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Regulator**

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GROUND OR STRATA FAILURE – SLOPE STABILITY – OPEN CUT COAL MINES

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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.

Due to the various controls that were derived from the bowtie analysis for the principal hazard of ground or strata failure – slope stability within the open cut coal industry, the overall program plan was split into three stages. This report summarises the assessment findings from stage one of the program, which covered 25 mines during the period from September 2020 to March 2021.

For stage one of the program, the threats and critical controls assessed for the material unwanted event (ground or strata failure – slope stability) are shown in Table 1. Stages two and three will cover the remaining controls derived from the bowtie.

Table 1: Threats, Consequence and Critical Controls for the Material Unwanted Event (Ground or strata failure - slope stability – Open cut Coal Mines) – Stage 1

THREAT	CRITICAL CONTROL
<ul style="list-style-type: none"> ■ Ground conditions ■ Natural or induced seismic event 	<p>PC 1.4 – Drilling and blasting practices</p>
<ul style="list-style-type: none"> ■ Unconsolidated material ■ Natural or induced seismic event 	<p>PC 3.4 – Dump to design</p>

Legislative requirements and published guidance relating to the principal hazard of ground or strata failure 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 ground or strata failure. 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 ground or strata failure – slope stability.

Improvement areas were also identified and discussed with the sites during the assessments for managing their ground or strata 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 ground or strata failure, 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 geotechnical engineers at most sites.
- Where any geotechnical failures 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.
- Ground or Strata Principal Mining Hazard management plans were often found to be current and had clearly defined the necessary controls.
- Geotechnical engineers were completing inspections as required and any hazards identified during these inspections were documented and recorded. Subsequent controls were clearly outlined within geotechnical inspection hazard reports which were made available to workers.
- Some sites did not have a procedure in place for workers to access exclusion zones for geotechnical hazards, or workers were not familiar with the sites controls for accessing geotechnical exclusion zones.
- At some mines, workers were unable to access areas where inspections were required, such as highwalls, to establish the condition of the wall as well as any indication of the wall potentially failing.

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 geotechnical engineer when completing ground or strata risk assessments, when any abnormalities occur with drill and blast activities, or any changes required to manage ground or strata conditions.
- Mine operators should train and communicate to all workers the controls developed from their ground or strata risk assessment, such as the requirements for accessing exclusion zones in vehicles or on foot.
- Mine operators should ensure where geotechnical hazards have been identified they must be communicated to workers and the affected area barricaded (physical barrier) to prevent inadvertent access.
- Sites should barricade off access routes to unused mining areas to reduce unnecessarily exposing workers to hazards in these areas.
- Open cut examiners, supervisors, and workers must thoroughly inspect work areas for geotechnical hazards prior to commencing work in their area and ensure all identified hazards are controlled prior to commencing work.
- Mine operators should ensure access is provided for workers to safely conduct inspections of the work areas to establish the condition of walls. Where areas cannot be properly inspected this must be reported and documented in the open cut examiners statutory report.
- Workers who identify any geotechnical hazard must report it to their supervisor immediately, then if safe and possible to do so, prevent access to the area.
- Where any changes are required to the sites drill and blast processes, a change management process should be completed, including a risk assessment with all relevant stakeholders prior to making the change.
- Dump TARPS should be designed to enable all workers to easily understand what controls are required when conditions change, allowing the worker to assist in making the changes.

- Where TARPs or JHA's are in place, workers must read and understand the required controls to work in the area and sign off that they have read and understood the controls.

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 ground or strata failure – 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 ground or strata failure
 - 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 and Controls assessed

Threats:

- Ground conditions
- Natural or induced seismic event
- **Critical control:** PC 1.4 – Drilling and blasting practices
 - **Control objective:** Achieve stable wall conditions.
 - **Performance requirement:**
 1. Blast holes are drilled to design.
 2. Blasts are completed to design.

Specific findings for this critical control included:

- Drill and blast practices were well documented, providing all stakeholders working within the drill and blasting area with accurate information to enable activities to be completed compliant to plans.
- Nearly all sites assessed were using the most up to date tools to transfer accurate information from mine planning to the drill and blast teams working on the ground.
- Drill operators were prepared to source alternative controls to ensure drill holes were drilled to plan when GPS systems fail.
- Drill and blast teams were able to display what was required to conduct drilling in compliance to the plan such as, angle holes, pre-split drilling and what action was to be taken when the plan could not be achieved.
- Most sites had comprehensive blast packs in place which provided information to blast teams as to what was required for each blast to assist them in carrying out their duties in compliance to plans.
- Some sites were introducing down-hole explosive loading data which provides a more accurate record of how much explosives are loaded into each hole.

