NSW GOVERNMENT

NSW Resources Regulator

PLANNED INSPECTION PROGRAM

# CONSOLIDATED REPORT: FIRE OR EXPLOSION: ELECTRICAL – SURFACE COAL

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# Contents

# Executive summary

A crucial part of the NSW Resources Regulator's incident prevention strategy involves targeted assessment and planned inspection programs for mines and petroleum sites. This is a focus on assessing an operation's control of critical risks through evaluating the effectiveness of control measures in the mine's safety management system.

To this end the Regulator developed a bowtie hazard management framework and standardised assessment checklist for each program plan. Under each program plan, the effectiveness of the safety management system at each mine site is assessed against a standard set of control supports and critical controls.

This final report summarises assessment findings from 23 mines in relation to the principal hazard of fire or explosion – surface coal. Assessments were conducted during the period from December 2019 to September 2020.

The threats and critical controls assessed are shown in Table 1.

Note: not all mines were assessed for all critical controls.

Table 1. Threats and Critical Controls for the Material Unwanted Event (Fire or Explosion)

| THREAT | CRITICAL CONTROL |
|---|---|
| Electrically generated heat | PC1.1 – Electrical protection |
| Explosive atmosphere | PC6.1 – Ventilation<br>PC6.2 – Explosion protected equipment<br>PC6.3 – Monitoring with inter-tripping |

Legislative requirements and published guidance relating to the principal hazard of fire or explosion is listed in Appendix A. Figure 1 presents safety compliance findings for each de-identified mine and critical control. Explanatory notes on the assessment system are also listed in Appendix B.

# Key Findings

Regulatory compliance action was required at a number of sites due to various contraventions of the relevant regulations and acts. Fortunately, no sites required immediate intervention relevant to this planned inspection program, however, numerous statutory notices were issued under section 191 of the *Work Health and Safety Act 2011* and section 23 of the *Work Health and Safety (Mines and Petroleum Sites) Act 2013*.

One such issue which was discovered at various sites was in relation to the associated principal hazard management plan, risk assessment, and control plan. Upon inspection of these documents it was commonly found that they were either not current or had not been reviewed in conjunction with existing site hazards. As part of this deficiency, it was concerning to note that there were actions assigned as part of the risk assessment process which had not been progressed or verified as being completed. The responsible person for each action was unclear in some instances, which was a likely contributing factor as to why some actions had not been completed.

A similar theme existed for hazardous area assessments, where they were not aligned with the current configuration, nor were recommendations from the assessment implemented. Advice from subject matter experts who were involved with assessment was either ignored or the site had consciously decided to inherit the risk by not implementing a higher level of controls. This was particularly relevant to reclaim tunnels across the planned inspection program and there were routine cases of non-conformance to the hazardous area assessments completed for these pieces of infrastructure. On occasion, the maintenance of installations within these areas was also to a poor standard or simply had not been completed by workers with the required skills and competencies.

Finally, a significant portion of the inspections undertaken had identified that the site had not completed appropriate protection studies, specifically in relation to load flows, faults, grading, and arc blast. This was of concern to inspectors as the sites were not conforming to relevant installation standards or known verification requirements. Some sites did display evidence of such studies being completed, however these were either not current or relevant (in some instances greater than five years old). Upon further investigation, it was regularly discovered that there was no formalised review process for these assessments or studies to ensure that they remain compliant to current standards and practices.

# Recommendations

Mine operators should ensure a comprehensive risk assessment is conducted by a team of participants that are suitably qualified and experienced. The risk assessment should:

- identify the electrical risks associated with fire or explosion
- identify appropriate controls to eliminate the risk or reduce as low as reasonably practicable (as per hierarchy of controls)

- outline the relevant components of the safety management system which address the risk and detail the implementation of the associated controls
- incorporate any feedback or recommendations from assessments or audits which have been conducted by subject matter experts.

