NSW GOVERNMENT

NSW Resources Regulator

INVESTIGATION REPORT

RIB FAILURE AT CLARENCE COLLIERY

4 July 2018

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Executive summary

Two operators, worker A and worker B, were working in the 806A panel, about 215 metres below the surface, at the Clarence Colliery mine on Wednesday 4 July 2018. Both workers suffered serious injuries when coal and mudstone from the rib collapsed. At the time of the incident, worker A was operating the continuous miner and worker B was the cable hand.

On arriving at the 806A face, worker B identified a section of the rib that he noticed needed barring down. The portion of unstable rib identified by worker B was near the continuous miner.

Workers A and B then assisted a colleague with an unrelated task for a short time before returning to the site where the incident occurred. Worker A started the continuous miner and began operation via remote control. Worker A was positioned on the continuous miner's driver's side, with his back facing the rib and worker B was near the rear boom of the continuous miner. At this time, a large amount of material, made up of coal and mudstone, collapsed from the upper portion of the rib. The material hit both workers, with a large piece of coal and mudstone weighing about 600 kilograms hitting worker A. Worker B was knocked to the ground. A shuttle car driver was alerted to the incident and called for emergency help before rendering first aid. Both workers were air lifted to hospital as a result of their injuries.

Our investigation determined the likely cause of the incident was a combination of:

- overdrive of roof height, which exceeded three metres
- barring down slabs of coal from the ribs left an overhang of material, including coal and mudstone on the upper section of the rib/roof
- the presence of mudstone, layered between the coal and sandstone roof, with known low adhesive quality
- a lack of or inadequate control measures to prevent rib spall.

Recommendations

Mine operators should ensure:

- that ribs are adequately supported, especially in areas where workers are required to operate in close proximity to the ribs
- the mapping of ribs, including the extent and thickness of the mudstone roof, to assist with managing risks to the health and safety of workers associated with rib support
- the review of rib related trigger action response plans (TARPs) to ensure they are up-to-date and appropriately accessible to workers
- that all hazards associated with mining operations are managed in accordance with the hierarchy of controls.

Contents

1. Purpose of the report

This report describes the mining workplace investigation conducted by the NSW Resources Regulator into the cause and circumstances of the incident.

The report has been published under section 70(1)(b) of the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* in order to share lessons and information about the incident with industry and the community, so that proactive steps can be taken to improve industry safety and prevent similar incidents from occurring.

2. Investigation overview

2.1. Resources Regulator

The Regulator investigates major workplace incidents in the NSW mining, petroleum and extractives industries. We carry out a detailed analysis of incidents and report its findings to enhance industry safety and to give effect to our *Compliance and enforcement approach*.

2.2. Legislative authority to investigate

Investigators are appointed as government officials under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and are deemed to be inspectors for the purposes of the *Work Health and Safety Act 2011*. We have also delegated some additional functions to investigators, including exercising the power to obtain information and documents for the purposes of monitoring compliance with the WHS Act.

2.3. Regulator response

Inspectors attended the Clarence Colliery mine on 4 July 2018 after the incident was reported. Initial information was obtained and the scene was secured.

Investigators attended the mine on 5 July 2018. Investigators completed an examination of the incident scene and other areas of the mine that were relevant to the investigation.

2.4. Investigation information release

We published an Investigation Information Release on 20 July 2018. It reinforced the requirement for all mine operators to ensure they identify hazards and manage risks to health and safety associated with ground strata support in accordance with the provisions of the *Work Health and Safety Act 2011*, the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and associated Regulations.

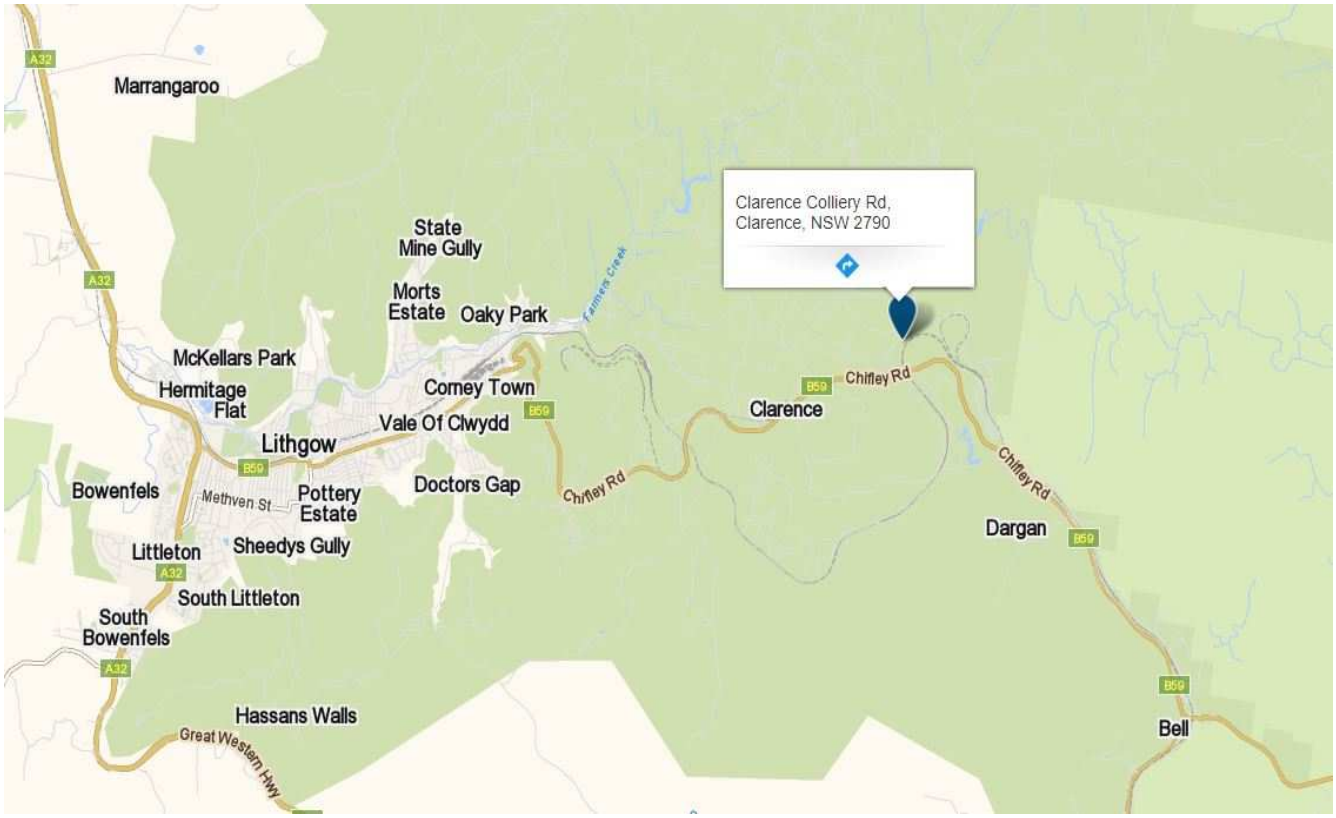
Mine operators were also reminded of their obligations to prepare principal hazard management plans and assess rib conditions during the life of the mine workings.

