safe electrical circuits. Additional controls could include, but are not limited to, earth fault monitoring, overload protection requiring manual reset, increased mechanical protection of cables and equipment, and increased inspection regimes for intrinsically safe circuits (this may include visual as well as insulation testing).

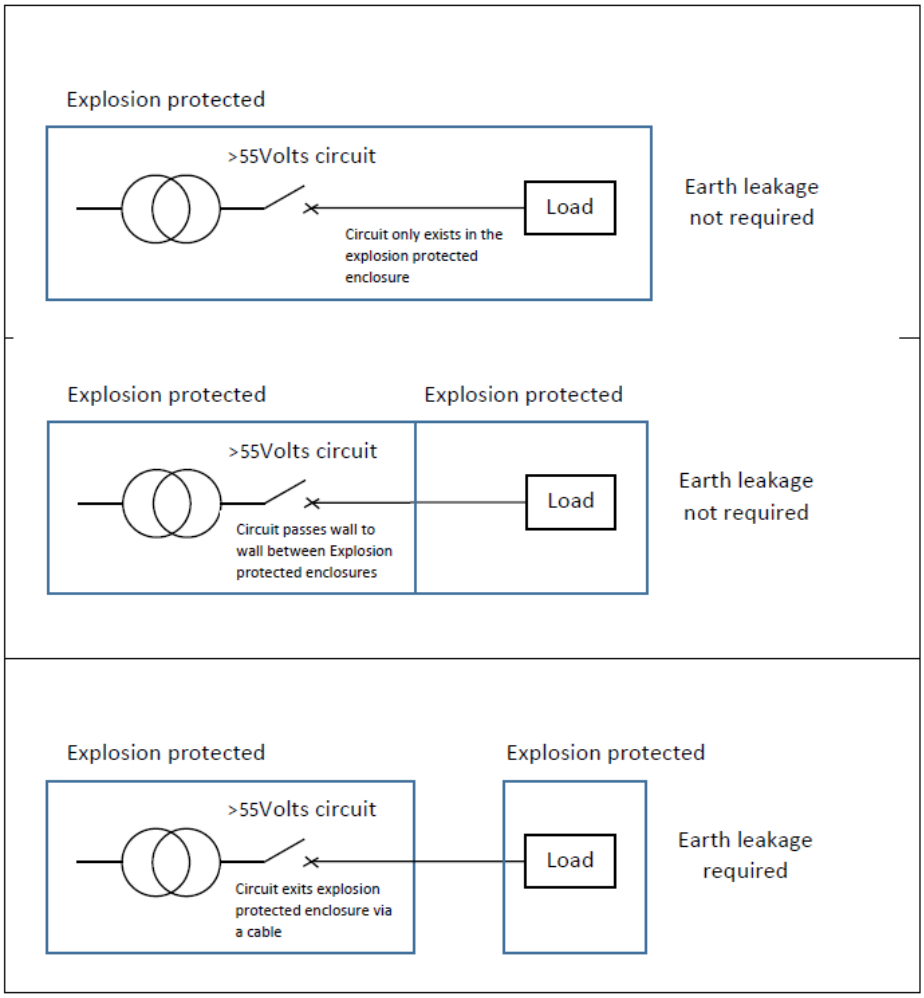
4.27 Protection of Circuits – General

The design, installation and maintenance of electrical circuits at the mine shall provide for reliable circuit interruption of all power and control circuits. Refer Handbook SA/SNZ HB119:2019 “Mines and Quarries electrical protection”.

All circuits in an ERZ1 above 55 volts shall have earth leakage protection unless fully contained in an explosion protected enclosure. This is not a requirement for Intrinsically Safe circuits or circuits isolated from earth. For circuits below 55 volts to earth, consideration should be given in the risk assessment process for earth leakage protection to be installed.

Circuits leaving the explosion protected enclosure via cables to another enclosure are not deemed to be contained.

All high voltage and low voltage circuits in an ERZ1 that are not fully contained in an explosion protected enclosure require earth fault limitation This is not a requirement for Intrinsically Safe circuits or circuits isolated from earth. For circuits at extra low voltage, earth fault current limitation is not mandatory but should be considered as part of a risk management process.



