NSW GOVERNMENT

NSW Resources Regulator

PLANNED INSPECTION PROGRAM

CONSOLIDATED REPORT: ENTANGLEMENT – SMALL MINES

June 2021 – March 2022

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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. There 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, we 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 findings from 48 mines in relation to assessments for the hazard of entanglement from June 2021 to March 2022.

The threats, consequences and critical controls assessed for the material unwanted event of entanglement are shown in Table 1. Note that not all critical controls were applicable at all mines.

Table 1: Threats, consequence and critical controls for the material unwanted event – entanglement – small mines

THREAT/CONSEQUENCE		CRITICAL CONTROL
Threat	Engagement with moving parts	PC1.1 – Equipment safeguarding
		PC1.2 – Safe-standing zones
	Unexpected movement of machine parts	PC2.2 – Isolation standards
Consequence	Physical trauma fatality	MC1.2 – Emergency stops

Legislative requirements and published guidance relating to the hazard of entanglement are listed in Appendix A. Figures 1 - 3 present safety compliance findings for each de-identified mine and critical control assessed for the material unwanted event of entanglement. Explanatory notes on the assessment system are also listed in Appendix B.

Key findings

Regulatory compliance action was required at several sites due to various contraventions of the relevant legislation. One site required immediate intervention and was issued a prohibition notice under section 195 of the Work Health and Safety Act 2011, with respect to:

- workers could become entangled with exposed rotating or moving parts of the conveyors located on a mobile crushing plant
- a mobile crushing plant does not have operator controls that are able to be locked into the "off" position to enable the disconnection of all motive power
- workers could become entangled with exposed rotating or moving parts of the fixed crushing plant, screening plant and conveyors located on a mobile crushing plant.

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. Significant issues were identified across several sites in relation to implementation and maintenance of emergency stop controls. These include:

- emergency stop functions (push button, handle, bar, lanyard, etc) were not readily available, maintained, tested, appropriate, or installed correctly
- poor standard of signage for emergency stops or isolation points, including colour, durability, visibility, and isolation requirements.

In addition, it was identified that:

- there was no or little documented requirement for plant isolation, including shut down procedures, identifying all energy sources and isolation points, isolation procedures, control or de-energising all store energy, locks, tagging, testing the isolation is effective, etc
- documentation relating to the principal control plans (Risk Assessments, TARPs, etc.) were not relevant, current, implemented or readily available
- safeguarding features were missing, allowing access to nip, pinch or shear point(s) on mobile or fixed crushing or screening plant, vibrating screening plant springs, belt drives and transfer points
- inspections of safeguarding features were not relevant, current, implemented or readily available
- workers were non-compliant or not familiar with nominated controls (guarding, emergency stop controls, isolation controls/procedures, no-go zones, etc)
- staff were not included in training related to no-go zones and other entanglement controls.

Recommendations

Mine operators should ensure that all emergency stop functions are available and operational at all times. The span of control of each emergency stop device shall cover the whole machine.

Emergency stop devices shall be designed to be easily identified and activated by the operator and others who could need to activate them. The emergency stop device may be one of the following types:

- pushbuttons easily activated by the palm of a hand
- wires, ropes, bars (lanyards, pull wires, etc)
- handles
- foot-pedals without a protective cover, where other solutions are not applicable.

Mine operators should ensure a comprehensive site-based risk assessment for the mechanical and electrical engineering control plan is conducted by a team of participants who are suitably qualified and experienced. The risk assessment should, so far as reasonably practicable:

- identify all hazards on site related to entanglement and implement effective controls to eliminate or mitigate the risk, or reduce it to as low as reasonably practicable (as per hierarchy of controls)
- include a cross-section of the operations workforce, including the site health and safety representative(s), and incorporate any feedback or recommendations from assessments or audits which have been conducted by subject matter experts
- outline the relevant components of the safety management system that address the risk and detail the implementation of the associated controls
- detail where an engineering control has a critical control function, such as safeguarding, isolation points, and emergency stops. The design, functionality, placement, maintenance, and verification requirements should be documented and implemented
- detail where an administrative control has a critical control function, such as safe-standing and no-go zones, including the requirements for accessibility to the document/procedure, manner of display, training content/frequency, practical assessment, and the verification process should be included in the document/procedure.

Mine operators should also ensure that appropriate resources are made available to adequately manage entanglement risks, as well as to validate and verify the effectiveness of controls. These processes should be regularly reviewed to not only confirm compliance, but also identify any deficiencies. As part of this, defined review periods should be implemented as part of a safety management system, and

clearly outline what triggers a review outside of these nominated timelines (such as a notifiable incident).