3. Clarence Colliery

3.1. The mine

Clarence Colliery is 15 kilometres east of the Lithgow township. It is an underground coal mine using the place change partial extraction mining method. It began mining operations in 1979. The mine extracts up to 3 million tons of thermal coal annually, 40 per cent of which supplies coal fired electricity generating power stations. The remainder is supplied to exports markets.

Figure 1 Map identifying the location of Clarence Colliery



3.2. The mine owner

The Clarence Colliery mine holders, at the time of the incident, were Coalex Pty Ltd (ACN 000 694 315) and Clarence Coal Investments Pty Ltd (ACN 003 772 174). Clarence Colliery is an unincorporated joint venture between the following parties:

- Coalex Pty Ltd
- Clarence Coal Investments Pty Ltd
- Centennial Clarence Pty Ltd
- SK Networks Resources Australia Pty Ltd.

3.3. The mine operator

The mine is operated by Clarence Coal Pty Ltd (ACN 083 465 212), owned by Coalex Pty Ltd. Coalex Pty Ltd is entirely owned by Centennial Coal Company Limited (ACN 003 714 538).

Clarence Coal Pty Ltd submitted a nomination of operator to the (then) NSW Department of Primary Industries on 22 February 2007. The form was submitted by Clarence Coal's chief operating officer. The department accepted the nomination, advising Clarence Coal Pty Ltd via a letter dated 14 March 2007. At the time of the incident, Clarence Coal Pty Ltd employed 256 workers. There were 51 workers completing various duties underground on 4 July 2018.

4. Circumstances of the incident

4.1. The incident

When worker B arrived at the 806A face, he identified a section of the rib that he decided needing barring down.

A rib, in an underground coal mine, is the wall of an excavated area and barring down is a process in which workers manually use a scaling tool (a type of crowbar) to knock down sections of the rib that may be unstable. This is done to try to prevent potential injuries to workers and/or damage to property.

The portion of unstable rib identified by worker B was near where the continuous miner was situated at the time of the incident. The barring down was not reported to any other worker, nor was there a requirement to do so, despite worker B's limited experience. The process of barring down pinnacles and columns can result in upper sections of the rib remaining with no support (Figure 2).

Workers A and B then helped a colleague with an unrelated task before returning to the continuous miner and the location where worker B barred down the portion of rib. Worker A started the continuous miner and began operation via remote control. Worker A was positioned on the continuous miner's driver's side, with his back facing the rib and worker B was located near the continuous miner's rear boom. At this time, a large amount of material comprising of coal and mudstone, collapsed from the upper portion of the rib. The material hit the workers with a large block of coal/mudstone weighing about 600 kilogram hitting worker A. (Refer to Figure 3). Worker B was also knocked to the ground.

Figure 2 Potential overhang of unsupported rib after barring down pinnacles or columns (red crosses)

