NSW GOVERNMENT

NSW Resources Regulator

TARGETED ASSESSMENT PROGRAM

CONSOLIDATED REPORT METEX TAP PROGRAM – FIRE OR EXPLOSION

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Executive summary

This report summarises the findings of a targeted assessments program (TAP) undertaken at 10 underground metalliferous mines in relation to the management of fire or explosion risks.

The findings of the assessments are grouped into those that can be applied to all aspects of the risk management process and those that are specific to the principal hazard of fire or explosion.

General findings included a lack of integration of safety management system documentation, from risk assessment through to developing the fire or explosion principal hazard management plan, principal control plans and subordinate documents. In some cases, fire or explosion principal hazard management plans were not underpinned by a risk assessment and failed to consider all legislated requirements.

Several mines were implementing critical control identification and management processes. It was identified that those mines did not always have a clearly documented plan guiding the selection, implementation and integration of critical control concepts into the existing safety management system. Mines should have clearly documented implementation plans for the introduction of critical controls and ensure the criteria for critical control selection is clearly defined.

The TAP revealed that some mines failed to identify all reasonably foreseeable hazards and risk controls for fixed plant and mobile equipment that was introduced to site. When identifying control measures to manage the risk of fire or explosion at the mine, operators must consider all potential sources of ignition, the arrangements for the prevention, early detection and suppression of fires and the types of equipment for fighting fires.

Where mines used air compressors underground to supply refuge chambers, only one mine identified the hazard associated with compressor failure during an underground fire event and the risk of reticulating contaminated air into refuge chambers. The other mines were unable to demonstrate consideration of the hierarchy of controls to eliminate this hazard, by locating air compressors on the surface.

None of the mines assessed had considered the risk of carbon monoxide build-up in refuge chambers. There is a risk of carbon monoxide build-up in refuge chambers and mine operators must consider this risk. Some manufacturers of refuge chambers do not have a carbon monoxide scrubber in the unit, while others do.

There were various non-compliances relating to the design, construction and management of underground explosives magazines. Mine operators had not audited their underground explosives magazines to verify compliance against the requirements of Australian Standard AS 2187 Explosives – Storage, transport and use, as is required by clause 31(2) of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014.

Background

The TAP provides a planned, risk-based and proactive approach to assessing how effective an operation is when identifying and implementing controls for critical risks. The TAPs apply the following principles:

- a focus on managing prescribed 'principal hazards' from the WHS (M&PS) Regulation
- evaluation of the effectiveness of control measures implemented through an organisation's safety management system
- consideration of the operation's risk profile and the targeting of operations deemed to be highest risk.

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

Each TAP is undertaken by a team of inspectors from various disciplines, such as electrical and mechanical engineering, who work together with the operation's management team to undertake an assessment of the control measures associated with the relevant hazard and their implementation.

Scope

The scope of the targeted assessments includes two elements:

1. a desktop assessment of:
   - compliance against legislation with respect to the management of risks to health and safety associated with fire or explosion at the mine
   - controls the mine has identified to prevent and mitigate the risks to health and safety associated with fire or explosion
   - means the mine has identified to monitor the effectiveness of those controls.
2. a workplace assessment of the implementation of those controls.

The process

The process for undertaking a TAP generally involves the following stages:

- preliminary team meetings, preparation and review of documents
- execution of an on-site assessment involving:

- a site desktop assessment of relevant plans and processes measuring legislative compliance of the relevant plans
- the inspection of relevant site operations.

- discussion and feedback to the mine management team on the findings and actions that need to be taken by the operator.

Managing fire or explosion risks in underground metalliferous mines

Fires and explosions are identified in the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 (WHS (M&PS) Regulation) as a principal hazard that has a reasonable potential to result in multiple deaths in a single incident or a series of recurring incidents.[1]

The WHS (M&PS) Regulation requires mine operators to identify principal hazards and conduct a risk assessment that involves a comprehensive and systematic investigation and analysis of all aspects of risk to health and safety associated with the principal hazard (clause 23) and prepare a principal hazard management plan for each principal hazard (clause 24).