It is recommended that mine operators, upon reading this report, review their site's relevant risk assessment, principal control plans, and associated documents, to manage the risks associated with entanglement 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, 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:
  - a desktop assessment of:
    - compliance against legislation with respect to the management of health and safety risks associated with entanglement – 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 entanglement.
  - 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, consequences and controls assessed

Threat: Engagement with moving parts

Critical control: PC 1.1 – Equipment safeguarding.

Control objective: Guards prevent people accessing entanglement hazards.

Performance requirement:

- entanglement hazards are identified
- access to entanglement hazards is prevented by equipment safeguarding.

When acquiring or maintaining plant, mine operators must ensure that safeguarding systems for plant have been considered, assessed, implemented, inspected, and maintained. The mine operator should have documented requirements for safeguarding that includes reasonably practicable criteria for guards, interlocks, two-handed controls, and dead man's devices, as well as a checking process for assessing the safeguarding effectiveness.

The documentation should nominate:

- the code of practice – Managing the risks of plant in the workplace
- the standard used to control the hazard, such as the AS4024 series compliance standards or equivalent
- risk assessment of the site hazards requiring safeguards to determine the types of safeguards to be applied
- inspection requirement and frequency, as well as acceptability criteria
- maintenance requirements and process for defect rectification
- training requirements for those inspecting and maintaining safeguards
- verification process to validate effectiveness systems for safeguards are being adhered to.

Regarding this specific critical control, the following issues were identified throughout the planned inspection program:

- guarding was not installed or missing, allowing access to nip, pinch, shear points especially:

  - crusher or screening plant
  - conveyor belt drives, transfer points (feeders, skirts, chutes, bins, etc)
  - springs located on vibrating screens
- no documented systems for safeguarding of machinery, (e.g. guards, interlocks, perimeter fence guarding, presence-sensing systems, etc)
- guarding or access covers were inadequately secured, or did not require a tool to be removed, such as missing bolts, loose bolts that could be undone by hand, over-centre toggles, or cable ties
- installed guarding did not prevent access to nip, pinch, and shear points, especially:
  - crusher or screening plant
  - conveyor belt drives.

Critical control: PC 1.2 – Safe-standing zones.

Control objective: People remain a safe distance from unguarded entanglement hazards.

Performance requirement:

- entanglement hazards are identified
- people comply with safe-standing zone requirements.

When developing systems and procedures for safe-standing zones, the mine operator should consider the following:

- identification of equipment at the site where entanglement hazards cannot be effectively mitigated by hard barriers, either due to the nature of the hazard or the operational requirements of the plant, and that management of proximity to the hazard is a practical and effective control.
- requirements for access to the document/procedure, manner of display, training content/frequency, practical assessment, and verification process should be included in the document/procedure.

Regarding this specific critical control, the following issues were identified throughout the planned inspection program:

- monitoring and reinforcing compliance with safe standing zones through supervisors carrying out inspections, compliance audits and planned task observations was poor or non-existent

- nominated safe distances from unguarded entanglement hazards was not documented
- staff were not included in training related to no-go zones and other entanglement controls
- a lack of access to, or superseded version of, no-go zone and isolation documents.

Critical control: PC 2.2 – Isolation standards.

Control objective: Prevent equipment starting while people are working near entanglement hazards.

Performance requirement:

- entanglement hazards are identified
- plant cannot start when people are working near entanglement hazards
- prevent equipment starting while people are working near entanglement hazards.

When obtaining or overhauling equipment, mine operators must ensure that isolation systems for plant that have been considered, assessed, implemented, inspected, and maintained. The operation should have a site system for isolation that includes a permit system, personal isolation equipment, general site isolation equipment, dissipation of energy and lock-out devices, as well as a verification process for their ongoing effectiveness.

Regarding this specific critical control, the following issues were identified throughout the planned inspection program:

- a lack of signage identifying hazards such as ‘isolate elsewhere before removing guard’, ‘isolation point’, ‘no unauthorised access’, etc
- plant was not fitted with a means of isolating energy sources as described in isolation system or procedures
- not all energy sources (electrical, hydraulic, pneumatic, etc) were identified or could be isolated
- isolation controls (push button, handle, bar, lanyard, etc) were not readily available, maintained, appropriate, or installed correctly
- workers were not given appropriate instruction, information, training, or supervision to ensure that plant had been isolated from all types of energies (electrical, hydraulic, pneumatic, etc) and could not inadvertently re-energise.

Consequence: Physical trauma fatality

Critical control: MC 1.2 – Emergency stops.

Control objective: Enable stopping of the plant in the event a worker becomes entangled.

Performance requirement:

- entanglement hazards are identified
- emergency stops are available and ready for use in the event of an entanglement.