4.28 Documentation

Documentation for electrical plant must be in accordance with AS/NZS 2290.1:2021 Electrical equipment for coal mines – Introduction, inspection, and maintenance, refer to clause 2.2 of AS/NZS 2290.1 and refer to *Coal Mining Safety and Health Act 1999*, Section 44-4 for further information.

The designers, manufacturers, importers, or suppliers of plant for use at a coal mine must provide the following information:

- Manufacturers declaration of conformity for the electrical equipment to the certification and conditions in accordance with “AS ISO/IEC 17050 Conformity Assessment”, including the date and name.
- Certificate of Conformity, including the respective issue number and annexes.
- Installation instructions.
- Manufacturer’s instructions, in particular inspection and maintenance guidance instructions and schedules, inspection, and maintenance instructions.
- Drawings and schedules relating to circuit identification.
- Information for repair and overhaul

Equipment that has been overhauled or repaired; the certified service facility must provide a statement of compliance report. It must include details of work performed including the before and after inspection and test results in accordance with AS/NZS 3800 or IEC 60079-19.

4.29 Low Power Storage Devices (LPSDs)

The purpose of this section is to describe the assessment required of LPSD devices prior to their safe use in an underground coal mine. This assessment is in relation to Section 242 of the Coal Mining Safety and Health Regulation 2017, and to Sections 242(2)(b) and 242(4)(b) which require an automatic trip of electricity supply to non-intrinsically safe plant. A satisfactory assessment will enable LPSD devices to remain energised after the mine's power has been removed by conventional ventilation based underground power inter-tripping regimes.

A typical low power storage device can be a single cell battery or an energy storage device such as a supercapacitor. These supercapacitors are typically a high-capacity capacitor with capacitance values much higher than other capacitors and bridge the conceptual gap between conventional electrolytic capacitors and small electrochemical batteries. They typically store 10 to 100 times more energy per unit volume or mass than electrolytic capacitors.

Supercapacitors store significantly more energy than conventional capacitors, the total energy stored in a supercapacitor is determined by its capacitance and its charge voltage. By comparison, the energy stored in an electrochemical cell is determined by its chemistry and the volume of electrolyte.

Both Supercapacitors and small electrochemical batteries may retain energy for extended periods of time (days, weeks) even when charging power is removed.

Where alternative devices are available that have the same functionality and are certified as intrinsically safe, these must be utilised. If the LPSD is easily removed and the equipment can be operated safely without significant loss of function, the LPSD should be removed.

Where certified devices are not available, or circuits that contain an LPSD that are not a part of a certified intrinsically safe circuit, they must be assessed against the following criteria prior to use in an underground coal mine.

- Be a single cell electrochemical battery or energy storage device, such as a supercapacitor.
- Be used for memory backup or real time clock functions.
- Validate that the LPSD and the circuitry connected to it does not represent an ignition risk when spark tested with a safety factor of 1.5.
- Validate that the LPSD does not cause a component external to the enclosure containing the LPSD to exceed a surface temperature of 150 degrees Celsius, or a component within the enclosure to exceed 450 degrees Celsius.
- Lithium electrochemical cells may represent an unacceptable heating risk unless they are practically assessed.
- The LPSD must be mounted in an enclosure which provides an appropriate level of mechanical impact and ingress protection.
- The LPSD must be adequately retained and suitably secured so it will not become free or separate from the equipment assessed.

A formal risk assessment must be undertaken by the mine to identify all risks associated with the proposed installation of the LPSD in the underground parts of the mine, and to identify controls that prevent the LPSD from creating an unacceptable level of risk at the mine. The formal risk assessment for the site should include, but not be limited to, the following:

- Ventilation in the area where the LPSD is to be located.
- Enclosure requirements where the LPSD is installed.
- Expected general body methane levels in the location of the LPSD, with and without normal ventilation.
- Australian Standards requirements including;
  - AS/NZS 60079.0:2019 – Maximum surface temperature.
  - AS/NZS 4871.1:2012 – Conformity assessment undertaken in accordance with AS/NZS 60079.14:2022.
  - AS/NZS 60079.14:2022 – Conformity assessment requirements.
  - AS/NZS 60079.11:2011 – Type verifications and type tests, spark ignition test, temperature tests, tests for cells and batteries. Test report issued by an Australian accredited certifying body confirming these results.
  - 60079.17:2017 – Fit for purpose assessment. While 60079.17 cannot be used as an alternative to a properly issued CoC for underground applications, the assessment and documentation necessary for safe use of a LPSD is expected to use Annex C of Part 17 as a guide.