Additionally, the Work Health and Safety Regulation 2017 prescribes the requirement to manage the hazards associated with flammable gas, vapour, mist or fumes and combustible dust (clause 51).

In developing the control measures to manage the risks of fire or explosion, WHS (M&PS) Regulation Schedule 1, clause 6 requires the following matters to be considered:

- the potential sources of flammable, combustible and explosive substances and materials, both natural and introduced, including gas, dust, ores, fuels, solvents and timber
- the potential sources of ignition, fire or explosion, including plant, electricity, static electricity, spontaneous combustion, lightning, light metal alloys, hot work and other work practices
- the potential for propagation of fire or explosion to other parts of the mine
- the potential sources of flammable material with a flash point of less than 61° Celsius, including material on the top of any shaft, outlet or well at the mine
- arrangements for the management and control of the transport and storage of combustible liquids

[1] Clause 5(a) WHS (M&PS) Regulation

- arrangements for the prevention of fires, including the types and location of systems for the early detection and suppression of fires
- the equipment for fighting fire at the mine
- arrangements for the management and control of volatile or hazardous materials in underground mines
- procedures to be used for carrying out hot work at the mine.

Additional information and guidance on managing risks associated with fire or explosion may be available from the published guidance at Appendix A.

Assessment findings

The findings of this assessment are grouped into the following categories:

- **General findings** that can be used to inform all aspects of an operation's safety management and provide valuable information and insight across all sectors and operation types.
- **Specific findings** should be used to inform and improve safety management systems to address this principal hazard.
- **Areas of good practice** observed during targeted assessments that may provide guidance for all mines.

General findings

Document management

Issue: Some mines could not demonstrate integration of safety management system (SMS) documentation from risk assessment through to the fire or explosion principal hazard management plan, explosives principal control plan and subordinate documents. Fire or explosion principal hazard management plans and explosives principal control plans did not reference all subordinate documents for managing risks to health and safety, including procedure documents.

Response: Mine operators must ensure that the SMS provides a comprehensive and integrated system for the management of all aspects of risks to health and safety at the mine.[2]

[2] Clause 13 WHS (M&PS) Regulation

Clause 24(2)(a) of the WHS (M&PS) Regulation requires the principal hazard management plan to 'provide for the management of all aspects of risk control in relation to the principal hazard'. Further detail around this requirement is given in clause 24(3)(a-i) of the WHS (M&PS) Regulation. Mine operators must therefore ensure that principal hazard management plans reference all relevant standards and systems of work used to manage the hazard. The plans need to be accessible and relevant to any person required to access the documents. Additionally, clause 26(6) of the WHS (M&PS) Regulation requires mine operators to prepare an explosives control plan that sets out the means by which the mine operator will manage the risks associated with explosives or explosive precursors at the mine in accordance with clause 9.

Issue: Some mines did not have documented triggers for review of the SMS when changes to work procedures or systems of work occurred. It was also observed that some SMS documents were not reviewed in accordance with the mine's stated review schedules to maintain currency and effectiveness.

Response: Mine operators must ensure that the SMS for the mine is reviewed within 12 months of the commencement of mining operations and at least once every three years after that, to ensure it remains effective. In addition, if a control measure is revised under clause 38 of the WHS Regulations or clause 10 of the WHS (M&PS) Regulation, the operator must ensure that the SMS is reviewed and, as necessary, revised in relation to all aspects of risk control addressed by the revised control measure.[3]

Risk assessment

Issue: It was observed at some mines that risk assessments underpinning the fire or explosion principal hazard management plan failed to consider all surface and underground work areas and work activities at the mine and did not identify all reasonably foreseeable hazards.

Response: Mine operators have a duty to identify reasonably foreseeable hazards[4], and must identify all principal hazards associated with mining operations at the mine site, and must conduct, in relation to all principal hazards identified, a risk assessment.[5] Additionally, mine operators have a general duty to manage risks associated with mining operations, by undertaking risk assessment in accordance with clause 9 of the WHS (M&PS) Regulation.

