Resources Regulator
Department of Regional NSW

Consolidated report (stage 3)

Ground or strata failure -slope stability of stockpiles – 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 three of the program, which covered 45 mines during the period from November 2021 to August 2022 and focussed primarily on raw coal and product coal stockpile areas.

For stage 3 of the program, the threats, consequence and critical controls assessed for the material unwanted event (ground or strata failure – slope stability) are shown in Table 1. Stage one was completed in March 2021 and stage 2 was completed in November 2021.

Table 1: Threats, Consequences and Critical Controls for the Material Unwanted Event (Ground or strata failure - slope stability – Open cut Coal Mines) – Stage 3

THREAT/CONSEQUENCE		CRITICAL CONTROL
Threat	Ground conditions *(Steep stockpile face)* Water	PC 1.8 – Stockpile construction
Threat	Ground conditions *(Steep stockpile face)* Voids or other workings beneath *(Stockpile bridging)* Unconsolidated material (Stockpile face overload) Water	PC 1.9 – Stockpile operating procedures
Threat	Ground conditions *(Steep stockpile face)* Voids or other workings beneath *(Stockpile bridging)* Unconsolidated material *(Stockpile face overload)* Water Natural or induced seismic event Spontaneous combustion	PC2.6 – Stockpile monitoring
Consequence	Crushed by falling material Engulfed by falling material	MC2.2 – Stockpile dozer operator protection

Legislative requirements and published guidance relating to the principal hazard of ground or strata failure is listed in Appendix A. Figures 1 and 2 present safety compliance findings for each 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

- Stockpiles were generally constructed and maintained to remain in a stable state.
- Stockpile dozer operators were able to demonstrate adequate knowledge of the stockpile operating procedures that protect them from ground or strata failure hazards. They could explain the controls required for detecting and managing rat-holing or bridging.
- Some sites had not implemented reasonably practicable engineering controls that could minimise / prevent harm to workers from strata failure incidents. These include GPS guidance, tilt switches and in-dozer remote valve/belt shut-off capability.
- Stockpile monitoring and inspection regimes were generally adequate and implemented to the site standard.

Recommendations

- When installing tilt switches on dozers, consider a mechanism for operators to perform an operational check.
- Assess remote shutdown capability on dozers for the reclaim belt or drawdown gates/valves, in case of delayed/failed communication with the control room or train load-out operator.
- Conduct simulated emergencies involving dozers on coal stockpiles.
- Where direct line of site is not available for control room or train load-out operators, to view dozers pushing into draw down points, CCTV cameras should be installed.

Assessment findings

Threats, consequence and controls assessed

Threats:

- ground conditions

  (Steep stockpile face)
- water

Critical control: **PC1.8 – stockpile construction**

— Control objective: Stockpiles remain stable during their design lifespan.

— Performance requirement:

1. Stockpile construction is identified as a control for stockpile instability.
2. Stockpiles are constructed to be stable.

Specific findings for this critical control included:

- Stockpiles are generally well maintained, though recent above average rainfall created issues with equipment access.
- Heavy/light vehicle interaction controls could be improved, particularly in stacker reclaimer areas as well as around coal bins.
- Any out-of-specification coal is usually separated into isolated stockpiles or placed in drying cells.
- Some sites roll over coal stockpiles, making it safer for dozer operation and to assist in managing spontaneous combustion.

Threats:

- ground conditions
  (Steep stockpile face)
- voids or other workings beneath
  (stockpile bridging)
- unconsolidated material
  (stockpile face overload)
- water

Critical control: PC1.9 – stockpile operating procedures

— Control objective: stockpiles remain stable during operation.

— Performance requirement:

1. Stockpile operating procedures are identified as a control for stockpile instability.
2. Stockpile operation is controlled.