Mine operators should also ensure that appropriate resources are made available to adequately manage the fire or explosion risks, as well as to validate and verify control effectiveness. These processes should be regularly reviewed to not only confirm compliance but also identify any deficiencies which may exist within the controls. As part of this, defined review periods should be implemented as part of a mature safety management system and also clearly outline what triggers a review outside of these nominated timelines (e.g. a notifiable incident).

It is recommended that mine operators, upon reading this consolidated report, review their site's relevant risk assessment, principal hazard management plans, and associated documents to manage the electrical risks associated with fire or explosion that are unique to their site. During the review process, mine operators are also encouraged to consider the above recommendations, as well as the guidance published within Appendix A as a minimum.

# Introduction

The NSW Resources Regulator's planned assessment programs provide a planned, risk-based and proactive approach to assessing how effective an operation is when it comes to controlling critical risk. These programs apply the following principles:

- A focus on managing prescribed 'principal hazards' from the Work Health and Safety (Mines & Petroleum Sites) Regulation 2014.
- Evaluation of the effectiveness of control measures implemented through an organisation's safety management system.
- Consideration of the operation's risk profile.

The objective of risk profiling is to identify the inherent hazards and the hazard burden that exist at individual operations in each mining sector in NSW. The information is then used to develop the operational assessment and inspection plans that inform the program.

## Scope

Planned inspection programs include two assessment types:

- **Targeted assessments**, incorporating:
  - desktop assessment of:
    - compliance against legislation with respect to the management of health and safety risks associated with fire or explosion (electrical focus) – see Appendix A for details
    - the definition of the controls the mine utilises to prevent and mitigate the risks to health and safety associated with fire or explosion (electrical focus)
  - a workplace assessment of the implementation of those controls through the inspection of plant and worker interviews.
- **Planned inspections**, which involve a workplace assessment of the implementation of controls through the inspection of plant and worker interviews only.

# The process

The process for undertaking an assessment under a planned inspection program generally involves the following stages:

- Preliminary team meetings, preparation and review of documents
- Execution of an on-site assessment involving:
  - an on-site desktop assessment of relevant plans and processes measuring legislative compliance of the relevant plans (targeted assessments only)
  - the inspection of relevant site operations (both targeted assessments and planned inspections)
- Discussion and feedback to the mine management team on the findings and actions that need to be taken by the mine operators in response.

# Assessment findings

## Controls assessed

### Threat:

- Electrically generated heat

**Critical control:** PC1.1 Electrical protection

When installing or working with electrical equipment that have the potential for a fire or explosion, mine operators must ensure that electrical protection systems are implemented and effective. Protection systems should detect and disconnect any overloaded or faulty electrical equipment to reduce the risk of harm when using such equipment. This is a critical control to ensure the health and safety of workers and the following criteria were assessed at each site:

- Inspected electrical equipment that presented a fire or explosion risk were fitted with electrical protection.
- The time / current coordination of the electrical protection ensured it operated before a fire or explosion was initiated.
- The capacity of the disconnection device was sufficient to safely interrupt the available electrical energy.

With regard to this specific critical control, the following issues were identified throughout the planned inspection program:

- A significant portion of the inspections undertaken had identified that the site had either not completed or did not have a relevant protection study. This was specifically in relation to load flows, faults, grading, and arc blast.
- Whilst some sites had completed earthing and lightning studies on new/modified plant, it was found on multiple occasions that older plant at the site had been overlooked.
- Change management processes at some mines failed to capture updates to electrical maintenance systems whereby work orders and protection settings sheets did not represent the current configuration.
- With regards to oil sampling (or dissolved gas analysis), there was a large variation identified between timeframes and ranged anywhere from 6 months to 5 years between scheduled sampling events. Further to this point, it was unclear how mines determined such time frames and could not provide evidence of a risk-based approach.

- In addition to the above point, current transformers (oil filled) were not captured in the oil sampling testing schedule.
- Timeframes for high voltage maintenance processes including injection testing, varied between sites with 12 months, 2 yearly, and 5 yearly periods all identified. Again, it was unclear how mines determined such time frames and could not provide evidence of a risk-based approach.