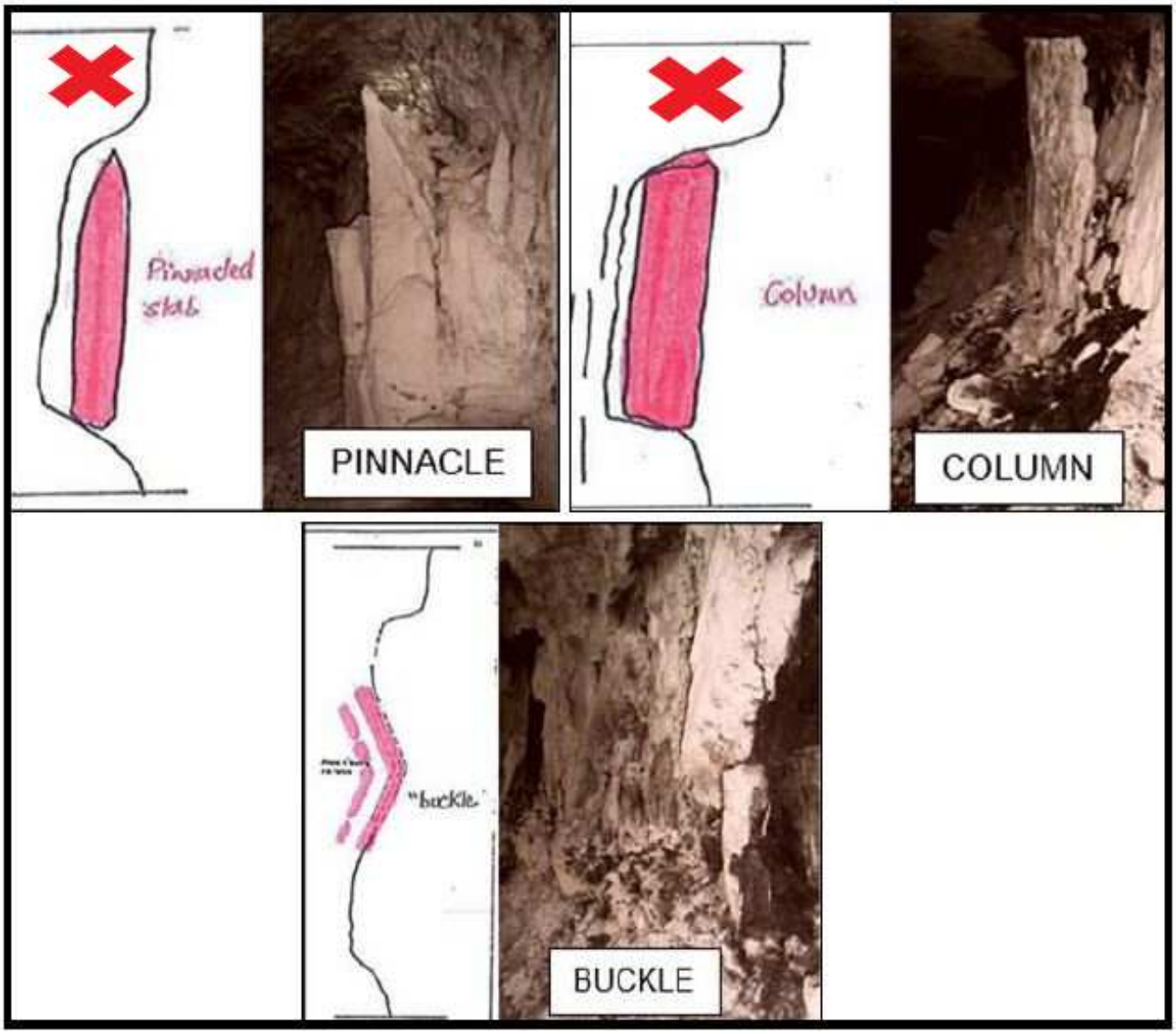


Figure 3 The coal and mudstone block (marked with No.8 'A' frame) which struck worker A

4.2. Location of incident

The incident occurred in 'G' heading of the 806A panel within the underground workings of the mine. The panel and heading were about 215 metres underground within the Katoomba coal seam. Only the roof of the incident site was supported with mesh and bolts in an 8 bolts/2 m 4/4 pattern (Refer to Figure 4).

Figure 4 Photo outbye of the incident site

Before the incident, the mine did not routinely install rib support and was aware of the presence of mudstone (Refer to Figure 5), geological faults within the panel and mud stone slabbing (Refer to Figure 6). In a geological report supplied to the mine in 2016, commissioned to review incidents including rib spall, the mine operator's attention was drawn to the presence of mudstone in various thicknesses and poor cohesion qualities.

Figure 5 Mudstone layer between coal and sandstone roof at incident site and mesh sheets

During an examination of the scene, mudstone was identified within the heading outbye of the incident scene, measuring about 50 millimetres thick and increasing in depth towards the incident site up to 190 millimetres.

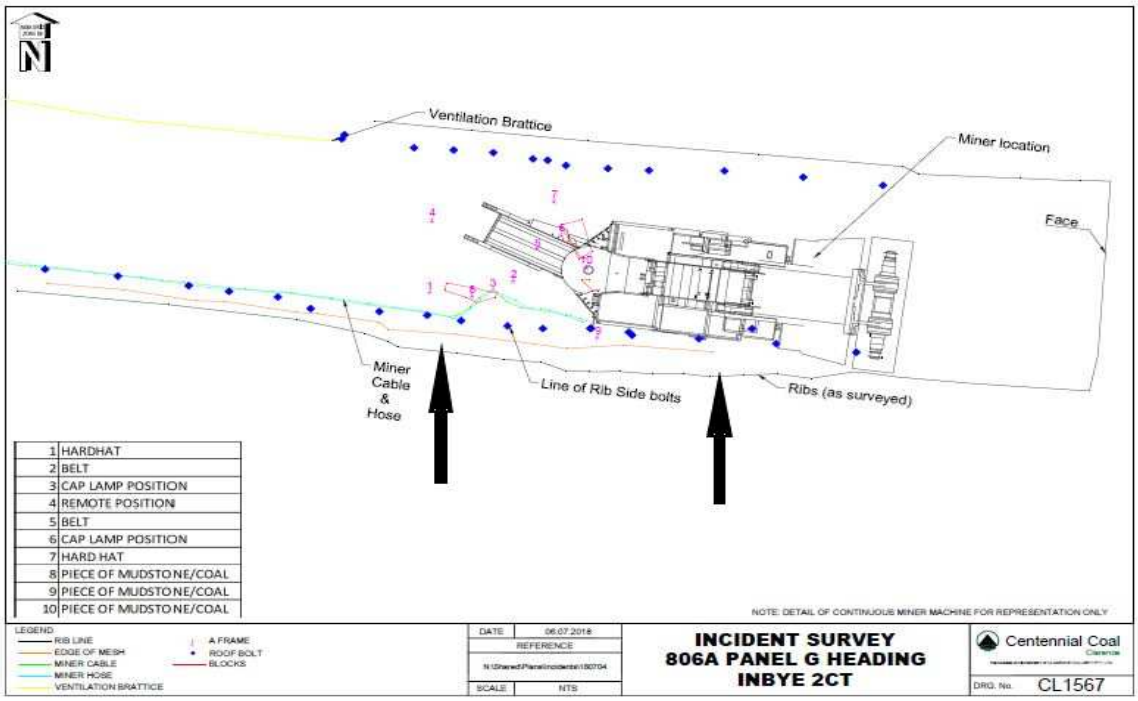
Figure 6 Mudstone roof slabbing supported by mesh and bolts, outbye of incident site

The roof height at the incident scene was measured to be 3.13 metres (Refer to Figure 7).

Figure 7 Roof height measured at rear right of the CM boom to be 3.13 metres

A survey of the right side rib line (looking inbye) completed after the incident, revealed a significant volume of material collapsed from the rib (Refer to Figure 8). As shown in Figures 4, 6 and 7, the installation of roof mesh at the incident site was ordinarily installed to ensure it butted against the rib/roof cornice. Figure 5 shows the distance been the roof mesh and rib post incident.