[3] Clause 17 WHS (M&PS) Regulation
[4] Clause 34 WHS Regulation
[5] Clause 23 WHS (M&PS) Regulation

Risk assessments should consider all areas of the mine and tasks undertaken, to identify all hazards applicable to the site and demonstrate management of risk, by nominating clearly defined risk controls.

Issue: Some mines could not demonstrate that the fire or explosion principal hazard management plan considered mandatory matters identified in Schedule 1, clause 6 of the WHS (M&PS) Regulation and could not clearly demonstrate how identified risks, associated with those matters, were being managed.

Response: When developing control measures to manage risks associated with fire or explosion, the principal hazard management plan must include consideration of matters specified in Schedule 1, clause 6 of the WHS (M&PS) Regulation and must provide for the management of all aspects of risk control in relation to the principal hazard.[6]

Critical controls

Issue: Several mines assessed were implementing a critical control identification and management process. It was identified that some mines did not have a documented plan for implementation and integration into the existing Safety Management System and did not define criteria for the critical control selection.

Response: The International Council on Mining and Metals (ICMM) provides guidance on the implementation of critical control management (CCM) systems. This guidance advises that, 'a successful CCM process will have monitoring and reporting components embedded into business-as-usual operations, this includes integrating scheduled verification activities and reporting into current maintenance and inspection systems'.[7]

Additionally, there should be a fundamental understanding of the critical control approach at all levels of the organisation and a process of review.

In relation to the selection of critical controls, mines should ensure that criteria are clearly defined to ensure a credible and sustainable focus on those controls having the greatest impact in managing risks associated with rare but catastrophic events. The ICMM provides a definition for critical control that may provide guidance in the selection of site-critical controls.[8]

[6] Clause 24 WHS (M&PS) Regulation
[7] Critical Control Management Implementation Guide, International Council on Mining & Metals, 2015, p50
[8] Critical Control Management Implementation Guide, International Council on Mining & Metals, 2015, p53

Training

Issue: While all mine operators demonstrated theory-based worker training in the use of fire extinguishers and fire suppression systems, some interviews with workers identified inadequate practical training in the operation of this equipment.

***Response*:** Mine operators must ensure that each worker at the mine is provided with suitable and adequate information, training and instruction relating to the hazards associated with the work carried out by the worker, the implementation of control measures, relevant parts of the safety management system and the emergency plan for the mine.[9]

Issue: It was identified that some mine operations had not conducted comprehensive testing of the mine emergency plan within the previous 12-month period, as required by clause 93 of the WHS (M&PS) Regulation.

Response: Mine operators must test the emergency plan at intervals of no more than 12 months and as soon as is reasonably practicable after there has been a significant revision to the plan.[10]

When testing the mine's emergency plan, it is recommended that mine operators undertake a scenario-based exercise of a foreseeable emergency event that ensures a rigorous and comprehensive examination of all aspects of the emergency plan and workers' response to the event.

Specific findings

Placement of air compressors underground

Issue: Mines with air compressors located underground were unable to demonstrate adequate consideration of risk of fire to the plant and risks associated with reticulation of contaminated air into refuge chambers in the event of an underground fire at the mine.

Response: Mine operators must manage risks to health and safety associated with mining operations at the mine site in accordance with Part 3.1 of the WHS Regulations,[11] including consideration of the

[9] Clause 39 WHS Regulation, clause 104 WHS (M&PS) Regulation
[10] Clause 93 WHS (M&PS) Regulation
[11] Clause 9, WHS (M&PS) Regulation

hierarchy of controls[12] to eliminate the hazard by locating air compressors at the surface and reticulation systems that cannot be compromised by fire and explosion.

Issue: It was observed that all air compressors located underground were not fitted with fire suppression or a capacity for remote shut-down in an emergency. Mine operators were generally unaware of OEM fitted alarms and automatic shut-down features in the event of an emergency.

Response: When developing control measures to manage the risks of fire or explosion, mine operators must consider the potential sources of ignition including plant, the arrangements for the prevention of fires, including the types and location of systems for the early detection and suppression of fires and the equipment for fighting fire at the mine.[13]

Issue: It was observed that some underground air compressors were not located to ensure that ventilated air passing over the compressor is routed to a return airway, as near as practicable to the compressor.

