NSW Resources
Resources Regulator

Consolidated report

Coal mines - uncontrolled gas or dust explosion review

July 2024 to August 2024

Published by the Department of Primary Industries and Regional Development

Title: Consolidated report – coal mines - uncontrolled gas or dust explosion review

First published: September 2024

Department reference number: RDOC24/140366

More information

Amendment schedule		
Date	Version	Amendment
September 2024	1.0	First published

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Executive summary

An incident occurred at Grosvenor Mine in Queensland on 29 June 2024. There was an ignition of gas observed in the tail gate of longwall 105 panel and mine workers were evacuated from the mine. Post evacuation of workers, the gas ignition developed into a large uncontrolled fire, with dense smoke emitted from the return ventilation shaft. The mine required to be sealed to control the fire event.

The Resources Regulator was notified of the incident by the Queensland Coal Inspectorate (Resources Safety and Health, Queensland).

In response, the Resources Regulator carried out an inspection program with the purpose to assess the status of risk control management and incident mitigation relevant to this type of event in NSW underground coal mines. The assessments specifically targeted 8 underground coal mines with longwall mining operations and methane present as a seam gas.

In the absence of detailed information regarding the Grosvenor Mine gas ignition and contributory factors leading to the major fire event requiring the mine to be sealed, the Regulator's assessment reviewed the following criteria: ignition sources, ventilation and gas management controls and post-incident responses for mine monitoring and sealing.

The Regulator assessments have resulted in several recommendations to underground coal mine operators including the use of polymerics, post incident monitoring and emergency sealing arrangements.

Assessment program

The Regulator's assessment program was conducted between July and August 2024 at 8 underground coal mines.

The assessments reviewed the implementation, integrity, and effectiveness of proactive (P) and reactive (R) controls at each mine site, including assessment criteria types:

- ventilation (P)
- gas drainage (P)
- gas monitoring (P)
- ignition sources (P) (frictional ignition, spontaneous combustion and polymerics)
- incident management (R)
- mine sealing (R)

Assessment criteria

The Regulator's assessment reviewed 8 individual criteria types and specific criteria question were developed for a control documentation assessment (CDA) and a control implementation assessment (CIA) questionnaire review at the mine site. A tabulation of the criteria type and CDA and CIA criteria questions is provided in Table 1.

Table 1. Criteria types (CDA & CIA criteria) for assessment program - fire or explosion – underground coal mines

Criteria type	CDA Criteria	CIA Criteria
Prevention - ventilation	1. What factors have been considered in designing the longwall ventilation system? 2. Verify the recent longwall ventilation performance.	1. Verify understanding of longwall ventilation requirements. 2. Verify longwall ventilation quantities and gas levels. 3. Verify ventilation control devices. 4. Verify control of MG regulator. 5. Verify TG gas levels. 6. View copy of monthly ventilation report
Prevention - gas drainage	3. What factors have been considered in designing the Longwall gas drainage system? 4. Provide an overview of the current gas drainage system. 5. Have critical controls to manage gas drainage been identified? 6. The performance of the gas capture system is monitored 7. View procedures for holing of drainage holes 8. Flame traps or other arrangements for preventing ignition source at gas plant affects the underground	7. Verify areas of the current gas drainage system as nominated. 8. Verify inspections nominated. 9. Verify the performance of the gas capture system is monitored.
Prevention – gas monitoring	9. What factors have been considered in longwall ventilation monitoring design? 10. Identify areas where gases may have the potential to result in an explosive range. 11. Methane Gas Monitoring 12. Confirm procedures are in place to remove hazardous energy source before the atmosphere becomes explosive. 13. Verify tube bundle system 14. Verify availability of monitoring post incident?	10. Methane Gas levels. 11. Verify methane Gas Monitoring is in place and compliant. 12. Verify LW panel intakes, face, immediate TG area and return airway are in the target range. 13. Verify Control room arrangements. 14. Verify Gas monitoring.
Incident management	15. Verify maintenance of the management system during deteriorating conditions 16. Verify review of incidents/alerts/bulletins from other sources	