Figure 8 Survey of the incident site with right side rib (inbye) having collapsed



4.3. Authority to mine

Development of the 806 panel plan was signed by the mining engineering manager on 29 September 2016 and the authority to mine permit was signed as shown in Table 1. Development of the panel began on 20 April 2018.

Table 1 Authority to mine authorisations

Authority to mine	Date signed
Technical services	12 September 2016
Geology	15 September 2016
Ventilation officer	15 September 2016
Mechanical engineer	26 September 2016
Electrical engineer	26 September 2016
Service engineer – conveyors	12 September 2016
Production manager	15 September 2016
Environmental requirements	16 September 2016
WHS	26 September 2016
Mining engineering manager	26 September 2016

4.4. The injured workers

4.4.1. Worker A

Worker A was employed by Clarence Coal Pty Ltd on a permanent basis, as a production operator. The worker began work at the mine on 19 October 1998 and predominantly worked three day shifts each week (Friday, Saturday and Sunday) and overtime as required. At the time of the incident, the worker was completing duties as continuous miner driver.

4.4.1.1. Training

Worker A completed his employer induction when he started at the mine in 1998. He then completed the following additional relevant training:

- Joy 12CM12 Radio Remote CM – completed 4 August 2016.
- Cable management – completed 6 December 2006 and required re-assessment 4 December 2008.
- Conduct local risk assessment – completed 4 August 2009 and required reassessment 3 August 2008.
- Strata failure management plan – completed 16 October 2016.
- Toolbox talk - 18 May 2018 (proposed rib TARP).
- Energy control competency assessment.
- Control and no go zones (general) – completed 1 December 2017.

4.4.2. Worker B

Worker B started to work at the mine on 9 April 2018, three months before the incident, as a cable hand, working day shifts Monday to Friday.

4.4.2.1. Training

Worker B completed an employee induction on the 9 April 2018 and completed the following additional relevant training:

- General induction – 9 April 2018
- Cable management – completed 12 April 2018.
- Conduct local risks assessment – completed 10 April 2018.
- Strata failure management plan – completed 14 April 2018.
- Toolbox talk - 18 May 2018 (proposed rib TARP)
- Control and no go zones (general) – completed 14 April 2018.

4.4.3. The continuous miner

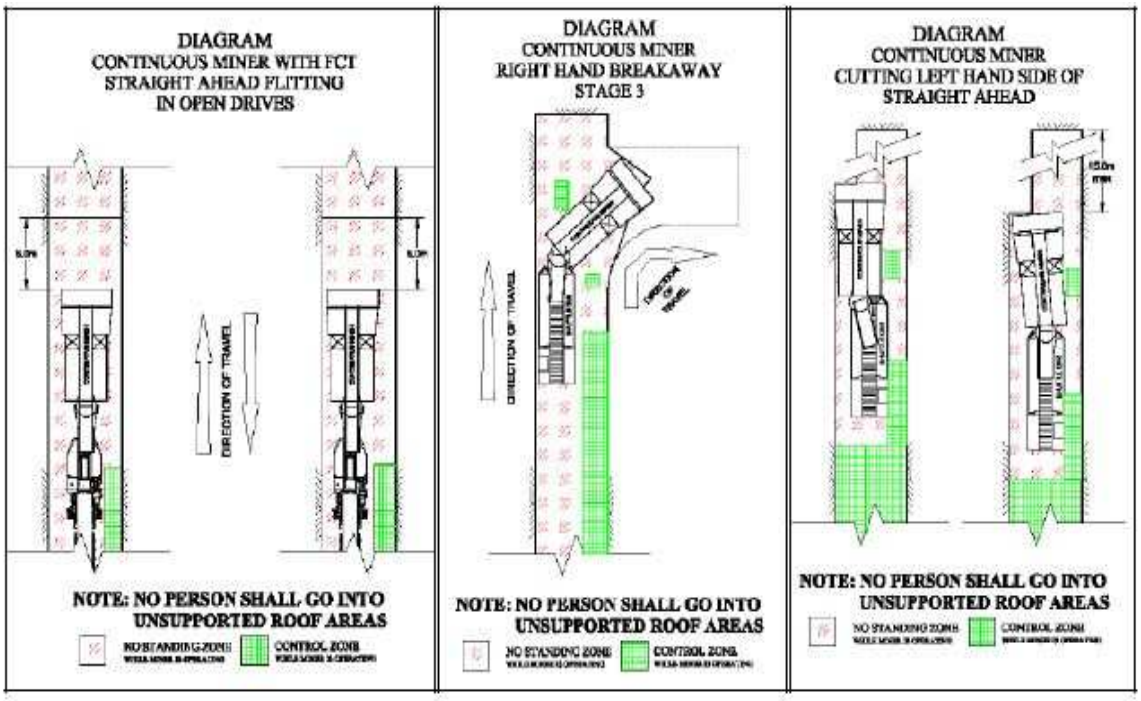
Detail	Description
Continuous miner	CM307
Make and model	Joy 12CM12
Manufacturer	Joy 2003
Serial number	JM4774
Hours of use	6467 as of 2 July 2018

The continuous miner operated at the time of the incident was bought on 1 August 2008 and had a mechanical inspection every 24 hours. It was serviced in accordance with the manufacturer's maintenance schedule.

Figure 9 Continuous miner 806A panel 'G' heading as found by investigators

The operation of the continuous miner required both the continuous miner driver and cable hand to work in close proximity to the ribs. Figure 10 provides an example of the continuous miner control zones identified in green.

Figure 10 Continuous miner operation control zones



4.4.4. Work being performed by workers on day of the incident

4.4.4.1. Undermanager - shift start-up meeting

At 6.45am, all underground deputies met the undermanager. There were six deputies on day shift on the day of the incident. Each deputy was responsible for supervising a designated work area, known as a panel, including workers in that panel. During this meeting, the undermanager provided the deputies with the details of workers allocated to each panel for the shift.