## Threat:

- Explosive atmosphere

**Critical control:** PC6.1 Ventilation

Various areas of mining operations are exposed to potentially explosive mixtures of gases or dust, therefore mine operators must ensure that these areas are well ventilated to dilute such mixtures. Ventilation systems are required to be installed where there is a risk of an explosive atmosphere accumulating and should be designed to reduce the gases or dust limits below the lower explosive limit (LEL). As a result, the following criteria were assessed for this critical control:

- Installed ventilation systems diluted gases and dust to below the LEL.

With regard to this specific critical control, the following issues were identified throughout the planned inspection program:

- Some sites failed to provide a safety integrity level assessment (or functional safety assessment) for ventilation/power inter-tripping and gas monitoring/inter-tripping.
- Not all sites had forced ventilation in tunnels, nor could they provide evidence of completed ventilation engineering/surveys reports to ensure sufficient air flow for the tunnels.
- Some sites had a lack of detail within the reclaim tunnel access procedure in terms of build-up of gases while ventilation was absent, and the subsequent purge times until safe re-entry after event.

## Threat:

- Explosive atmosphere

**Critical Control:** PC6.2 Explosion protected equipment

In certain circumstances electrical equipment is potentially capable of igniting explosive atmospheres or propagating an explosion beyond an enclosure. It is for this reason that explosion protected equipment should be installed or used to ensure the health and safety of workers when working in areas that potentially accumulate gas or dust.

The below criteria were assessed:

- Areas that may contain an explosive atmosphere were identified.
- Installed or introduced electrical equipment was appropriate for the hazardous area classification.
- Explosion protected electrical equipment, both installed and introduced was maintained in an explosion protected state.
- Non-explosion protected equipment was prevented from entering an area classified as hazardous.

With regard to this specific critical control, the following issues were identified throughout the planned inspection program:

- A number of sites displayed poor practices in reclaim tunnels and were commonly misaligned with the hazardous area assessments that had been completed.
- The recommendations from these assessments had also failed to be implemented or had been ignored.
- The maintenance of installations in reclaim tunnels and other hazardous areas was not being completed adequately or by the appropriately qualified persons.
- Some sites had identified other hazardous areas within their operations, however had not completed a hazardous area assessment.
- Not all sites could produce evidence of any assessments in an attempt to align with *MDG 28 - Safety requirements for coal stockpiles and reclaim tunnels.*
- Some sites were not aware that hazardous area classifications can change proportionally to housekeeping (dust zones).
- Qualifications and experience of the personnel completing the hazardous area assessments were absent on some of the reports assessed during the program.
- Site personnel in some instances were not aware of the classification of the hazardous area, and signage was lacking to identify this, hence access for these areas did not include training for people entering.

## Threat:

- Explosive atmosphere

**Critical Control:** PC6.3 Monitoring with inter-tripping

On occasions where explosive atmospheres build up to a level above the LEL, monitoring devices should be implemented and designed to de-energise potential ignition sources. Effective inter-tripping systems will reduce the likelihood of an explosion and should be calibrated and periodically tested to ensure their effectiveness. The following criteria were assessed with regards to this critical control:

- Areas that may contain an explosive atmosphere were identified.
- Ignition sources are de-energised when atmosphere becomes explosive.

With regard to this specific critical control, the following issues were identified throughout the planned inspection program:

- Numerous sites had inconsistencies with regards to the gas monitoring trip levels.
- The function of these sensors was not well understood (i.e. what do they trip).
- Testing arrangements of these systems were variable within reclaim tunnels.
- The application of both ventilation and gas monitoring arrangements was inconsistent at some sites and had not been installed on a risk-based approach.
- While some sites had documented TARP's for tunnel atmosphere levels, the trigger levels were different to the alarm levels recommended in *MDG 28 - Safety requirements for coal stockpiles and reclaim tunnels.*

# Assessment findings by mine

This table presents aggregate assessment findings by critical control providing a summary view of the status of each mine's hazard management processes. Importantly, the system recognises the value of fully implemented and documented controls by awarding an additional point if both elements were assessed as present. More details explaining the assessment system are found at Appendix B.

