



NSW DEPARTMENT OF  
PRIMARY INDUSTRIES

**Technical Reference  
Electrical Engineering Safety  
EES003**

**NSW DPI Technical Reference  
Practices for the Life-Cycle  
Management of Explosion  
Protected Equipment**

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

**December 2006 (version 1)**



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## FOREWORD

Historically electricity has been the ignition source of many catastrophic coal mine explosions world wide. As a result of those explosions special techniques (explosion protection techniques (Ex)) have been developed for the design of electrical plant which significantly reduces the risk of an explosion of coal methane gas or coal dust. Those techniques have been developed into equipment conformity standards that document criteria that must be adopted to reduce risk. Initially those standards were developed country by country. More recently they have been transformed into International (IEC) standards.

The catastrophic consequences and consequent high risk of an explosion in an underground coal mine has caused regulators world wide to insist that Ex electrical equipment be tested by an independent (from the designer and manufacturer), competent and recognised body. This forms the basis of specified requirements for electrical equipment before it can be used in a hazardous zone.

It has long been recognised that equipment used in coal mining environments is subject to extremely arduous conditions and is readily damaged and repairs are necessary to restore the explosion protected properties. Because the repair of explosion protected equipment and flexible cables is complex it requires a high degree of expertise, a systematic process and special facilities. This high degree of rigor on the repair process is achieved through a legislative licensing process.

Complementing all of this are:

- Standards for the selection, installation, inspection, maintenance, overhaul and repair of apparatus
- Standards for the design and repair of cables
- Standards for competency of people working on hazardous area equipment
- Competency requirements for mine electrical engineers

In summary there are standards, certification schemes, licensing schemes and competency requirements that if used in a coherent manner can give a high degree of confidence in the explosion protected properties of electrical equipment. However without constant competent overview of this equipment it is easy to compromise the explosion protected properties and significantly increase the risk of a coal mine explosion.

It is the responsibility of the coal operator to be cognoscente of all this and develop arrangements for the life-cycle management of electrical explosion protected equipment. Legislation places the responsibility for this to occur on the Manager of Electrical Engineering.

This Technical Reference will be used by Mine Safety Operations to assess the effectiveness of coal operation arrangements for the life-cycle management of electrical explosion protected equipment.

This Technical Reference can also be used by coal operators to assess the effectiveness of their present arrangements for dealing with explosion protected equipment and to check that electrical ignition sources from electrical equipment have been identified and dealt with. If a coal operator is setting up new practices for the life-cycle management of Ex equipment this



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Technical Reference can serve as a step-by-step guide to establishing the minimum requirement.

This Technical Reference will assist employers, self-employed persons, employees, contractors and other parties involved with practices for electrical explosion protected equipment and cables.

**John Francis Waudby**

Senior Inspector of Electrical Engineering



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## Chapter 1 Establishment

### 1.1 Title

This is the DPI Electrical Engineering Safety Technical Reference – Practices for the Life-Cycle Management of Explosion Protected Equipment

### 1.2 Purpose

This Technical Reference is intended to provide a framework for DPI officers to assess coal operation arrangements for the life-cycle management of electrical explosion protected equipment. It can also be used by coal operators as guidance material for implementing, managing or reviewing their practices for the life-cycle management of electrical explosion protected equipment as part of the operation's Electrical Engineering Management Plan. This Technical Reference may also be used to support the Major Hazard Management Plan "Fire and Explosion Management Plan".

This Technical Reference describes an accepted methodology for preparing arrangements for the life-cycle management of Ex equipment that can be tailored to suit the particular needs of a coal operation. It is intended to protect the safety of workers.

The outcomes sought to be achieved by this Technical Reference are to protect people and property from the risks associated with the use of explosion protected equipment at coal operations including:

- Electrocutation
- Electric Shock
- Electrical burn injuries
- Arc blast injuries
- Injuries sustained through operation of the equipment
- Unintended operation of the equipment
- Ignitions of flammable mixtures of gas or dust
- Fire

### 1.3 Scope

This Technical Reference extends to all coal operations in New South Wales. The range of explosion protected equipment that should be considered includes mains and battery power supplies to explosion protected equipment, explosion protected enclosures, plug and adaptors, associated equipment and cables for intrinsically safe equipment, test appliances and instruments. It also includes associated inspection, maintenance and overhaul practices.