- Sites had systems in place to manage the transfer of drill hole information such as dipping holes prior, to establish what explosives were required to achieve the blast plan and reduce the risk of misfire or blast fume.
- Sites had a reconciliation process in place to record blasting information for use in future blasts.

Threats:

- Unconsolidated material
- Natural or induced seismic event
- **Critical control:** PC 3.4 – Dump to design
 - **Control objective:** Dumps remain stable
 - **Performance requirement:**
 - Factors that affect dump stability are identified.
 - Dumps constructed to design.
 - Dumps are inspected and monitored to ensure compliance with the design and dumping standards.

Specific findings for this critical control included:

- Dump areas were planned, well documented and communicated. This was demonstrated in weekly plans presented at pre-start meetings and displayed in start-up rooms, and communicated to the workers on the job.
- Dump dozer operators were familiar with hazards on the dump and what action was to be taken when dumps were not to standard.
- Most sites were using GPS systems where plans are uploaded to equipment for workers to monitor dump plan compliance, with some sites having similar systems installed in supervisors' vehicles.
- Several sites have dump TARPs in place to assist all workers to identify the hazards associated with dumps and what controls are required at various levels in the TARP.
- Statutory reports include dump inspection requirements and require TARP levels to be communicated between all shifts.

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 – Ground or Strata Failure – slope stability – open cut coal mines – overall results

Mine	Threat	
	1. Ground conditions 5. Natural or induced seismic event	3. Unconsolidated material 5. Natural or induced seismic event
	PC1.4	PC3.4
	Drilling and blasting practices	Dump to design
Mine A	Yellow	Yellow
Mine B	Green	Yellow
Mine C	Yellow	Green
Mine D	Green	Green
Mine E	Green	Green
Mine F	Green	Green
Mine G	Green	Green
Mine H	Green	Green
Mine I	Green	Green
Mine J	Green	Green
Mine K	Green	Green
Mine L	Green	Green
Mine M	Green	Green
Mine N	Green	Green
Mine O	Green	Green
Mine P	Green	Green
Mine Q	Green	Green
Mine R	Green	Green
Mine S	Green	Green
Mine T	Green	Green
Mine U	Green	Green
Mine V	Green	Green
Mine W	Green	Green
Mine X	Green	Green
Mine Y	Green	Green

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

Notices issued

Of the 25 sites assessed under the inspection program, nine separate mines received notices relating to the principal hazard of ground or strata failure of any substance, 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 ground or strata failure 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 – Ground or Strata Failure – Slope Stability - Open cut Coal mines

NOTICE TYPE	TOTAL ISSUED	NUMBER OF MINES
s.195 prohibition notice	1	1
s.191 improvement notice	7	7
s.23 notice of concerns	4	4
Total	12	9

Of the combined 12 notices issued, there were some common themes which were apparent throughout the program plan. Table 3 summarises the type of contraventions and also 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
Lack of controls to restrict unnecessary or unauthorised workers and vehicles from entering areas with hazardous ground conditions.	6
Documentation relating to controls for ground or strata failure (PHMP, TARPs etc.) not relevant, current, or readily available	5
Workers not familiar with nominated controls on site	4
Lack of controls to restrict vehicles and people from entering drop-off edge or void	4
Training information for workers not clearly defined or detailed in relation to the hazard	3
Hazardous ground controls (face scaling, monitoring, reporting, barriers, catch bunds, etc) not readily available, used, appropriate or maintained.	2
Workers observed to be non-compliant with the nominated controls on site	1

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 ground or strata failure

The following is a list of certain legislative requirements for the management of ground or strata failure 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]
 - Schedule 1 (1) Ground or strata failure (a) (b) (c) (d) (e) (f) (g) (h) (i) (j) (k) (l) (m) (n) (o) (p) (q) (r) (s) (v)
 - Clause 30 Mining induced seismic activity (1) (2) (a) (b) (c) (d) i,ii,iii,iv,v,vi) (f) (g)
- Safety Bulletin SB20-01 Failure of highwalls, Low walls, and Dumps.

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 critical¹ 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 $\geq 80\%$ but $< 100\%$ of possible points	Yellow
An assessment result of $\geq 65\%$ but $< 80\%$ of possible points	Orange
An assessment result of $< 65\%$ of possible points	Red