All plant used on site, whether fixed, mobile, permanent, or hired, shall have a method of effectively stopping its operation in the event of an emergency. There are many types of stop controls used in the mining industry that can be used in the event of an emergency, including plant stop buttons, hydraulic stop buttons, conveyor lanyards, and e-stops.

The mine operator should have a system for emergency stops that includes what the functionality of an acceptable emergency stop is and where they should be located, as well as a verification process for their ongoing effectiveness. The system should include the following:

- conduct a risk-based assessment on the design, functionality, and placement of stop controls
- nominate the requirements and operational systems to be applied
- inspection and testing requirement and their frequency
- maintenance requirements and management process while defects are rectified
- training requirements for those inspecting and maintaining nominated emergency stops
- verification process to validate effectiveness systems for e-stops are being maintained.

Regarding this specific critical control, the following issues were identified throughout the planned inspection program:

- poor standard and maintenance of signage for emergency stops, including colour, durability, and visibility
- emergency stop controls (push button, handle, bar, lanyard, etc) not readily available, maintained, tested, appropriate, or installed correctly
- no documented requirements for emergency stops that identify the placement, design, and functionality of e-stops, machine stops, and hydraulic stops
- emergency stops not located in required areas.

Findings by mine

Figures 1 - 3 present 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 if both elements were assessed as present. More details explaining the assessment system are found in Appendix B.

Figure 1: Assessment findings for the planned inspection program – entanglement – small mines – overall results < 65%

	Threat			Consequence
	1. Engagement with moving parts		2. Unexpected movement of machine parts	1. Physical trauma fatality
	PC1.1	PC1.2	PC2.2	MC1.2
Location	Equipment safeguarding	Safe standing zones	Isolation standards	Emergency stops
Mine A	Red	Red	Red	Red
Mine B	Red	Red	Red	Red
Mine C	Red	Red	Red	Red
Mine D	Red	Red	Red	Green
Mine E	Red	Red	Red	Orange
Mine F	Red	Red	Orange	Red
Mine G	Red	Yellow	Red	Red
Mine H	Red	Not applicable	Red	Red
Mine I	Red	Red	Red	Orange
Mine J	Red	Red	Orange	Red
Mine K	Red	Red	Yellow	Red
Mine L	Red	Red	Red	Green
Mine M	Red	Red	Red	Orange
Mine N	Red	Red	Orange	Orange
Mine O	Red	Yellow	Red	Red
Mine P	Yellow	Orange	Red	Red
Mine Q	Orange	Red	Yellow	Red

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

Figure 2: Assessment findings for the planned inspection program – entanglement – small mines – overall results ≥ 65% and < 100%

	Threat			Consequence
	1. Engagement with moving parts		2. Unexpected movement of machine parts	1. Physical trauma fatality
	PC1.1	PC1.2	PC2.2	MC1.2
Location	Equipment safeguarding	Safe standing zones	Isolation standards	Emergency stops
Mine R	Red	Green	Green	Red
Mine S	Red	Not applicable	Yellow	Yellow
Mine T	Orange	Red	Orange	Red
Mine U	Red		Yellow	Green
Mine V	Yellow	Red	Orange	Yellow
Mine W	Red	Yellow	Green	Red
Mine X	Green	Red	Green	Green
Mine Y	Red	Red	Green	Green
Mine Z	Green	Yellow	Yellow	Red
Mine AA	Green	Red	Yellow	Orange
Mine AB	Yellow	Yellow	Orange	Green
Mine AC	Orange	Orange	Green	Green
Mine AD	Green	Orange	Yellow	Orange
Mine AE	Red	Green	Yellow	Green
Mine AF	Red	Yellow	Green	Green
Mine AG	Red	Green	Green	Green
Mine AH	Yellow	Yellow	Yellow	Green
Mine AI	Red	Green	Green	Green
Mine AJ	Green	Red	Green	Green
Mine AK	Yellow	Yellow	Green	Green
Mine AL	Green	Yellow	Yellow	Green
Mine AM	Green	Green	Yellow	Green
Mine AN	Green	Green	Yellow	Green
Mine AO	Yellow	Green	Green	Green

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

Figure 3: Assessment findings for the planned inspection program – entanglement – small mines – overall results = 100%

Location	Threat			Consequence
	1. Engagement with moving parts		2. Unexpected movement of machine parts	1. Physical trauma fatality
	PC1.1	PC1.2	PC2.2	MC1.2
	Equipment safeguarding	Safe standing zones	Isolation standards	Emergency stops
Mine AP	●	●	●	●
Mine AQ	●	●	●	●
Mine AR	●	●	●	●
Mine AS	●	●	●	●
Mine AT	●	●	●	●
Mine AU	●	●	●	●
Mine AV	●	●	●	●

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

Notices issued

Of the 48 sites assessed under the inspection program, 47 received notices relating to the hazard of entanglement, while some 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 entanglement 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 – entanglement - small mines

NOTICE TYPE	TOTAL ISSUED	NUMBER OF MINES / CHPP'S
s.195 prohibition notice	2	1
s.191 improvement notice	49	33
s.23 notice of concerns	23	23
Total	**74**	**47**

Of the combined 74 notices issued, there were some common themes apparent throughout the program plan. Table 3 summarises the common contravention themes encountered. These themes can be related back to the critical controls outlined earlier and identify trends of concern.