At 7am, a second meeting was held in the area known as the lamp room. All workers attended this meeting. On the day of the incident, the meeting was conducted by the undermanager, who informed workers which panel they had been allocated to for the shift, the strata conditions and the name of their deputy. At the conclusion of the meeting, all workers travelled underground to their designated work panels.

4.4.4.2. Deputies - meeting with workers

The day shift deputy arrived for work at 6.20am and contacted the nightshift deputy for the 806A panel by phone to conduct a verbal handover. During the handover, several issues were discussed including work completed during the night, location of plant and equipment and the condition of strata within the panel. The day shift deputy was informed that the strata condition was moderate.

After attending both the meeting with the undermanager and the general meeting with all workers, the day shift deputy travelled underground to the 808 panel crib room. He viewed the statutory reports completed by the night shift deputy. No safety issues were identified.

The deputy then conducted a meeting with workers, allocating the following tasks.

- continuous miner operator (worker A)
- cable hand (worker B)
- shuttle car operator
- spare hand
- electricians.

At the completion of the meeting all workers left and travelled to the 806A panel to start work.

4.4.4.3. Continuous miner operator

Worker A was tasked as the continuous miner operator. The primary role of the continuous miner driver was to operate the plant to extract and load material into a shuttle car in a continuous operation. The continuous miner, while in operation, is controlled with a remote-control unit.

The mine classifies this role as a multi-skilled production worker.

Worker A provided a statement regarding the incident, in which he described operating the continuous miner and starting the heads. He said:

> '*We moved back into position, I started the heads, next thing I was hit by the rib and I was pushed to the ground.*'

4.4.4.4. Continuous miner cable hand

Worker B was tasked as the cable hand, assisting the continuous miner operator. The primary role of a cable hand was to ensure the electrical cable, powering the continuous miner, did not make contact with the continuous miner during its operation. A cable hand would ensure, while the continuous miner is moving outbye or reversing from its operating position, that all trailing cables were suspended on hooks, normally located parallel to the rib line. A cable hand was also responsible for monitoring the shuttle car movements on behalf of the continuous miner operator.

The mine classifies this role as a multi-skilled production worker.

On arriving at the 806A panel, worker B completed a stop, look, assess and manage (SLAM) risk assessment. Under the heading *'have I checked the RIB or stope and are they safe*' the worker marked 'yes', with the control being to bar ribs when advancing.

During an inspection of the work site, worker B said he identified 'two packers' on the right side rib, in the vicinity of the incident site. This was despite the same location having been inspected by the deputy, who did not identify any section of rib that required barring down. Before the incident, worker B had been trained in the mine's strata failure management plan.

5. The hazard

The mine was aware that coal spall, particularly from ribs, was a hazard to workers and plant. The mine was further aware that variables, including roof height and geological faults, substantially increased the risk of rib spall, especially during production. The mine managed risks associated with rib spall through its mine safety management system.

6. The mine's safety management system

6.1. Safe work procedure 2976 identification of rib conditions in production district

The safe work procedure (SWP) provides guidance to workers in identifying rib hazards, which may cause risks to safety. The three main rib failures are:

- pinnacles
- columns
- buckling mid seam.

Pinnacles and columns were the main rib-related hazards identified. Workers were required to subjectively identify and accurately distinguish if a rib hazard was either a pinnacle or column, as the responses identified in the TARPs to control these hazards differed. For example, a 0.8 metre-thick slab interpreted as a column required rib support, whereas if the same slab was interpreted as a pinnacle, no rib support was required. To help workers to identify rib conditions and the appropriate control or action, the SWP had a rib ranking chart.

6.2. Strata failure management plan

The strata failure management plan (CL-28) (SFMP) version 9, reviewed in December 2017, identified controls and hazards associated with ground or strata failure, including uncontrolled falls of roof and ribs. The SFMP applied to all workers involved in the incident, including mining operations in the

Katoomba seam. Section 4.4 provides information on training and competency requirements relating to the SFMP, indicating employees would be trained in:

> '*support design principals, support plan interpretation, placement and removal of support, understanding the need for and importance of the various support systems and recognition of indicators of change that may affect roadway stability*.'

Section 4.6 indicated that workers would receive specific training in risk management, rib deterioration, TARPs and support plans, deterioration in outbye areas and ribs, including rib spall and poor rib management.

The SFMP identified the following TARP procedures and measures to address risks associated with ribs.

- **Trigger action response plans [schedule 1 part 1 (1)] ground or strata failure**

  This section indicated TARPs would be prepared regarding rib support and stated the TARPs would comply with requirements in accordance with legislation.

- **Methods and systems of work [schedule 1 part 1 (1)] ground or strata failure**

  This section indicated TARPs would provide appropriate support actions for expected strata conditions, including procedure for the installation of rib support.

- **Additional support [schedule 1 part 1 (1)] ground or strata failure**

  This section stated 'nothing in the SFMP or support rules (clause 891 and clause 892) was to be construed as preventing any person from setting more supports or setting supports at more frequent intervals than is required by support rules.'

6.3. Trigger action response plan (TARP) 1232

The TARP assisted workers to identify appropriate support, based on the identified strata level. Electronic versions were available to workers on a computer terminal in the crib room. The hard copy TARP in the crib room was found by investigators to be dated 7 September 2016. It was later found to be outdated, having been replaced by an updated TARP, after a separate rib incident in May 2018 (Refer to section 6.4. below).

The TARP dated 7 September 2016 described three strata levels, the first being normal strata (green), followed by moderate strata (yellow) and lastly, poor strata (red). Normal strata ordinarily did not require any rib support, while both moderate and poor strata required rib support, depending on the triggers being identified. These required a subjective assessment by workers to identify the correct response.