Response: Mine operators should consider Annex I (General requirements when locating compressors underground), clause 10 of *MDG18 Air compressors – underground use*, which states that ventilating air passing over air compressors should be routed to the return airway, as near as is practicable after passing the compressor.

Issue: Mines with air compressors located underground were unable to demonstrate adequate consideration of risk of fire to the plant and risks associated with reticulation of contaminated air into refuge chambers in the event of an underground fire at the mine.

Response: Mine operators must manage risks to health and safety associated with mining operations at the mine site in accordance with Part 3.1 of the WHS Regulations,[14] including consideration of the hierarchy of controls[15] to eliminate the hazard by locating air compressors at the surface and employing compressed air reticulation systems that cannot be compromised by fire and explosion.

Issue: It was observed that all air compressors located underground were not fitted with fire suppression or a capacity for remote shut-down in an emergency. Mine operators were generally unaware of any OEM fitted alarms and automatic shut-down features inherent in the compressor design.

Response: When developing control measures to manage the risk of fire or explosion, mine operators must consider the potential sources of ignition including plant, the arrangements for the prevention

[12] Clause 36 WHS Regulation
[13] Schedule 1, clause 6, WHS (M&PS) Regulation
[17] Clause 17 WHS (M&PS) Regulation
[17] Clause 17 WHS (M&PS) Regulation

of fires, including the types and location of systems for the early detection and suppression of fires and the equipment for fighting fire at the mine.[16]

Issue: It was observed that some underground air compressors were not located to ensure that ventilated air passing over the compressor is routed to a return airway as near as practicable to the compressor.

Response: Mine operators should consider Annex I (General requirements when locating compressors underground), clause 10 of *MDG18 Air compressors – underground use*, which states that ventilating air passing over air compressors should be routed to the return airway as near as is practicable after passing the compressor.

Explosives control plan and underground explosives magazines

Issue: Some mines could not demonstrate that the explosives control plan had been reviewed and updated as required by legislation and therefore failed to demonstrate currency and effectiveness of the plan.

Response: Mine operators must ensure that the safety management system is reviewed within 12 months of the commencement of mining operations and at least once every three years after that. In addition, if a control measure is revised under clause 38 of the WHS Regulations or clause 10 of the WHS (M&PS) Regulation, the operator must ensure that the safety management system is reviewed and as necessary, revised in relation to all aspects of risk control addressed by the revised control measure.[17]

***Issue*:** Some mine operators produced explosives control plans that included generic design guidelines that did not demonstrate a site risk-based approach to the management of explosives. The control plans lacked adequate detail in relation to the location of explosives magazines, the type and quantity of explosives stored in each magazine, the testing of magazine fire suppression systems and explosives stocktaking procedures.

Response: Operators of a mine site, where there is a risk to health and safety associated with explosives or explosive precursors, must prepare an explosives control plan for the mine that sets out how the operator will manage those risks in accordance with clause 9 of the WHS (M&PS) Regulation.[18]

[17] Clause 17 WHS (M&PS) Regulation
[17] Clause 17 WHS (M&PS) Regulation
[18] Clause 26, WHS (M&PS) Regulation

Issue: It was observed that underground explosives magazines did not comply with requirements of *AS 2187 Explosives – Storage, transport and use,* in relation to design, construction and management.

Response: Mine operators should consider clause 31(2) of the WHS (M&PS) Regulation, which requires mines to store and handle explosives in compliance with AS2187. To achieve compliance, mine operators should undertake a full audit of underground explosives magazines against the requirements of the Australian Standard and consider the diagram in Appendix G, which provides guidance in relation to the design of underground explosives magazines.

Risk controls for mobile and fixed plant

Issue: It was observed at some mines that fire suppression systems and other risk control measures on fixed and mobile plant, including heat shields and lagging, were not always implemented to maximise effectiveness.