Table 3: Notices issued - prevalence of categories of concern

IDENTIFIED CONCERN CATEGORY	TOTAL OCCURRENCES IN NOTICES
Emergency stop controls (push button, handle, bar, lanyard, etc) not readily available, maintained, tested, appropriate, or installed correctly	26
Poor standard of signage for emergency stops or isolation points, including colour, durability, visibility and isolation requirements	21
Documentation relating to plant isolation (shut down, procedures, energy sources, isolation points, locks, tagging, testing, etc) not relevant, current, implemented or readily available	18
Documentation relating to the principal control plans (Risk Assessments, TARPs, etc.) not relevant, current, implemented or readily available	15
Safeguarding features missing allowing access to nip point(s) on crushing or screening plant	14
Inspections of safeguarding features not relevant, current, implemented or readily available	12
Safeguarding features missing allowing access to nip point(s) on vibrating screening plant springs	7
Workers observed to be non-compliant with the nominated controls on site	7
Safeguarding features missing allowing access to nip point(s) on multiple plant	6
No nominated safe distance from unguarded entanglement hazards - no safe standing zones	6
Workers not familiar with nominated controls on site	5
Safeguarding features missing allowing access to nip point(s) on belt drive	5
Safeguarding features installed are ineffective allowing access to nip point(s) on belt drive	5
Safeguarding features missing allowing access to nip point(s) on transfer points (feeders, skirts, chutes, bins, etc)	4
Isolation controls (push button, handle, bar, lanyard, etc) not readily available, maintained, appropriate, or installed correctly	3
Workers not given appropriate instruction, information, training or supervision to ensure that plant has been isolated from all types of energies (electrical, hydraulic, pneumatic, etc) and cannot inadvertently be re-energised.	3

Further information

For more information on safety assessment programs, the findings outlined in this report, or other mine safety information, please contact the 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	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 hazard entanglement

The following is a list of certain legislative requirements for the management of entanglement 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 Regulation 2017:

- Clause 208 - Guarding
- Clause 191 - Emergency stop controls
- Clause 211 - Emergency stops
  - (1) If plant at a workplace is designed to be operated or attended by more than 1 person and more than 1 emergency stop control is fitted, the person with management or control of plant at the workplace must ensure that the multiple emergency stop controls are of the "stop and lock off" type so that the plant cannot be restarted after an emergency stop control has been used unless that emergency stop control is reset.
  - (2) If the design of plant at a workplace includes an emergency stop control, the person with management or control of the plant at the workplace must ensure that:
    - (a) the stop control is prominent, clearly and durably marked and immediately accessible to each operator of the plant
    - (b) any handle, bar or push button associated with the stop control is coloured red
    - (c) the stop control cannot be adversely affected by electrical or electronic circuit malfunction.

Work Health and Safety (Mines and Petroleum Sites) Regulation 2014:

- Clause 44A - Operation of belt conveyors
  - (2a) must ensure that all belts conveyors are fitted with an emergency stop system.
- Schedule 2 - Mechanical engineering control plan:

- (1) The operator of a mine or petroleum site must, in preparing a mechanical engineering control plan, take the following into account in determining the means by which the operator will manage the risks to health and safety from the mechanical aspects of plant and structures at the mine or petroleum site:
    - (b) the reliability of safeguards used at the mine or petroleum site to protect persons from the hazards posed by the plant or structure during each phase of its life cycle.
- (2) A mechanical engineering control plan must set out the control measures for the following risks to health and safety associated with the mechanical aspects of plant and structures at the mine or petroleum site taking into account the matters set out in subclause (3):
    - (a) injury to persons caused by the operation of plant or by working on plant or structures
    - (c) the unintended operation of plant.
- (3) The following matters must be taken into account when developing a control measure referred to in subclause (2):
    - (d) safe work systems for persons dealing with plant or structures including the isolation, dissipation and control of all mechanical energy sources from plant or structures.

Appendix B. Assessment system explained

We use 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 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 10 control supports and 5 were assessed as fully implemented (‘documented and implemented’) and 5 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