6.4. Trigger action response plan (TARP) 3515 ribs and rib support

TARP 3515, dated 28 May 2018, was a supplement to TARP 1232. There was no copy of this TARP accessible to workers underground. The TARP states its purpose was to:

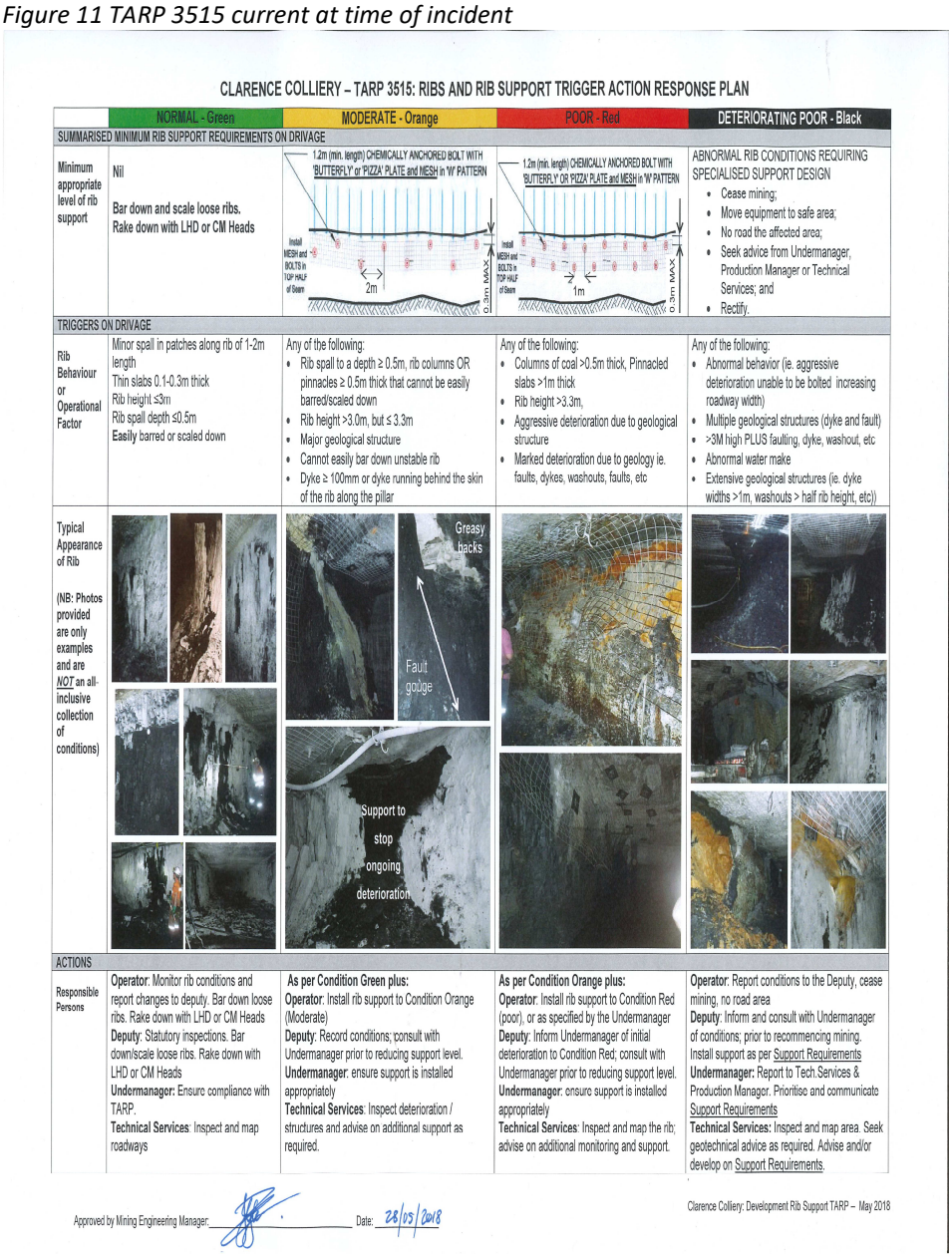
- identify and categorise rib conditions using photographic examples of rib conditions (noting that the photographs are NOT a comprehensive collection of all rib conditions expected to be encountered)
- inform the level of support required for rib support
- document roles and responsibilities regarding identifying, communicating and supporting ribs where required.

The TARP stated:

> '*Nothing in this TARP should restrict anyone from installing more support as deemed necessary*'.

The TARP represented the minimum rib support requirements and was developed as a result of the May 2018 rib incident involving a serious injury to a continuous miner operator and introduced in toolbox talks to workers. Controls in the TARP were colour coded (Refer to Figure 11). Green represented normal rib conditions, with lower end controls and black represented deteriorating ribs, requiring the highest level of controls including rib support. The requirement for higher level rib support (i.e. installing mesh/bolts or a combination) was subjectively determined by workers.