This Technical Reference does not apply to the use of non-explosion protected portable electrical equipment in a hazardous zone. For details on that matter:



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

This Technical Reference is supplemented by the following Technical References:

- EES001 NSW DPI Technical Reference – Electrical Engineering Management Plan
- EES002 NSW DPI Technical Reference - Control and Supervision of Electrical Work
- EES004 NSW DPI Technical Reference – Practices for Portable Electrical Apparatus
- EES005 NSW DPI Technical Reference - Electrical Protection and Earthing
- EES006 NSW DPI Technical Reference - Removal and Restoration of Power

## 1.4 Authority

This is an Electrical Engineering Safety Technical Reference and is recommended by the Department of Primary Industries.

## 1.5 Definitions

**Certified** means electrical explosion protected equipment certified as Group I equipment in one of the following schemes: AUS Ex, ANZ Ex or IEC Ex.

**Plant** includes any machinery, equipment or appliance.

## 1.6 Applicable legislation

The Occupational Health and Safety Act 2000

The Occupational Health and Safety Regulation 2001

The *Coal Mine Health and Safety Act 2002*

The *Coal Mine Health and Safety Regulation 2006*

## 1.7 Referenced Gazette Notices

Gazette Notice for Specification of Plant that can be used in a Hazardous Zone

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

Gazette Notice for considering certain workshops to be licensed

Gazette Notice for the specification of requirements to be licensed as a cable repair workshop

## 1.8 Referenced Standards and Guidelines

AS/NZS 1020 The control of undesirable static electricity

AS/NZS 1802 Electric cables - Reeling and trailing - For underground coal mining purposes

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



AS/NZS 2081 Series: Electrical equipment for coal and shale mines - Electrical protection devices

AS/NZS 2290.1: Electrical equipment for coal mines - Introduction and maintenance - For hazardous areas

AS/NZS 2381 Series - Electrical equipment for explosive gas atmospheres - Selection, installation and maintenance

AS 2430.3 Series – Classification of hazardous areas

AS/NZS 4240 Remote controls for mining equipment

AS/NZS 4761 Series - Competencies for working with electrical equipment for hazardous areas (EEHA) - Competency Standards

AS/NZS 4871 Series - Electrical equipment for coal mines, for use underground - General requirements

AS/NZS 60079.10 Electrical apparatus for explosive gas atmospheres. Part 10: Classification of hazardous areas

EES001 NSW DPI Technical Reference – Electrical Engineering Management Plan

## **1.9 Acronyms**

AS – Australian Standard

AS/NZS – Australian New Zealand Standard

Ex – Explosion protected

IEC – International Electrotechnical Commission

MEMMES – Mining Electrical & Mining Mechanical Engineers Society of Engineers Australia

OH&S – Occupational Health and Safety

SEP – Standard of Engineering Practice



## Chapter 2 Life-cycle Management of Electrical Explosion Protected Equipment

### 2.1 Identification of hazardous zones in the mine

Hazardous zones underground in coal mine are defined in the Coal Mine Health and Safety Regulation 2006. There may also be other hazardous areas determined in accordance with AS 2430.3 series and AS/NZS 60079.10 (examples of the later being methane drainage and flammable liquid stores). These Australian Standards require the mapping of hazardous areas.

Details of hazardous zones and hazardous areas should be placed on mine plans, section plans, emergency plans and any surface installation plans. These plans should be readily available to electrical staff and mining supervisors. Signage detailing the commencement of the hazardous zone or defined hazardous areas should be placed in all in-take airways.

Battery charging stations should be assessed for any hazardous areas caused by the battery charging and discharging process.

Consideration should be given to the determination of areas within the hazardous zone where equipment is restricted to that which is permitted for Hazardous areas, Zone 0, e.g. sealed and goaf areas or coal bins.

In the event of fan failure the whole mine is considered to be a hazardous zone with a significant potential for gas concentrations to exceed 1.25% as such power has to be removed from all electrical equipment that does not meet the specified requirements.

**Information Note:** People have to be withdrawn to a safe place when the gas concentration exceeds 2%, which infers the withdrawal of such apparatus as miner's caplamps.