Specific findings for this critical control included:

- One site did not have GPS guidance installed on dozers where it was deemed reasonably practicable to have the technology to mitigate the risk.
- One site where GPS guidance was installed, however it was not being maintained to an operable standard.
- Some sites the coal train loader operators or control room operators were unable to view the dozer stockpile operation via camera or line of sight.
- Some sites did not have remote shutdown (belt/valves) capability installed on dozers where it was deemed reasonably practicable to have the technology for the risk.
- Most sites had implemented effective training programs for stockpile dozer operations that cover the relevant hazards and controls.
- Sites using a buddy system to train stockpile dozer operators.
- Stockpile operators were mostly familiar with the site stockpile operating procedures and a lot of sites use a task rotation process to assist managing skill levels and fatigue.
- Equipment operators were able to explain the controls required for detecting and managing rat-holing or bridging hazards.
- Most sites have adequate stockpile access protocols such as: boom gates; sign-on/log-on via control room operator to access coal stockpiles; cameras installed on stockpiles and accesses; supervisor/operator inspections; and equipment log-on systems.
- Stockpile height requirements are documented in procedures and are enforced at operations.
- Sites had procedures in place for double-stacking coal on stockpiles.
- Sites had procedures in place for road trucks to assist in managing tipping operations.

Threats:

- ground conditions
  (steep stockpile face)
- voids or other workings beneath

(stockpile bridging)

- unconsolidated material

(stockpile face overload)

- water
- natural or induced seismic event
- spontaneous combustion

Critical control: PC2.6 – Stockpile monitoring

— Control objective: Early warning signs of stockpile instability were detected, and action taken to keep people safe

— Performance requirement:

1. Stockpile monitoring was identified as a control for stockpile instability.
2. Stockpiles were monitored for factors that may impact their stability.

Specific findings for this critical control included:

- One site where the relevant shift inspection reports were not completed to the site standard.
- Coal stockpile inspection requirements differ across sites. Some operations having open cut examiners completing inspections and other sites appoint a competent person such as the CHPP supervisor.
- At most sites the stockpile operators also completed an inspection as part of their operating procedure.
- All sites had a documented process for completing stockpile area inspections and were hand-written or in electronic format.
- Most sites had shift hand-over processes between equipment operators, for the purpose of communicating stockpile conditions and hazards. Formats included whiteboard documentation and stockpile sign on/off reports that referredto operating conditions.
- Open cut examiners/supervisors discussed stockpile conditions and hazards at pre-start meetings.

Consequence:

- crushed by falling material.
- engulfed by falling material.

Critical control: MC2.2 – stockpile dozer operator protection.

— Control objective: stockpile dozer operators are protected from engulfment risks.

— Performance requirement:

1. Stockpile dozer operator protection is identified as a control to protect operators from stockpile instability.
2. Protection devices separate dozer operators from engulfment related hazards.

Specific findings for this critical control included:

- pre-start forms for dozers that did not include some safety critical items
- sites without tilt switches installed on dozers where it was deemed reasonably practicable to have the technology for the risk of ground failure
- breathing apparatuses were not secured within the dozer cabin into a position where it was immediately accessible to the operator, in case of emergency

- the tilt switch installation did not enable a preoperational check by the operator
- many sites had spare equipment for use during maintenance and breakdowns events on permanent stockpile equipment.
- equipment operators were trained in fire suppression systems as part of their dozer operator training
- sites had documented the required training for equipment operators in the use of breathing apparatuses
- very few sites conducted simulated emergencies involving dozers on coal stockpiles.