Criteria type	CDA Criteria	CIA Criteria
Ignition sources - frictional ignition	17. The mine should consider potential ignition sources 18. Likely ignition sources have been identified and appropriate controls implemented to address each source.	15. Verify controls in place and maintained for: • Pick and spray maintenance • Inspect picks and sprays, including replaced picks • Collision avoidance Shearer to shield, bolts etc • Operational controls – horizon, mining through structure, bore holes • Frictional ignition Management plan training completed • Review ATM and discuss understanding with deputy and operator • Check understanding of procedures and controls for intersecting boreholes
Ignition sources - spontaneous combustion	19. Verify the spontaneous combustion risks for the mine are understood – history, rider seams, coal left in goaf 20. Verify the mine ventilation is monitored for gases that may indicate the development of a heating. 21. Verify mine workings are inspected for any condition that may indicate the development of a heating. 22. Verify action is taken when abnormal conditions are identified.	16. Verify inspections and mining officials. • The mining official with responsibility for applying the Spontaneous Combustion TARP can explain the TARP L1 triggers and responses. • The mining official with responsibility for applying the Spontaneous Combustion TARP can explain the TARP levels that would trigger a withdrawal from the mine. • People who carry out inspections can recall the inspection frequency and relevant spontaneous combustion related criteria outlined in the inspection plan. 17. Verify people who collect bag samples can recall the site procedure for collecting bag samples
Ignition sources - polymerics	23. Verify are polymerics used for strata support/remediation? 24. Verify are polymerics used in coal? 25. Verify what is the maximum reaction temperature of the polymerics used? 26. Verify what is the thermal runaway temperature of your coal? 27. Verify what post use tests/inspections are carried out prior to restarting after applying polymerics?	18. Verify are locations of polymeric application recorded? 19. Verify Is there a record of post use inspections/tests? • Are relevant personnel aware of the post use inspections and tests? • What are the triggers for re-starting after the application of polymerics?

Criteria type	CDA Criteria	CIA Criteria
Mitigating - mine sealing	28. Verify does the mine have arrangements for sealing all, or part of, the mine (WHS(M&PS)R cl 65 (3) (h) and cl 71)? 29. Verify is the sealing method sufficient for long term sealing? 30. Verify how long would it take to seal the mine? 31. Verify is the sealing equipment readily available? 32. Verify can the sealing be carried out remotely, away from potential blast lines? 33. Verify for partial mine sealing – what are the locations, can it be carried out from the surface? 34. Verify how many entries require to be sealed to totally seal the mine? How many boreholes are required to be sealed? 35. Verify how is the environmental monitoring of the underground and surface areas to be monitored during a sealing operation? 36. Verify are blast zones identified? 37. Testing and maintenance of sealing methods	20. Verify the required facilities, infrastructure, equipment and supplies are available for deployment in a timely manner. 21. Check equipment for partial mine sealing

Assessment criteria findings

In summary the assessment findings were:

- 464 individual findings – CDA (296), CIA (168)
- 43 findings with enforcement action recorded
- 15 findings related to other matters with enforcement action
- A total of 18 notices were issued to 7 mines in the program plan – WHSA s23 (8), WHSA s191 (10)

Figure 1 provides an overall assessment of the findings of the CDA review.

Figure 1. Summary assessment findings overall results by criteria – CDA review

Figure 2 provides an overall assessment of the findings of the CIA review.