### 2.2 EEMP and Life-cycle management of Ex plant



#### Clause 19(1)(c), (d), (e) and (f)

Requires that only specified plant be used in a hazardous zone, that this plant be maintained in an explosion-protected condition and that overhaul and repair of Ex equipment and flexible reeling, trailing and feeder cables is only to be done at licensed facilities.

Measures have to be taken to prevent arcing faults compromising explosion protection properties of plant and installations (including cables).

Electrical explosion protected equipment at a coal operation must be subject to life-cycle management under the auspices of an Electrical Engineering Management Plan, constituted under the coal operation's Occupation Health and Safety Management System, and be subject to the review and audit procedures contained within that system. The life-cycle management of Ex plant must be developed, implemented and periodically reviewed through consultation with a qualified engineer.



## 2.3 Record keeping

A list of all electrical explosion protected equipment with certificate/approval and serial numbers and installation location needs to be maintained at the mine.

Verification dossiers of equipment need to be kept at the mine or at a place determined suitable and readily accessible to the Manager of Electrical Engineering.

Records and details of flexible cables can be kept at licensed facilities.

## 2.4 Application of Ex plant life-cycle management

It applies to mine owned equipment, contractor's equipment and hired equipment.

The mine may accept arrangements that the contractors and/or hirers have in place. Where this is so, the Manager of Electrical Engineering shall verify that those arrangements conform to this Technical Reference.

## 2.5 Competency Requirements for life-cycle activities

- Refer to AS/NZS 4761 for competency requirements

## 2.6 Selection of electrical explosion protected equipment

The equipment must meet specified criteria. As part of that criteria the transfer and provision of information is a critical component. Standards of Engineering Practice should specify design and information requirements.

- Refer to the Gazette Notice for Specification of Plant that can be used in a Hazardous Zone

**Information Note:** The information specified in the gazette notice must be kept in a verification dossier in accordance with AS/NZS 2290.1

**Information Note:** Cables used solely for intrinsically safe circuits that do not comply with the specified standards should be designed and/or installed to minimise risk from static electricity and fire. They must also be designed and installed to maintain intrinsic safety properties under fault conditions. Refer to AS/NZS 2381.

The equipment must be such that electrical arcing faults do not compromise the explosion-protection properties of plant and installations (including cables). Some points to consider are:

- MEMMES document on arc fault control
- Certificates of conformity
- Operational risk assessment
- Fault study considerations
- Protection settings
- Energy let through during clearance of a fault



Before purchasing or hiring electrical explosion protected equipment, authority must be obtained from the Manager of Electrical Engineering.

## **2.7 Acceptance of explosion protected equipment at the mine**

Standards of Engineering Practice should specify site acceptance requirements including the requirements for:

- Competency requirements for assessment before acceptance
- Responsibility for acceptance
- Information as specified in the gazette notice
- Validity and currency of certification/approval. Details can be checked on the DPI website for approvals and on the websites for the ANZ Ex Scheme and IEC Ex Scheme.
- For any equipment (new, hired, overhauled or repaired), a signed verification of compliance to Australian Standards, certification and/or approval requirements

**Information Note:** In addition to the explosion protected concept standards, there are a number of Australian Standards that coal mining explosion protected equipment should comply with, AS/NZS 4871, AS/NZS 2081 and AS/NZS 4240. Compliance against these standards must also be established

- For repaired equipment a repair report from a licensed facility to identify repairs conducted and method of repair
- Review of pre-overhaul reports and verification of engineering characteristics of equipment reported
- For overhauled equipment an overhaul report identifying condition of equipment prior to overhaul and transparent terms of compliance after overhaul
- Site examination for compliance to Australian Standards, certification and/or approvals and a compliance plate is installed
- Registrations into the mine plant register and mine maintenance plan
- Determination of inspection and maintenance activities and time intervals
- Review of the verification dossier contents against AS/NZS 2290.1, the gazette notice for specification of hazardous zone equipment and Chapter 5 of OH&S regs 2001
- Registration and filing of the verification dossier
- For intrinsically safe systems:
  - System drawings detailing entity parameters, layout and certified entity equipment
  - Review of system drawings
  - Confirmation that the installation complies with the parameters and any certification/approval conditions
  - Earthing requirements



- Minimising EMI effects from other circuits

## **2.8 Installation and commissioning of electrical explosion protected equipment at the mine**

Standards of Engineering Practice should specify site installation and commissioning requirements:

