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NSW Resources Regulator

CONSOLIDATED REPORT

SPONTANEOUS COMBUSTION – UNDERGROUND COAL MINES

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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.

The Regulator has 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 report summarises the assessment findings of the program, which covered 9 mines during the period from June 2020 to January 2022.

The threats, consequence and critical controls assessed for the material unwanted event (spontaneous combustion) are shown in Table 1.

Table 1: Threats, Consequence and Critical Controls for the Material Unwanted Event (Spontaneous Combustion – Underground Coal Mines)

THREAT/CONSEQUENCE	CRITICAL CONTROL
■ Oxygen available to coal ■ Adiabatic coal oxidation	PC 1.1 – Ventilation design
■ Oxygen available to coal ■ Adiabatic coal oxidation ■ One or more fatalities	PC 1.2 – Identify and respond to heating

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

Key Findings

Throughout the inspection program, there were several examples where sites could demonstrate a good application in controlling the principal hazard of spontaneous combustion.

Improvement areas were also identified and discussed with the sites during the assessments for managing their spontaneous combustion hazards.

Resource Regulator inspectors were able to share information from other mine sites of work that was being done well to manage the hazards associated with spontaneous combustion, as well as any incidents that had occurred within the mining industry and what controls were applied to prevent a similar type of incident from re-occurring.

Some of these key findings were:

- Risk assessments had been completed in consultation with workers as well as involving internal and external ventilation/spontaneous combustion expertise at most sites.
- Where any incidents of spontaneous combustion had occurred, various stakeholders were involved within the incident investigation as well as developing the necessary controls to prevent a similar type of incident from occurring.
- Spontaneous Combustion Principal Mining Hazard management plans were found to be current and had defined the necessary controls.
- Supervisors and Ventilation Officers were completing inspections as required and any hazards identified during these inspections were documented and recorded. Subsequent controls were outlined within mine inspection hazard reports, which were made available to workers.
- Some sites (mines with a low to moderate propensity to spontaneous combustion) did not have adequate procedures in place for workers to understand or be aware of spontaneous combustion hazards, or workers were not familiar with the sites controls for spontaneous combustion.
- At some mines, sealing off all access drifts and shafts in the event of a significant spontaneous combustion or mine fire event, are still in draft format and infrastructure to complete is not in place.

Recommendations

The planned inspection program identified varying levels of control implementation and effectiveness across all the sites assessed. This highlighted several practices which could be improved to assist in protecting the health and safety of workers when exposed to this hazard. Based on the assessments completed, the recommendations are as follows:

- Mine operators should engage an external spontaneous combustion engineer when completing spontaneous combustion risk assessments and complete a spontaneous combustion test on the seam currently being mined, to determine the ignition temperature of their coal seam(s).
- Mine operators should train and communicate to all workers, the controls developed from their spontaneous combustion risk assessment, such as the requirements for maintaining good ventilation appliance standards, and good ventilation practices.
- Mine operators should ensure where spontaneous combustion hazards have been identified, they must be communicated to workers and the affected area barricaded (physical barrier) to prevent inadvertent access.
- Sites should remove all waste material and stowage from seal sites, and hard floor is established prior to installing any VCD.
- Ventilation Officers, Supervisors, and deputies must thoroughly inspect work areas for spontaneous combustion hazards, and report specifically for signs of spontaneous combustion, rather than generalising the ventilation/statutory report.
- Mine operators should ensure that seals and ventilation devices are installed as designed with the correct wall thickness, the secondary support installed to protect the ventilation device is installed correctly and secure to the roof, and the area around the device has been adequately sealed to prevent leakage .
- Control Room operators should be adequately trained in spontaneous combustion management, alarm recognition, monitoring locations and have a thorough understanding of the TARP's associated with the ventilation management plan and the spontaneous combustion management plan.
- Where any widening/partial widening of roadways is undertaken, the coal ribs should be well supported and sealed, to prevent a possible future leakage path of air, resulting in a

spontaneous combustion event. This is especially relevant on longwall installation access roads.

- Mine operators should complete tasks associated with sealing parts of a mine, or the whole mine, in the event of an emergency.
- Mine operators should consider completing gas drainage of coal seams in sufficient timeframes to allow for reduced air quantities (and pressures), so that return roadways remain below statutory limits, rather than using high ventilation quantities to dilute gas levels.

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 and
- 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 spontaneous combustion – 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 spontaneous combustion
    - a workplace assessment of the implementation of those controls through the inspection of plant and worker interviews.
- Planned assessments, 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

Threats, Consequence and Controls assessed

Threats:

- **Oxygen available to coal**
- **Adiabatic coal oxidation**
- **Critical control:** PC 1.1 – Ventilation design
  - **Control objective:** Cool any heat generated by coal oxidation and reduce oxygen levels in areas not designed to be ventilated.
  - **Performance requirement:**
    1. The spontaneous combustion risk for the mine is understood.
    2. Identified ventilation design controls are documented.
    3. Ventilation design controls direct ventilation to working areas of the mine and minimise leakage paths around VCDs and into goaf areas.