Response: When developing risk control measures to manage the risk of fire or explosion, mine operators must consider the potential sources of ignition on fixed and mobile plant and the arrangements for the prevention, detection and suppression of fires.[19]

Mine operators should adopt a risk-based approach to ensure that fire extinguishers provided to fight fire on fixed and mobile plant are located to facilitate safe access to maximise effective response, and that all risk control measures, including heat shields and lagging, are fit-for-purpose and remain effective throughout the lifecycle of the plant.[20]

Mining design guideline (*MDG15 -Mobile and transportable plant for use on mines and petroleum sites*, clause 4.6.1 Fire risk assessment) provides guidance in relation to considerations for risk assessment of fire risks associated with the mobile plant.

***Issue*:** It was observed at some mines that risk assessments to manage fire or explosion risk in relation to diesel equipment generally considered diesel equipment collectively, failing to consider the specific types of diesel equipment at the mine site.

Response: When developing control measures to manage the risk of fire or explosion, mine operators must consider the potential sources of ignition associated with each item of plant having regard to individual characteristics, hazards and risks associated with specific plant.

[19] Schedule 1, clause 6, WHS (M&PS) Regulation
[20] Clause 37, WHS Regulation 2017

Bushfire

Issue: Some mines did not identify a reasonably foreseeable hazard of bushfire in site risk assessments and did not manage risks associated with bushfire as part of the mine's safety management system.

Response: Mine operators must identify reasonably foreseeable hazards that could give rise to risks to health and safety at the mine site,[21] and where identified, must manage the risks in accordance with clause 9 of the WHS (M&PS) Regulation.

As part of managing risks associated with bushfire at the mine, mine operators must ensure that the mine emergency plan includes any site procedures implemented for managing bushfire risks at the mine, as well as details of the people having the competency to fight fires and to train others in firefighting.[22]

Refuge chambers

Issue: In the event of workers relying on a closed air supply in a refuge chamber, there is a risk of excessive build-up of carbon monoxide. Every refuge chamber inspected had a carbon monoxide monitor within the refuge chamber, however not every refuge chamber had the ability to scrub carbon monoxide.

Response: Mine operators must identify reasonably foreseeable hazards that could give rise to risks to health and safety at the mine site,[23] and where identified, must manage the risks in accordance with clause 9 of the WHS (M&PS) Regulation. Mine operators must ensure, so far as is reasonably practicable, that plant is without risks to the health and safety of any person in accordance with section 21(2) of the *Work Health and Safety Act 2011*.

As part of managing risks associated with underground mine fires, mine operators must consider the risk of a build-up of carbon monoxide in refuge chambers.

Areas of good practice

One mine had implemented a risk control intended to prevent smoke dispersing throughout the underground atmosphere, in the event of fire at an underground fuel storage area. The risk control

[21] Clause 34, WHS Regulation 2017
[22] Schedule 7, clause 5 WHS (M&PS) Regulation
[23] Clause 34, WHS Regulation 2017

included a fusible pilot line, that in the event of a fire, caused the normally closed ventilation door to open, creating a ventilation path directly to the return airway.

It was also identified that one mine had installed a carbon monoxide sensor on its underground air compressor that shut off the air compressor when carbon monoxide was detected on the intake. The use of carbon monoxide detectors to shut down an air compressor provides an engineering control for the risk of an underground fire reticulating contaminated air into refuge chambers.

Compliance

Notices were issued by assessment teams in response to the following identified compliance issues.

Notice	In relation to:
Improvement notices, s191 Section 191, *Work Health and Safety Act 2011*	■ Unlabelled opened bulk container in work area containing unknown chemical. ■ Failure to consider reasonably foreseeable hazard of bushfire. ■ Emergency plan identifying disused escapeways as accessible. ■ Underground explosives magazines non-complaint with AS 2187, as is required by clause 31, WHS (M&PS) Regulation. ■ Inoperable fire alarms for electrical switch rooms that were identified as a risk control in risk assessment. ■ Products incorrectly stored as recommended on the safety data sheets. ■ Gas cylinders not segregated as required by the dangerous goods code of practice. ■ Gas cylinders exposed to direct sunlight. ■ Workers from the store were not aware of the immediate hazards and controls of the workplace and did not demonstrate knowledge or understanding for the safe storage and segregation of hazardous substance and dangerous goods. ■ The electrical engineering control plan did not adequately address the requirements of Schedule 2 of WHS (M&PS) Regulation with respect to arc flash management, electrical equipment in hazardous environments, management of batteries, and life cycle management of high voltage switch-gear and transformers.