- Conduct or review of operational risk assessments, or a review by the manager of electrical engineering
- Implementation of risk controls identified in the risk assessment or risk controls specified by the manager of electrical engineering
- Implementation of any conditions of certification or approval
- Implementation of manufacturer's requirements
- Competency of persons for installation, commission and review of associated reports and documentation
- Inspection after transportation underground to the work location
- Installation and commissioning procedure that provide for:
  - Compliance with certification and/or approval conditions
  - Compliance with Australia Standards (AS/NZS 2381, AS 2290.1, AS/NZS 4871, AS/NZS 2081 and AS/NZS 4240 as appropriate)
  - Specify protection settings and verification of enclosure fault containment rating
  - Specify housing and earthing requirements for intrinsically safe equipment.
  - Recording commissioning acceptance and filing of reports
  - An independent verification process and counter sign of commissioning acceptance.

## **2.9 Operation of electrical explosion protected equipment at the mine**

Ex plant is only to be energized in a hazardous zone if it is in an explosion protected condition.

Ex plant is only to be energized for the first time in a hazardous zone if it is verified by a qualified electrical person as being in an explosion protected condition.

Only specified plant can be used in a gas concentration greater than 1.25%.

- **Refer to the Gazette Notice for Specification of Plant that can be used in a Hazardous Zone**

Where non-specified plant has been subject to gas concentrations greater than 1.25%, then that plant must be purged and it must be verified that the plant is free of gas before power is restored.

Battery powered plant (other than Exia) must not be left unattended in a hazardous zone.



## 2.10 Maintenance of electrical explosion protected equipment at the mine

The Coal Mine Health and Safety Regulation 2006 requires that Ex plant be maintained in an explosion protected condition. Standards of Engineering Practice should specify site maintenance requirements:

- Selection and review of service providers for installation, maintenance and inspection
- Implementation of any conditions of certification or approval
- Implementation of manufacturer's requirements
- Competency of persons
- Compliance with Australia Standards (AS/NZS 2381 and AS 2290.1)
- Frequency of inspection and maintenance is to be determined by FMEA and manufacturer's instruction, taking in to account environment and operational factors
- Signed-off as completed
- Verified as being adequately completed
- Maintenance personnel provided with the relevant certification/approval information, manufacturer's documents, instruments and recommendations.

## 2.11 Defect management of electrical explosion protected equipment at the mine

The defect management scheme to nominate requirements for electrical explosion protected equipment:

- Competency of persons
- Defects recorded and reported
- Reporting of in-service failure of electrical explosion protected equipment
- Investigation process is conducted should an in-service failure of electrical explosion protected equipment occur
- Defective item identification so that it is not mistakenly put back into use
- The defect management procedure requires a compliance check of a replacement item prior to use in the hazardous zone
- The equipment catalogues/registers kept up to date when replacement equipment occurs
- A defective component part of an electrical explosion protected systems is not available for replacement
- Have a system of notification to the original equipment manufacturer (OEM), supplier, overhaul workshop or certification body of defects. The quality management system Non-Conformance Report (NCR) form must be used.



## 2.12 Control of overhaul and repair facilities

Electrical explosion protected apparatus must only be overhauled or repaired at licensed facilities.

- Refer to the Gazette Notice for considering certain workshops to be licensed

The mines have a selection and review process for service providers that includes:

- Compliance requirements for repair, overhaul and pre-overhaul activities
- Verification of the credentials (competence, accreditation, license, etc.) of contractors
- Repair, overhaul and pre-overhaul procedures of contractors
- A preferred list of service providers for various items of equipment
- Verify a service provider is equipped and competent to repair, overhaul and/or provide pre-overhaul services
- The mine provide specifications for repair, overhaul and pre-overhaul inspections provided to service providers
- The mine specifies the reports required
- The mine reviews provided reports
- Competencies for review of reports.

## 2.13 Additional compliance information

Standards of Engineering Practice need to identify how recommendations from defect management, incident investigation and external notifications (safety alerts, gazettal, manufacturer's information etc) are introduced into requirements for Ex equipment management.

## 2.14 Portable apparatus (other than caplamps & portable gas detectors)

Explosion protected portable apparatus must be incorporated in the management of Ex equipment and also used in accordance with the portable apparatus scheme used at the mine.