Figure 2. Summary assessment findings overall results by criteria – CIA review

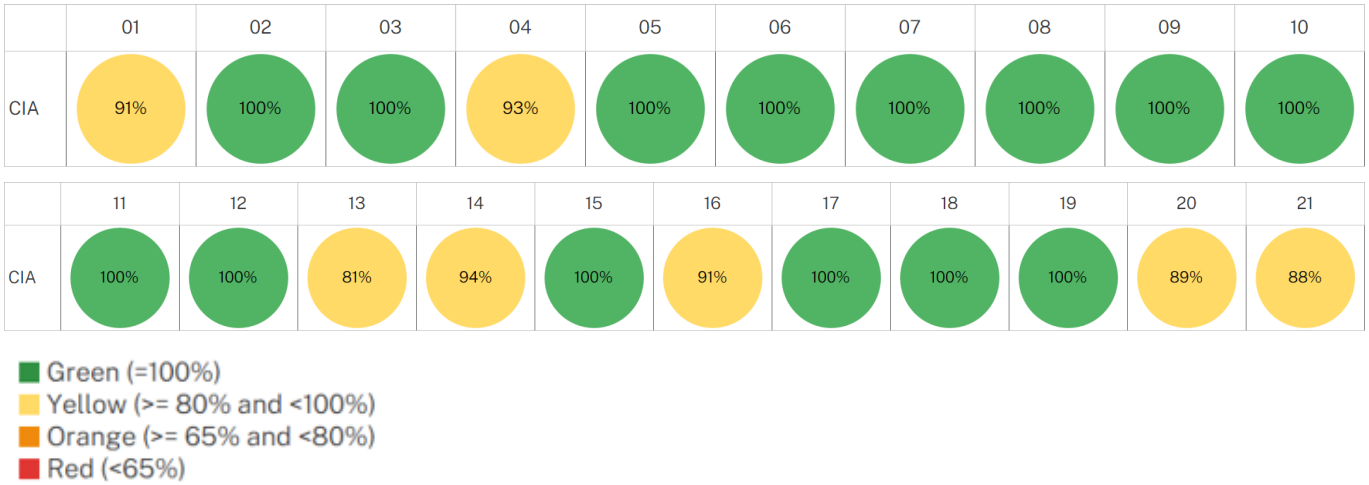


Figure 3 provides the overall total assessment findings of the CDA and CIA review.

Figure 3. Summary assessment findings overall results by criteria – CIA review

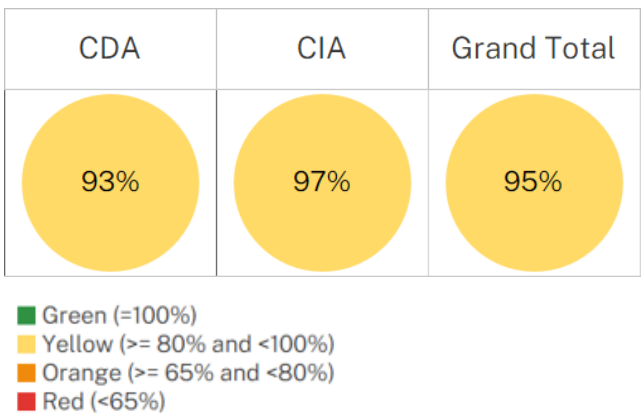


Figure 4 provides a summary of the overall assessment ratings for the CDA and CIA review.