Figure 11 TARP 3515 current at time of incident



CLARENCE COLLIERY – TARP 3515: RIBS AND RIB SUPPORT TRIGGER ACTION RESPONSE PLAN

	NORMAL - Green	MODERATE - Orange	POOR - Red	DETERIORATING POOR - Black
SUMMARISED MINIMUM RIB SUPPORT REQUIREMENTS ON DRIVAGE				
Minimum appropriate level of rib support	Nil Bar down and scale loose ribs. Rake down with LHD or CM Heads	1.2m (min. length) CHEMICALLY ANCHORED BOLT WITH 'BUTTERFLY' or 'PIZZA' PLATE and MESH in 'W' PATTERN Install MESH and BOLTS in TOP HALF of Seam 2m 0.3m MAX	1.2m (min. length) CHEMICALLY ANCHORED BOLT WITH 'BUTTERFLY' OR 'PIZZA' PLATE and MESH in 'W' PATTERN Install MESH and BOLTS in TOP HALF of Seam 1m 0.3m MAX	ABNORMAL RIB CONDITIONS REQUIRING SPECIALISED SUPPORT DESIGN • Cease mining; • Move equipment to safe area; • No road the affected area; • Seek advice from Undermanager, Production Manager or Technical Services; and • Rectify.
TRIGGERS ON DRIVAGE				
Rib Behaviour or Operational Factor	Minor spall in patches along rib of 1-2m length Thin slabs 0.1-0.3m thick Rib height ≤3m Rib spall depth ≤0.5m **Easily** barred or scaled down	Any of the following: • Rib spall to a depth ≥ 0.5m, rib columns OR pinnacles ≥ 0.5m thick that cannot be easily barred/scaled down • Rib height >3.0m, but ≤ 3.3m • Major geological structure • Cannot easily bar down unstable rib • Dyke ≥ 100mm or dyke running behind the skin of the rib along the pillar	Any of the following: • Columns of coal >0.5m thick, Pinnacled slabs >1m thick • Rib height >3.3m, • Aggressive deterioration due to geological structure • Marked deterioration due to geology ie. faults, dykes, washouts, faults, etc	Any of the following: • Abnormal behavior (ie. aggressive deterioration unable to be bolted increasing roadway width) • Multiple geological structures (dyke and fault) • >3M high PLUS faulting, dyke, washout, etc • Abnormal water make • Extensive geological structures (ie. dyke widths >1m, washouts > half rib height, etc))
Typical Appearance of Rib (NB: Photos provided are only examples and are *NOT* an all-inclusive collection of conditions)		Greasy hacks Fault gouge Support to stop ongoing deterioration		
ACTIONS				
Responsible Persons	**Operator**: Monitor rib conditions and report changes to deputy. Bar down loose ribs. Rake down with LHD or CM Heads **Deputy**: Statutory inspections. Bar down/scale loose ribs. Rake down with LHD or CM Heads **Undermanager:** Ensure compliance with TARP. **Technical Services**: Inspect and map roadways	**As per Condition Green plus:** **Operator**: Install rib support to Condition Orange (Moderate) **Deputy**: Record conditions; consult with Undermanager prior to reducing support level. **Undermanager**: ensure support is installed appropriately **Technical Services**: Inspect deterioration / structures and advise on additional support as required.	**As per Condition Orange plus:** **Operator**: Install rib support to Condition Red (poor), or as specified by the Undermanager **Deputy**: Inform Undermanager of initial deterioration to Condition Red; consult with Undermanager prior to reducing support level. **Undermanager**: ensure support is installed appropriately **Technical Services**: Inspect and map the rib; advise on additional monitoring and support.	**Operator**: Report conditions to the Deputy, cease mining, no road area **Deputy**: Inform and consult with Undermanager of conditions; prior to recommencing mining. Install support as per Support Requirements **Undermanager:** Report to Tech.Services & Production Manager. Prioritise and communicate Support Requirements **Technical Services:** Inspect and map area. Seek geotechnical advice as required. Advise and/or develop on Support Requirements.

Approved by Mining Engineering Manager: _____ Date: 28/05/2018

Clarence Colliery: Development Rib Support TARP – May 2018

Table 2: SWP-2976 rib ranking chart

Rank (Higher value more severe):	Visual Rib Condition (may include some or all of listed conditions):	Rib Instability Features (may include some or all of listed conditions) :	Action:
1.	• Rib upright / flat. • Tight.	• No visible cracking or spall. • Strong Coal / Rock bond at the roof horizon.	• No action required.
2.	• Minor Spall. • Mainly tight.	• Minor spall in patches along rib of 1 – 2m length. • Some cracking. • Thin slabs 0.1m – 0.3m thick, not reaching above half seam height.	• Continue to monitor rib behaviour, bar down coal if appropriate.
3.	• Moderate Spall. • Presence of Pinnacled Slabs and / or Columns. • Presence of buckling about mid-seam.	• Pinnacled slabs 0.3m – 1m thick. • Columns of coal 0.3m – 0.5m thick. • Height of slabs reaching approximately 900mm below roof level.	• Bar down coal showing unstable characteristics. • Continue to monitor for further deterioration. • Utilize Miner or LHD to assist barring down of ribs / clean area up if appropriate.
4.	• Decay evident. • Columns and / or Pinnacles common. • Evidence of geological structure through rib. • Mining height and / or roadway width exceeds 3m or 5.5m respectively.	• Columns of coal >0.5m thick. • Pinnacled slabs >1m thick. • Spall either to roof level or to the parting approximately 900mm below roof level. • Marked deterioration due to geological features such as faulting, shearing, washouts and dykes.	• Bar down coal showing unstable characteristics. • Utilize **rib support as per Strata TARP** where high intensity rib decay is evident or likely. • Utilize Miner or LHD to assist barring down of ribs / clean area up if appropriate.

6.5. Interpretation and use of TARPs at the mine

There were several issues identified during the investigation, with the potential to cause confusion to workers with respect to the identification of hazards associated with TARPs and controls.

Table 3 Inconsistencies with TARPs potentially causing confusion to workers

Feature of rib	Response in rib ranking table	Response in rib TARP
Minor spall in patches along rib of 1-2 metres lengths	Monitor and bar down	Monitor and bar down
Thin slabs 0.1-0.3 metres thick		Monitor and bar down
Thin slabs 0.1-0.3 metres thick, not reaching above half seam height	Monitor and bar down	
Pinnacle slabs 0.3-1 metres	Monitor and bar down	Monitor and bar down when >0.5 metres thick. Rib support where >0.5 metres thick and hard to bar down
Columns of coal 0.3-0.5 metres thick	Monitor and bar down	Monitor and bar down
Height of slabs reaching 900 millimetres below roof level	Monitor and bar down	Doesn't specify
Columns of coal >0.5 metres thick	Bar down and utilise rib support as per TARP	Install rib support
Pinnacle slabs >1 metre thick	Bar down and utilise rib support as per TARP	Install rib support
Spall either roof level or parting approximately 900 millimetres below roof level	Bar down and utilise rib support as per TARP	Doesn't specify
Rib height >3 metres	Install rib support	Install rib support

6.6. Standard 2397 – Continuous Miner Control Zones

The introduction to the Standard states:

> '*The Clarence Colliery Continuous Miner Control Zone Plan is intended to provide controls, guidelines and awareness for all persons at the mine site that operate and work within areas of the operation of the continuous miner*.'