- Refer to the EES004 NSW DPI Technical Reference – Practices for Portable Electrical Apparatus

## 2.15 Caplamps

Caplamps are explosion protected and must be incorporated within the practices for life-cycle management of Ex equipment.

Modern caplamps often use multiple explosion protection techniques and incorporate other devices such as PED systems. As such persons, who service, inspect and maintain caplamps will need to have competencies related to those techniques and components.



It is expected the mine will only replace components with like for like and only if it is highly unlikely that explosion protected properties will be compromised.

The manager of electrical engineering shall determine to what extent caplamps can be dis-assembled and exactly what can be done to return a non functioning caplamp back to a serviceable state.

The repairs shall only be done in accordance with the manufacturer's requirements, and any certification or approval conditions.

A specific area shall be nominated for maintenance/repairs.

A certificate is issued after each repair, stating the nature of the repairs and status of the unit.

## **2.16 Portable gas detectors**

Portable gas detectors are explosion protected and must be incorporated within the practices for life-cycle management of Ex equipment. Calibration may also be included.

It is expected the mine will only replace components with like for like and only if it is highly unlikely that explosion protected properties will be compromised.

The manager of electrical engineering shall determine to what extent gas detectors can be dis-assembled and exactly what can be done to return a non functioning gas detector back to a serviceable state.

The inspection, maintenance, servicing and calibration shall be done in accordance with:

- Certification conditions
- Approval conditions
- AS 2290.3.

It is expected the mine will only replace components with like for like and only if it is highly unlikely that explosion protected properties will be compromised.

## **2.17 Flexible reeling, trailing and flexible feeder cables used in hazardous zones**

Flexible reeling, trailing and feeder cables must only be repaired at licensed facilities.

➤ **Refer to the Gazette Notice for the specification of requirements to be licensed as a cable repair workshop**

Flexible reeling, trailing and feeder cables must only be repaired at licensed facilities.

Flexible cable management in a hazardous zone to be addressed in SEP's and to include:

- Review of cable repair reports when cables are returned to the mine
- Transport and storage of spare cables
- Testing and inspection of cables in the operation
- SEP for the standard of installation of cables



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- Responsibilities for installation
  - Responsibilities for inspecting and reporting on the status of cable installations and management
  - Removal of power when SEP's are not met
  - Damaged cable reporting and investigation
  - Reporting of arcing in a hazardous zone
  - Cable replacement practices – licensed cable repair workshops give repaired cables a condition score, the lower the score, the worse the overall condition. Cable replacement should be identified as being required when a cable condition score falls below the mine site standard.
- Refer to the Gazette Notice for the specification of requirements to be licensed as a cable repair workshop



## Chapter 3 Management of Static Electricity



### Clause 19(1)(g)

Requires measures to be taken to prevent the ignition of gas by a static electric charge.

This relates specifically to:

- Electrical plant
- Control measures such as earthing and bonding on other plant
- Testing of other plant to establish anti-static properties.

Non-electrical plant that may have a static electricity risk may be managed via other management plans such as the Mechanical Engineering Management Plan. Where this is the case the EEMP should establish the required standards for controlling the risk from static electricity. AS 1020 is an important reference.

For cables complying with AS1802 and AS1972 no additional measures are required beyond appropriate installation and cable management.

For certified Ex plant that has an 'x' mark – this may relate to special precautions to be taken because there is a static electricity hazard.

Care needs to be taken when selecting equipment (plastic enclosures are an obvious example) to ensure that a static electricity hazard is not introduced when there is alternative equipment (metallic enclosures connected to earth are an obvious example).

For portable apparatus that may have a static hazard a common risk control is the use of leather carry cases and/or leather covers.

- Refer to the Gazette Notice for fire resistant and anti-static testing specification



## Chapter 4 Feedback Form

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

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

Senior Inspector Electrical Engineering  
Mine Safety Operations  
NSW Department of Primary Industries  
PO Box 344  
MAITLAND NSW 2310  
Fax: (02) 4931 6790  
Phone: (02) 4931 6641

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

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**What do you find most useful about this Technical Reference?**

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**What do you find least useful?**

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**Do you have any suggested changes to this Technical Reference?**

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Thank you for completing and returning this Feedback Form.



## Chapter 5 NSW DPI Contact Details

### NSW DPI Mineral Resources offices located in coal mining regions

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