FIGURE 1. ASSESSMENT FINDINGS FOR THE PLANNED INSPECTION PROGRAM FIRE OR EXPLOSION: ELECTRICAL – SURFACE COAL

| | Electrically generated heat | Explosive atmosphere | | |
|---|---|---|---|---|
| | PC1.1 | PC6.1 | PC6.2 | PC6.3 |
| | Electrical protection | Ventilation | Explosion protected equipment | Monitoring with inter-tripping |
| Mine A | Green | Not applicable | Red | Red |
| Mine B | Red | Not applicable | Red | Red |
| Mine C | Red | Not applicable | Not applicable | Not applicable |
| Mine D | Green | Red | Red | Red |
| Mine E | Red | Red | Red | Red |
| Mine F | Yellow | Red | Red | Yellow |
| Mine G | Red | Green | Green | Green |
| Mine H | Green | Green | Red | Green |
| Mine I | Green | Not applicable | Not applicable | Not applicable |
| Mine J | Green | Green | Green | Green |
| Mine K | Green | Not applicable | Green | Green |
| Mine L | Green | Not applicable | Green | Green |
| Mine M | Green | Green | Green | Green |
| Mine N | Green | Not applicable | Not applicable | Not applicable |
| Mine O | Green | Not applicable | Not applicable | Not applicable |
| Mine P | Green | Green | Not applicable | Not applicable |
| Mine Q | Green | Green | Green | Green |
| Mine R | Green | Green | Green | Green |
| Mine S | Green | Green | Green | Green |
| Mine T | Green | Not applicable | Not applicable | Not applicable |
| Mine U | Green | Green | Green | Green |
| Mine V | Green | Not applicable | Not applicable | Not applicable |
| Mine W | Green | Green | Green | Green |

Green (=100%)
Yellow (>= 80% and <100%)
Red (<65%)
Not applicable

# Notices issued

Of the 23 sites assessed under the inspection program, 20 separate mines received notices relating to the principal hazard fire or explosion with an electrical focus, whilst some mines received notices in relation to other matters. For the purposes of this report, contraventions related to other matters have been removed from the analysis. The notices issued for electrical matters related to fire or explosion were examined in detail and Table 2 below lists the notices issued by type and details.

Table 2. Notices issued for the planned inspection program for fire or explosion: electrical – surface coal

| NOTICE TYPE | TOTAL ISSUED | NUMBER OF MINES |
|---|---|---|
| s.195 prohibition notice | 0 | 0 |
| s.191 improvement notice | 15 | 10 |
| s.23 notice of concerns | 17 | 16 |
| **Total** | **32** | **20** |

Of the combined 32 notices issued, there were some common themes which were apparent throughout the program plan. Table 3 summarises the type of contraventions and outlines the total occurrences encountered. These themes can be related back to the critical controls outlined earlier and identify some trends which are of concern.

Table 3. Notices issued - prevalence of categories of concern

| IDENTIFIED CONCERN CATEGORY | TOTAL OCCURRENCES IN NOTICES |
|---|---|
| Hazardous areas not being maintained appropriately | 7 |
| Protection study not completed, or did not align with installation standards and verification requirements | 6 |
| Various portable electrical tools were not being maintained adequately | 5 |
| Competencies or authorisation processes for working within hazardous areas were not defined or could not be verified | 5 |
| Recommendations from hazardous area classifications, layer of protection analyses, and general audits were not implemented or considered necessary | 5 |
| Hazardous area assessment not current, relevant, or up to date | 4 |
| Inconsistent or substandard gas/ventilation monitoring arrangements within reclaim tunnels | 4 |
| Lack of functional safety controls and documented trip points for gas & ventilation sensors within reclaim tunnels | 4 |
| Insufficient systems to control non-approved electrical equipment within reclaim tunnels | 4 |
| Relevant principal hazard management plan or risk assessment not current or up to date | 4 |
| Storage and charging arrangements for batteries and battery powered equipment was not to standard | 3 |
| Inadequate consultation with Electrical Safety and Health Representative when reviewing relevant elements of the safety management system | 3 |
| Workers and supervisors unfamiliar with controls or requirements for working within hazardous areas | 3 |
| Switch rooms and substations not adequately maintained (including inaccurate single line diagrams) | 3 |
| Lack of detail in reclaim tunnel access procedure in terms of ventilation, accumulation of gases, and purge times etc. | 2 |