Figure 4. Overall assessment findings ratings for the CDA and CIA review

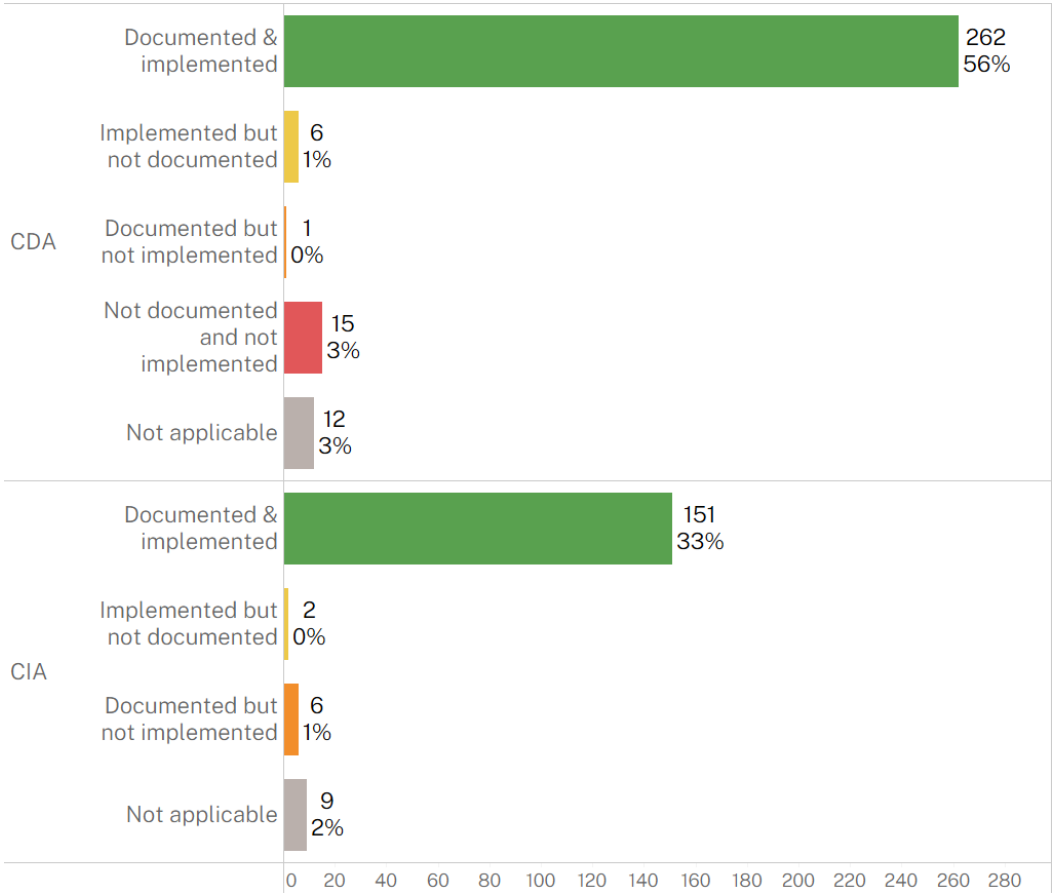
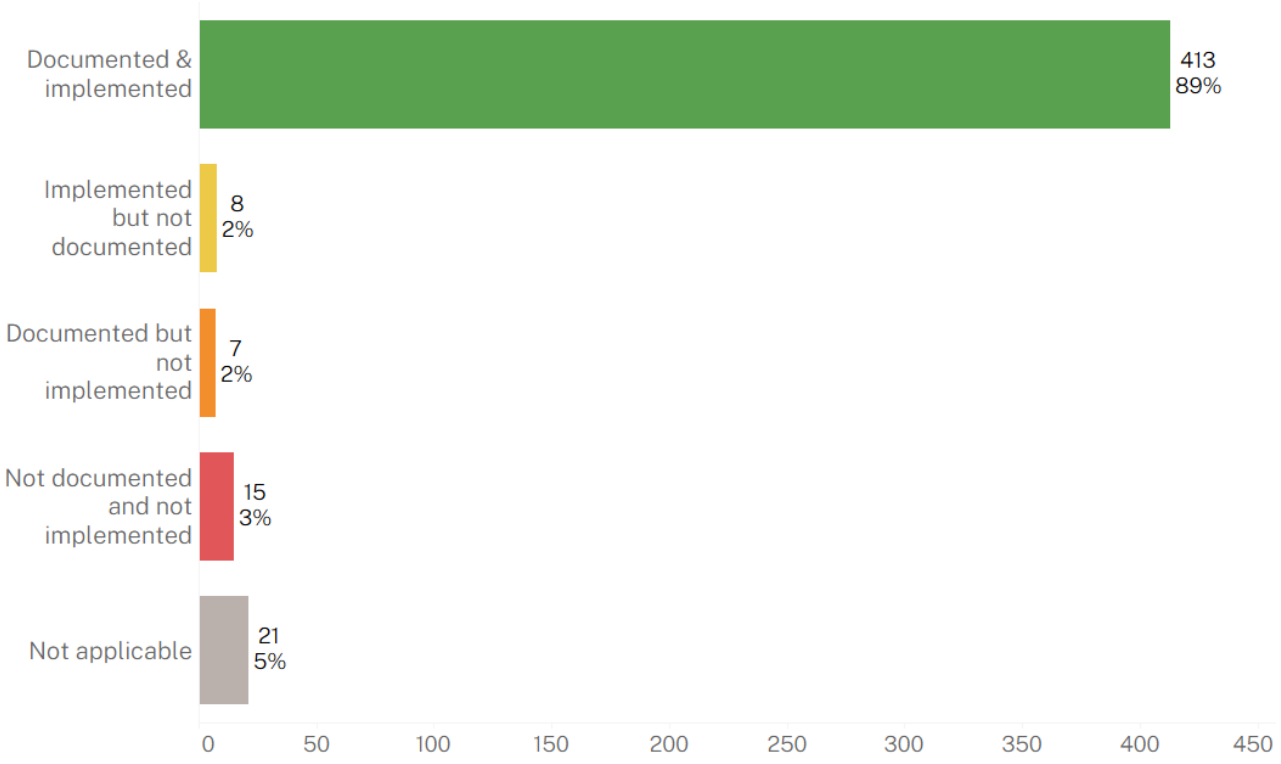