Notices of concern, s23 Section 23, *Work Health and Safety (Mines and Petroleum Sites) Act 2013*	■ No signs for restricted access to a toxic or corrosive work area. ■ Concerns regarding placement of fire extinguishers. ■ Workers not provided with practical training in the use of fire extinguishers. ■ Concerns regarding inadequate frequency of scenario emergency exercises. ■ Inadequate bunding of lubricants and chemicals. ■ Positioning of heat shield blankets fitted to fuel tanks on mobile plant.

Where to now

The TAP for fire or explosion is now completed for underground metalliferous mines.

This report provides all operators with an opportunity to review their own safety management systems armed with the insight and knowledge gained by the assessment team in regard to the management of fire and explosion risks.

The outcomes of these assessments will provide information that will be used to inform the Regulator's continuing education and compliance activities.

This TAP has identified many common issues related to the approach taken by sites to manage the hazard of fire or explosion. It also highlighted broader issues that were common across mine sites associated with the process of developing, implementing and reviewing risk assessments, management plans and procedures.

Operations should challenge their control measures and ensure risks are being managed, so far as reasonably practicable. Mine operators should ensure they have robust systems in place to verify the effectiveness of their risk control measures.

Issued by

Chief Inspector, Office of the Chief Inspector
NSW Resources Regulator
NSW Department of Planning, Industry and Environment

Further information

For more information on targeted assessment programs, the findings outlined in this report, or other mine safety information, please contact the NSW Resources Regulator. You can find the relevant contact details below.

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Appendix A: Legislative requirements and published guidance material

The following is a list of certain 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.

Legislation, section/clause	Legislative requirements
WHS (M&PS) Regulation, clause 9	Management of risks to health and safety
WHS (M&PS) Regulation, clause 10	Review of control measures
WHS (M&PS) Regulation, clause 13	Duty to establish and implement safety management system
WHS (M&PS) Regulation, clause 17	Review
WHS (M&PS) Regulation, clause 23	Identification of principal hazards and conduct of risk assessments
WHS (M&PS) Regulation, clause 24	Preparation of principal hazard management plan
WHS (M&PS) Regulation, clause 26	Principal control plans
WHS (M&PS) Regulation, clause 31	Explosives and explosive precursors
WHS (M&PS) Regulation, clause 93	Testing of emergency plan
WHS (M&PS) Regulation, clause 104	Duty to provide information, training and instruction
WHS (M&PS) Regulation, Schedule 1, clause 6	Schedule 1 Principal hazard management plans—additional matters to be considered
WHS (M&PS) Regulation Schedule 7, clause 5	Schedule 7 Matters to be included in emergency plan
WHS Regulation, clause 34	Duty to identify hazards
WHS Regulation,	Hierarchy of control measures

clause 36	
WHS Regulation, clause 38	Review of control measures
WHS Regulation, clause 39	Provision of information, training and instruction
WHS Regulation, clause 51	Managing risks to health and safety

The following published guidance material may assist mine operators to manage risks associated with fire or explosion;

MDG18 Air compressors (underground use) (NSW Resources Regulator)

MDG1020 Underground emergency escapes (NSW Resources Regulator)

Safety Bulletin 13-05: Too many underground fires (NSW Resources Regulator)

Code of Practice: Managing risks of hazardous chemicals in the workplace (Safe Work Australia)

Fire and Rescue NSW - Guidelines and general information (Fire and Rescue NSW)

Fire or explosion in underground mines and tunnels (Worksafe New Zealand)

Critical control management (International Council on Mining and Metals)

Critical Control Management Implementation Guide (2015) (International Council on Mining and Metals)

Mines Safety and Inspection Regulations 1995 (WA)