# Further information

For more information on safety assessment programs, the findings outlined in this report, or other mine safety information, please contact the NSW Resources Regulator:

| CONTACT TYPE | CONTACT DETAILS |
|---|---|
| Email | cau@planning.nsw.gov.au |
| Incident reporting | To report an incident or injury call 1300 814 609<br>or log in to the Regulator Portal |
| Website | www.resourcesregulator.nsw.gov.au |
| Address | NSW Resources Regulator<br>516 High Street<br>Maitland NSW 2320 |

# Appendix A. Legislative requirements and published guidance relating to the principal hazard of fire or explosion: electrical

The following is a list of legislative requirements for the management of fire or explosion risks referred to in this report as provided by the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 and Work Health and Safety Regulation 2017.

WHS (mines and petroleum sites) regulation 2014, CL 32 Electrical safety

WHS Regulation part 4.7- General electrical safety in workplaces and energised electrical work

NSW Code of Practice: Electrical engineering control plan

MDG 28 - Safety requirements for coal stockpiles and reclaim tunnels

Australian and New Zealand Standards:

- AS/NZS 3000 – Electrical installations “Wiring rules”
- AS/NZS3800 – Electrical equipment for explosives atmospheres – repair and overhaul
- AS/NZS2290.1 – Electrical equipment for coal mines – inspection and maintenance
- AS/NZS 60079.0 Explosive atmospheres – equipment-general requirements
- AS/NZS 60079.17 Explosive atmospheres – electrical installations inspection and maintenance
- AS/NZS 4761.1 Competencies for working with electrical equipment for hazardous areas

# Appendix B. Assessment system explained

The NSW Resources Regulator uses a bowtie framework to proactively assess how mine sites manage their principal hazards. Bowties are a widely used risk management tool that integrate preventative and mitigating controls onto threat lines that relate to a material unwanted event.

As part of program planning, controls were categorised by the NSW Resources Regulator's Mine Safety Inspectorate in accordance with the ICMM handbook. Only controls deemed critical[1] are assessed under a planned inspection program. For a control to be assessed as effective, each of its control supports must be in place and operational.

## Assessment findings

During each mine's onsite assessment, inspectors rate each control support and record the findings. Points are awarded depending on whether there was evidence that the control support had been documented and/or implemented.

For the finding outcomes in this report, points are awarded for each control support identified within a critical control. An effective control support is allocated four points where the control is assessed as fully implemented and documented. An overall assessment result for the critical control is then calculated as a proportion of the maximum possible points for that critical control. For example, if a critical control comprises ten control supports and five were assessed as fully implemented ('documented and implemented') and five were found to be 'not documented and not implemented' then the overall assessment result for that critical control would be 50%.

| FINDING OUTCOME | POINTS |
|---|---|
| Documented and implemented | 4 |
| Implemented but not documented | 2 |
| Documented but not implemented | 1 |
| Not documented and not implemented | 0 |

Critical control calculations also take into account instances where control supports were not applicable to the mine being assessed or when control supports were not able to be assessed during a site visit.

[1] Critical Control Management Implementation Guide, International Council on Mining and Metals (ICMM), 2015.

The overall assessment result for each critical control has been assigned a colour based on the assessment bands presented in the table below. The colour band results are then used to identify industry focus areas requiring improvement.

| CRITERIA | COLOUR |
|---|---|
| An assessment result of 100% of possible points | Green |
| An assessment result of ≥ 80% but < 100% of possible points | Yellow |
| An assessment result of ≥ 65% but < 80% of possible points | Orange |
| An assessment result of < 65% of possible points | Red |