Figure 5 provides a summary of the overall assessment combined ratings for the CDA and CIA review.

Figure 5. Overall assessment ratings for the combined CDA and CIA review



Compliance notices issued

In summary, there were 18 WHSA compliance notices issued to 7 of the 8 coal mines assessed during the assessment program in total. Some sites were issued more than one notice.

Table 2 provides the compliance notices issued to coal mines sites by type:

Table 2: WHSA compliance notices issued by type for coal mine sites

NOTICE TYPE	TOTAL ISSUED	NUMBER OF MINES
s.191 improvement notice	10	5
s.23 notice of concern	8	7
Total	**18**	**7** **Note: some mine sites were issued multiple notices**

Note: Some compliance notices issued concerned items not directly related to the assessment topic. Some notices issued covered more than one topic.

Assessment findings and recommendations

In summary, the assessment findings and recommendations for the criteria types assessed are:

Ventilation (P)

- All coal mines had appropriate ventilation design systems for longwall operations.
- There were a variety of ventilation system techniques used to suit the individual circumstances including perimeter returns, goaf bleed systems, tail gate intake to dilute gases, with quantities specified to match the expected gas makes at the mine.
- Control of the ventilation system was well understood by mining supervisors, and they could describe the parameters and actions to be taken as conditions changed.
- All methane gas levels were in the target range resulting in low tail-gate methane concentrations. The low tail-gate methane gas concentrations resulted in infrequent to zero shearer coal cutting speed reductions.

Gas drainage (P)

- Seven of the eight coal mines assessed had gas drainage systems in place.
- The gas drainage systems consisted of a mixture of in-seam drainage holes for pre-drainage, high goaf holes and gas wells for post drainage, down holes from the seam for some pre-drainage and also post-drainage of lower coal seams.
- All gas drainage systems had sufficient spare capacity to deal with anticipated flows with coal mines running at 10% to 66% of drainage capacity.
- All of the coal mines had mature gas drainage systems based on a well understood gas reservoir model, knowledge of required lead times for drilling and extensive monitoring of the systems.

- The result was the coal mines were operating with low levels of methane gas on the face and in the returns.

Frictional ignition (P)

- All coal mines assessed had appropriate controls in place to the manage the hazard of frictional ignition.
- No issues were identified in relation to frictional ignition management.

Spontaneous combustion (P)

- All coal mines had a good knowledge of their spontaneous combustion potential and had an appropriate management plan for the hazard.
- Mining supervisors understood their duties in relation to spontaneous combustion and the actions to be taken in changing/deteriorating conditions.