Findings by mine

Figures 1 and 2 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 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 – Stage 3 – overall results < 100%

	Threat			Consequence
	1. Ground conditions (steep stockpile face) 4. Water	1. Ground conditions (steep stockpile face) 2. Voids or other workings beneath (stockpile bridging) 3. Unconsolidated material (stockpile face overload) 4. Water	1. Ground conditions (steep stockpile face) 2. Voids or other workings beneath (stockpile bridging) 3. Unconsolidated material (stockpile face overload) 4. Water 5. Natural or induced seismic event 6. Spontaneous combustion	2. Crushed by falling material 3. Engulfed by falling material
	PC1.8	PC1.9	PC2.6	MC2.2
Mine	Stockpile construction	Stockpile operating procedures	Stockpile monitoring	Stockpile dozer operator protection
Mine A	●	●	●	●
Mine B	●	●	●	●
Mine C	●	●	●	●
Mine D	●	●	●	●
Mine E	●	●	●	●
Mine F	●	●	●	●
Mine G	●	●	●	●
Mine H	●	●	●	●
Mine I	●	●	●	●
Mine J	●	●	●	●
Mine K	●	●	●	●

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

Figure 2: Assessment findings for the planned inspection program – Ground or Strata Failure – Slope stability – Open cut coal mines – Stage 3 – overall results = 100%

	Threat			Consequence
	1. Ground conditions (steep stockpile face) 4. Water	1. Ground conditions (steep stockpile face) 2. Voids or other workings beneath (stockpile bridging) 3. Unconsolidated material (stockpile face overload) 4. Water	1. Ground conditions (steep stockpile face) 2. Voids or other workings beneath (stockpile bridging) 3. Unconsolidated material (stockpile face overload) 4. Water 5. Natural or induced seismic event 6. Spontaneous combustion	2. Crushed by falling material 3. Engulfed by falling material
	PC1.8	PC1.9	PC2.6	MC2.2
Mine	Stockpile construction	Stockpile operating procedures	Stockpile monitoring	Stockpile dozer operator protection
Mine L	●	●	●	○
MIne M	●	●	●	●
MIne N	●	●	●	○
Mine O	●	●	●	●
Mine P	●	●	●	○
Mine Q	●	●	●	●
Mine R	●	●	●	●
MIne S	●	●	●	○
Mine T	●	●	●	○
Mine U	●	●	●	●
Mine V	●	●	●	●
Mine W	●	●	●	●
Mine X	●	●	●	○
Mine Y	●	●	●	●
Mine Z	●	●	●	●
Mine AA	●	●	●	○
Mine AB	●	●	●	○
Mine AC	●	●	●	●
Mine AD	●	●	●	○
Mine AE	●	●	●	●
Mine AF	●	●	●	○
Mine AG	●	●	●	●
Mine AH	●	●	●	●
Mine AI	●	●	●	●
Mine AJ	●	●	●	○
Mine AK	●	●	●	●
Mine AL	●	●	●	●
Mine AM	●	●	●	●
Mine AN	●	●	●	○
Mine AO	●	●	●	●
Mine AP	●	●	●	○
Mine AQ	●	●	●	●
Mine AR	●	●	●	●
Mine AS	●	●	●	●

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

Notices issued

Of the 45 sites assessed under the inspection program, 13 separate mines were issued notices relating to the principal hazard of ground or strata failure, 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 – Stage 3

NOTICE TYPE	TOTAL ISSUED	NUMBER OF MINES
s.195 prohibition notice	-	-
s.191 improvement notice	10	9
s.23 notice of concerns	4	4
Total	**14**	**13**

Of the combined 14 notices issued, there were some common themes that were apparent throughout the program plan. Table 3 summarises the type of contraventions. These themes can be related back to the critical controls outlined earlier and identify some trends that were of concern.

Table 3: Notices issued - prevalence of categories of concern

IDENTIFIED CONCERN CATEGORY
No remote shutdown (belt/valves) capability on dozers.
No GPS guidance on dozers and one site where it had been installed however was not operational.
Dozers not having a tilt switch.
Pre-start form for dozers did not include some safety critical items.
Tilt switch installation does not enable a pre-operational check by the operator.
Coal train loader operators unable to see the stockpile dozers (via camera or line of sight).
No simulated emergencies had been undertaken for dozers pushing into reclaim valves.

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@regional.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 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 2022 and Work Health and Safety Regulation 2017.

WH&S (MPS) 2022 Schedule 1 Part 1 Ground or strata failure

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.

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.

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

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