Sites must keep a record of all underground installations and/or locations, test results, reports and associated risk assessments for the use of LPSDs in the underground mine on site.

5.0 Definitions

Electrical equipment – Electrical equipment is any item used for such purposes as generation, conversion, transmission, distribution or utilisation of electrical energy, such as machines, transformers, apparatus, measuring instruments, protective devices, equipment for wiring systems, appliances.

Electrical installation – Electrical installation is an assembly of associated electrical equipment to fulfil a specific purpose or purposes and having co-ordinated characteristics.

Feeder cable – A flexible cable intended primarily for use between a transportable or mobile substation, and associated electrical equipment supplied from such substation.

Informative – Refers to a standard or document that is only for information and guidance.

Liquid filled electrical equipment – Electrical equipment which has liquid as an insulating and/or cooling medium.

Live – An object must be deemed to be live when a difference of electrical potential exists or would exist between it and earth.

Normative – Refers to a standard or document that forms an integral part of the recognised standard in which it is mentioned.

Portable electrical equipment – Electrical equipment which is moved while in operation or which can easily be moved by a person or persons without mechanical assistance from one place to another while connected to the supply.

Pressurisation – The technique of guarding against the ingress of the external atmosphere into a room by maintaining clean air therein at a pressure above that of the external atmosphere.

Reeling cable – A flexible cable normally providing electrical connection between a mobile machine and a fixed point or points in the electrical system and capable of being wound onto a reeling drum.

Risk assessment – The overall process of risk analysis and risk evaluation and the process should be in accordance with AS/NZ ISO 31000:2009 Risk management – Principles and guidelines.

Trailing cable – A flexible cable normally providing electrical connection between a mobile or portable machine and a fixed point or points in the electrical system or between transportable equipment.

6.0 References – Normative Standards

The following documents are referred to, directly or indirectly, in this standard:

AS/NZS 1020:1995 The control of undesirable static electricity

SA TS 60079.32.1:2022 Explosive atmospheres, Part 32.1: Electrostatic hazards, guidance (IEC TS 60079-32-1:2013/AMD 1:2017 (ED. 1.1) MOD)

AS 1147.1 – 1989 (superseded) Electrical equipment for coal mines – Insulating materials – Materials for insulating power conducting components.

AS/NZS 1299:2022 Electrical equipment for mines and quarries – Explosion-protected three-phase restrained and bolted cable coupling devices for working voltages up to and including 11 kV

AS/NZS 1747:2022 Reeling, trailing and feeder cables used for mining – Repair, testing and fitting of accessories.

AS 1768:2021 – Lightning protection

AS/NZS 1802:2018 Electric cables – Reeling and trailing – For underground coal mining purposes

AS/NZS 1826:2008 Electrical equipment for explosive atmospheres – Special protection – Type of protection ‘s’. Note this standard has been superseded by AS/NZS 60079.33:2012

AS 1915 – 1992 Electrical equipment for explosive atmospheres – Battery operated vehicles

AS/NZS 1972:2006 Electric cables – Underground coal mines - Other than reeling and trailing cables

AS 1940:2017 The storage and handling of flammable and combustible liquids

AS/NZS 2081:2011 Electrical protection devices for mines and quarries

AS/NZS 2290.1:2021 Electrical equipment for coal mines – Introduction, inspection and maintenance – For hazardous areas

AS 2290.3 – 2018 Electrical equipment for coal mines – Maintenance and overhaul – Maintenance of gas detecting and monitoring equipment

AS/NZS 3000:2018 Electrical Installations (known as Australian/New Zealand Wiring Rules)

AS/NZS 3800:2020 Electrical equipment for explosive atmospheres – Repair and overhaul

AS/NZS 4240.1:2009 Remote control systems for mining equipment – Design, construction, testing, installation and commissioning

AS/NZS 4240.2:2009 Remote control systems for mining equipment – Operation and maintenance for underground metalliferous mining

AS/NZS 4240.3:2013 Remote control systems for mining equipment – Operation and maintenance for underground coal mining