Polymerics (P)

- Some of the coal mines assessed used polymerics on a regular basis. Other coal mines used polymerics on a more infrequent time frame.
- The use of polymerics in coal mines has been previously associated with the potential for spontaneous combustion of the coal to be initiated.
- The 3 major types of polymerics used in NSW coal mines are polyurethane resin, urea silicates and phenols.
- The phenols polymerics are normally used for void fillers and have a relatively low reaction temperature. Polyurethane resin and urea silicates polymerics are normally used for strata injection to provide strength and binding of the strata. These can have reaction temperatures between 80 and 100 degrees Celsius.
- Some coal mine operators are using polymerics with a reaction temperature higher than the in-situ coal thermal runaway temperature.

Recommendations (polymerics)

- Coal mine operators injecting polymerics in coal for strata support should consider the reaction temperature of the product in relation to the thermal runaway temperature of the in-situ coal.
- Coall mine operators injecting polymerics into coal where the reaction temperature of the product is approaching or at the thermal runaway temperature of the coal should consider what appropriate post application inspections or tests are to be carried out.

Post incident monitoring (R)

- All coal mines could describe their post-incident monitoring arrangements.
- In most cases, the post incident monitoring arrangements had not fully considered how they would be implemented, and documentation of the plan was found to be poor.
- Post-incident monitoring is of particular importance after an ignition, an explosion, a gas inrush (such as from a major floor break) or an underground fire. In these events if the mine has been

evacuated then it should be recognised that underground power may not be available and uninterrupted power supply (UPS) systems have a limited life for real time monitoring.

- Post-incident monitoring should be based on tube bundle systems.
- One coal mine had identified specific tube bundle points for post-incident monitoring but these had been reallocated for other purposes during a longwall sealing.

Recommendations (post-incident monitoring)

- All coal mines should develop, document and maintain the post-incident monitoring arrangements.
- Post-incident monitoring arrangements should include tube bundle monitoring at strategic locations.
- Where there is a shortage of tube bundle points, consider installing tubes for the required locations to the surface for use in post-incident monitoring.

Emergency sealing (R)

- All coal mines had some level of emergency sealing strategies in place.
- None of the coal mines had planned partial sealing strategies for areas of the mine.
- The coal mine sealing methods included use of fan louvres, drop doors in drifts, void filler spray arrangements, knife-gates on shafts, shaft caps and dozer push over highwalls to cover adits.
- Most coal mines had considered potential blast zones in the sealing arrangements, but some mines still had the sealing activities planned to occur from within the identified blast zone.
- Not all coal mines had considered the inspection and testing arrangements required to maintain their planned sealing activities.
- Coal mines had not considered the potential requirement for the proposed seals to be able to withstand overpressure events or the potential for secondary explosions resulting from the products of combustion from an uncontrolled underground fire.
- No coal mines had considered the sequence of sealing or conducted ventilation modelling to identify a sealing sequence.

Recommendations (emergency sealing)

- Coal mine operators should review their plans for emergency sealing considering the:
  - sequence of sealing
  - modelling required to support the proposed sequence of sealing
  - potential for secondary explosions
  - exposure of personnel to the effects of an explosion during sealing activities
  - resistance of the seals to an overpressure event or the ability to upgrade the seals to provide adequate resistance to an overpressure event
  - inspection and maintenance of the emergency seals.

Further information

For more information on safety assessment programs, the findings outlined in this report, or other mine safety information, please contact the Resources Regulator:

CONTACT TYPE	TOTAL ISSUED
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	Resources Regulator 516 High Street Maitland NSW 2320

Appendix A – Assessment criteria rating

Each assessed criteria is rated from one to 4 based on evidence supporting the expected control supports identified at the mine site.

Evidence supporting expected control supports

Expected control supports	Rating	Evidence supporting rating / comments
	4 3 2 1	

Assessment findings results are calculated based on the total points allocated to the assessed ratings as a percentage of the maximum possible points for each criteria group, and any findings rated as 'Not applicable' were excluded from the calculation.

Criteria assessed ratings and points

Assessed as	Rating	Points
Documented & implemented **Compliant**	4	4
Implemented but not documented **Improvement needed**	3	2
Documented but not implemented **Significant improvement needed**	2	1
Not documented and not implemented **Non compliant**	1	0
Not applicable (N/A)		

Findings results (points) with colours assigned as follows:

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