Specific findings for this critical control included:

- All mines reviewed had Risk Assessments and Spontaneous Combustion Management Plans that were current and in date.
- Not all mines had completed training in the Spontaneous Combustion TARPs, and the subsequent response to changes in mine environments that would trigger actions. This was especially relevant to control room operators and newly appointed supervisors.
- All mines had standards for installing ventilation devices to a design, but not all mines completed final inspections and checks to verify that the VCD was installed correctly. This included rib/roof and floor spraying to prevent leakage.
- Secondary support at VCD locations was not always installed onto solid floor, and subsequent inspections showed timber shrinkage had not been corrected.

- Monitoring locations around mine roadways was generally good, and background gas levels were generally well understood.
- Housekeeping standards at some sites required improvement, and it was noted in some cases, that the floor had not been cleaned properly, before the VCD was installed.
- Spontaneous combustion awareness varied considerably across the various mining districts and appeared to correspond with the coal seam R70 rating.

Threats/Consequence:

- **Oxygen available to coal**
- **Adiabatic coal oxidation**
- **One or more fatalities**
- **Critical control:** PC 1.2 – Identify and respond to heating
  - **Control objective**: Action is taken to control a heating when abnormal conditions are identified.
  - **Performance requirement:**
    1. The spontaneous combustion risks for the mine are understood.
    2. The mine ventilation is monitored for gases that may indicate the development of a heating.
    3. Mine workings are inspected for any condition that may indicate the development of a heating.
    4. Action is taken when abnormal conditions are identified.

Specific findings for this critical control included:

- Most sites have completed refresher training for supervisory personnel that included spontaneous combustion, ventilation, and gas management collectively.
- Most sites conduct communication sessions to the workforce upon final seal up of a longwall panel, including seal design, gas monitoring, gas contents, use of nitrogen, balance chambers

and bag sample collection and analysis. This constitutes the spontaneous combustion awareness training for most of the mine personnel.

- Statutory reports include seal and VCD inspections, and indicative signs of any heating. The reports are communicated to supervisors and senior staff, including the Ventilation Officer.
- Most sites have a designated ventilation deputy that completes the weekly seal and VCD inspection and assists the Ventilation Officer complete the monthly ventilation report.
- The level of environmental monitoring is directly related to the propensity for spontaneous combustion of a coal seam. Some sites have significantly more monitoring points than other sites, and as a result, some sites control room operators have a very comprehensive understanding of spontaneous combustion management controls and TARP actions.

Findings by mine

Figure 1 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 – Spontaneous Combustion – Underground Coal Mines – overall results

Mine	Threat	Threat/Consquence
	1. Oxygen available to coal 2. Adiabatic coal oxidation	1. Oxygen available to coal 2. Adiabatic coal oxidation 3. One or more fatalities
	PC1.1	PC1.2
	Ventilate design	Identify and respond to heating
Mine A	Yellow	Yellow
Mine B	Green	Yellow
Mine C	Green	Yellow
Mine D	Green	Green
Mine E	Green	Green
Mine F	Green	Green
Mine G	Green	Green
Mine H	Green	Green
Mine I	Green	Green

Green (=100%)
Yellow (>= 80% and <100%)
Orange (>= 65% and <80%)
Red (<65%)

Notices issued

Of the 9 sites assessed under the inspection program, 6 separate mines received notices relating to the principal hazard of spontaneous combustion, while 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 spontaneous combustion 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 – Spontaneous Combustion - Underground Coal Mines

NOTICE TYPE	TOTAL ISSUED	NUMBER OF MINES
s.195 prohibition notice	-	-
s.191 improvement notice	10	5
s.23 notice of concerns	6	4
Total	**16**	**6**

Of the combined 16 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
Other issues identified in the assessment that were not specific to spontaneous combustion.	5
Documentation relating to controls for ventilation design, including wall thickness, rib/roof/floor areas sprayed and sealed.	5
Workers not familiar with nominated controls on site.	2
Location and number of gas monitoring locations.	1
Training information for workers not clearly defined or detailed in relation to the hazard.	1
Hazard identification and response to increases in carbon monoxide.	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 or log in to the Regulator Portal
Website	https://www.resourcesregulator.nsw.gov.au/
Address	NSW Resources Regulator 516 High Street Maitland NSW 2320

Appendix A. Legislative requirements and published guidance relating to the principal hazard spontaneous combustion

The following is a list of certain legislative requirements for the management of spontaneous combustion 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.

- Work Health and Safety (Mines) Regulation 2014 [NSW]

Subdivision 3

  - Clause 66 Spontaneous Combustion
  - Clause 68 Sealing
  - Clause 70 Goaf Areas and Abandoned or Sealed Workings
  - Clause 71 Ventilation
  - Clause 73 Gas Monitoring

- MDG/TRG 1006 – Technical Reference Guide for Spontaneous Combustion Guideline.

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 integrates 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 results calculation

During the program, each control support assessed at each mine was rated and the findings recorded. Points were awarded depending on whether there was evidence that the control support had been documented and / or implemented. Importantly, the system recognises the value of fully implemented and documented controls by allocating four points if both these elements were present.

For finding outcomes, points were awarded for each control support identified within a critical control. An overall assessment result for the critical control was 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%.

Table 3: Finding outcome and points

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 took 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.

Table 4: Assessment results and colour code

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