AS 4242 – 1994 Earth-moving machinery and ancillary equipment for use in mines—Electrical wiring systems at extra-low voltage

AS/NZS 4871.1:2012 Electrical equipment for mines and quarries - General requirements

AS/NZS 4871.2:2010 Electrical equipment for mines and quarries - Distribution, control and auxiliary equipment

AS/NZS 4871.3:2010 Electrical equipment for mines and quarries - Substations

AS/NZS 4871.4:2010 Electrical equipment for mines and quarries - Mains powered electrical mobile machines

AS/NZS 4871.5:2010 Electrical equipment for mines and quarries - Battery powered electrical mobile machines

AS/NZS ISO 31000:2009 Risk management – Principles and guidelines

AS/NZS 60079.0:2019 Explosive atmospheres – Equipment - General requirements

AS/NZS 60079.1:2015 Explosive atmospheres – Equipment protection by flameproof enclosures ‘d’

AS/NZS 60079.2:2015 Explosive atmospheres - Equipment protection by pressurized enclosure ‘p’

AS/NZS 60079.7:2016 Explosive atmospheres - Equipment protection by increased safety 'e'

AS/NZS 60079.11:2011 Explosive atmospheres - Equipment protection by intrinsic safety ‘i’

AS/NZS 60079.14:2022 Explosive atmospheres – Electrical equipment for explosive gas atmospheres – Selection, installation and maintenance – General requirements

AS/NZS 60079.17:2017 Explosive atmospheres – Electrical installations inspection and maintenance

AS/NZS 60079.18:2016 Explosive atmospheres - Equipment protection by encapsulation ‘m’

AS/NZS 60079.28:2016 Explosive atmospheres - Protection of equipment and transmission systems using optical radiation

AS/NZS 60079.29.1:2017 Explosive atmospheres – Gas detectors – Performance requirements of detectors for flammable gases

AS/NZS 60079.29.2:2016 Explosive atmospheres – Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen

AS/NZS IEC 60825.1:2014 Safety of laser products – Equipment classification and requirements

AS/NZS IEC 60825.14:2011 Safety of laser products – A user's guide

AS 61508.1 – 2011 Functional safety of electrical/electronic/programmable electronic safety-related systems – General Requirements

AS 61508.2 – 2011 Functional safety of electrical/electronic/programmable electronic safety-related systems – Requirements for electrical/electronic/programmable electronic safety-related systems

AS 61508.3 – 2011 Functional safety of electrical/electronic/programmable electronic safety-related systems – Software requirements

AS 61508.4 – 2011 Functional safety of electrical/electronic/programmable electronic safety-related systems – Definition and abbreviations

AS 61508.5 – 2011 Functional safety of electrical/electronic/programmable electronic safety-related systems – Examples of methods for the determination of safety integrity levels

AS 61508.6 – 2011 Functional safety of electrical/electronic/programmable electronic safety-related systems – Guidelines on the application of IEC 61508-2 and IEC 61508-3

AS 61508.7 – 2011 Functional safety of electrical/electronic/programmable electronic safety-related systems – Overview of techniques and measures

AS/NZS 62013.1:2001 Caplights for use in mines susceptible to firedamp – General requirements – Construction and testing in relation to the risk of explosion

> **Note:** This standard replaced by **AS/NZS 60079.35.1:2011** Explosive atmospheres, Part 35.1:Caplights for use in mines susceptible to firedamp - General requirements - Construction and testing in relation to the risk of explosion.

AS/NZS 62013.2:2001 Caplights for use in mines susceptible to firedamp – Performance and other safety-related matters

BS 6656:2002 Assessment of inadvertent ignition of flammable atmospheres by radio-frequency radiation. Guide

PD CLC/TR 50426:2004 Assessment of inadvertent initiation of bridge wire electro-explosive devices by radio-frequency radiation. Guide

7.0 References – Informative Standards

The following documents from the NSW Department of Primary Industries / Minerals may be of assistance in determining the best practice for electrical equipment and electrical installations.

MDG 1 Guideline for Free Steered Vehicles

MDG 9 Design Guideline for the Construction of Electric Powered Shuttle Cars for Use in Coal Mines

MDG 3608-2022 Non-metallic materials for use in underground coal mines and reclaim tunnels in coal mines.