And the purpose states:

> '*This standard demonstrates the requirement of individuals at Clarence Colliery to understand the operational Control Zones for a Continuous Miner*'

The Standard provided guidance for workers, indicating locations of risk and safe standing zones while operating the continuous miner. Areas identified in red are areas or positions where workers should not place themselves, while areas identified in green are controlled zones, identifying safe standing locations.

Depending on the operation of the continuous miner, operators are required to stand in close proximity to ribs, which unless determined to be poor strata, were unlikely to be supported.

At the time of the incident, workers were preparing to start cutting straight ahead on the right hand side of the rib. The safe standing zones required operators to be positioned on the right hand side of the boom, which was where both workers were standing when the rib material spalled.

7. History of rib issues at the mine

7.1. The Regulator

The mine has a substantial history with rib-related issues. On 18 November 2016, a letter was sent to the mine from the Regulator regarding a rib incident involving an electrician being hit by spalling rib, resulting in a foot fracture. The letter drew the mine's attention to their existing controls and requested information regarding reviews, to ensure controls were adequate. One of the mine's incident reviews resulted in two workers being counselled over their failure to identify rib-related hazards. A toolbox talk was later presented to workers, to remind them of their responsibility to ensure the workplace is free of risks.

On 9 December 2016, the Regulator issued the mine a notice of concern. The notice was issued in relation to panel 816 and reported significant rib spalling occurring throughout the panel. A letter was sent by the mine manager to the issuing inspector on 16 December 2016, which identified control methods to prevent rib spall, including support for ribs with a height above three metres.

On 29 and 30 May 2018, the Regulator conducted a targeted assessment at the mine in relation to unrelated issues. During the assessment, several rib-related issues were identified, which resulted in the following compliance action:

- Section 23 (notice of concern) issued on 1 June 2018
- Section 191 (improvement notice) issued on 1 June 2018
- Section 155 notice issued on 6 June 2018
- Letter of concern by the Chief Inspector dated 2 July 2018.

7.2. The mine's rib related risk assessments

After each rib related incident, the mine conducted risk assessments. The mine reviewed its 'risk assessment-3368 ribs and rib management', which identified potential incidents involving risks to workers from rib spall during mining operations. A cross section of workers participated in the risk assessment, and a number of recommended controls were identified. The risk assessment identified a potential incident to be a cable hand being struck by rib on development, the cause of which was recorded as a failure to identify rib hazards. The risk ranking identified was 8(M). According to the risk matrix, this required the following management action:

> '*Action is required to eliminate or reduce the risk. If the risk is considered to be ALARP, then the decision to accept the risk is to be made by the manager of the Centennial Coal operations*.'

Other identified causes included:

- failure to identify rib hazard
- falling/sliding rib material
- geological structure
- inadequate support
- operator error
- over height driveage
- poor standards
- proximity to unstable rib
- unfavourable driveage direction.

There was no evidence found within the risk assessment, that routine installation of support (i.e. mesh and bolting of ribs) was identified or considered, despite information obtained during the investigation to indicate that workers often discussed this.

8. Foreseeability

The investigation identified issues regarding rib-related incidents that were known to the mine. The mine's strata failure management plan regarded rib instability as a major hazard.

8.1. May 2018 incident

On 5 May 2018, a worker was operating a continuous miner in the 908 panel E heading, requiring him to stand in close proximity to the right-hand rib. This was standard practice and in accordance with the continuous miner control zones. While operating the continuous miner, the right side rib strata failed and hit the worker. During a review of that incident by the mine, the worker said he felt a blow to the back of his head and right hand shoulder, causing him to be knocked to the ground. The worker was dazed and immediately felt sick. A witness described finding the worker in a semi-conscious state in a prone position surrounded by coal spall, with the continuous miner still running. Despite the incident report finding the rib at the incident was friable and weak, the root cause was recorded as:

> '*Operator had not identified soft rib conditions and bar down rib prior to standing to operate CM.*"

8.2. Geologist reports

The mine engaged a geologist to review a series of rib-related (fall of ground) incidents at the mine, between January 2007 and June 2016. This review resulted in three reports being prepared, dated 15 August 2016, 29 December 2016 and 27 April 2017. The geologist's review considered 109 rib-related incidents, all of which occurred in areas of the mine with no rib support.

The reports identified 66 per cent of incidents occurred in the immediate face area, where continuous miner operators and cable hands were more likely to be working.

There was no correlation between the depth of mining and the rib incidents, however there was evidence to indicate that the more severe rib incidents occurred in roadways with heights above 2.8 metres. The mine was aware that maintaining road heights between 2.8 metres and 3 metres substantially improved rib stability. The report identified an increase of rib height from 2.8 metres to 3.1 metres (an increase of about 10.7%) increased the risk of rib spall by 35 per cent. An examination of the incident scene by investigators established the height of the roadway, measured alongside the boom or tail of the continuous miner, was 3.13 metres.

8.3. Deputies' reports

The mine is required to nominate a deputy in accordance with the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014. As part of their duties, and in accordance with schedule 10, clause 10 (1), a deputy is to supervise workers and inspect work areas in a part of the mine. The deputy must hold a practicing certificate, authorising the exercising of the statutory function.

The mine requires all deputies to complete a 'statutory production area inspection report', which records information regarding certain safety hazards including but not limited to:

- level of gases
- condition of roof and ribs
- ventilation.

During the investigation, the reports for the panel dated between 4 June and 3 July 2018 (approximately 1 month) were examined. In particular, notes recorded in the '*State of Roof and Sides*' indicate the strata conditions were progressively deteriorating as work progressed inbye towards the incident site. Before 12 June, strata was mostly recorded as normal. Between 13 and 20 June, strata was being recorded as normal/moderate. From 20 June to the day of the incident, strata was predominately being recorded as moderate and, on several occasions referred to as poor. There were notes on the reports that rib support was required. There were no notes regarding the presence of mudstone, including its increasing thickness.

8.4. Rib spall 3 July incident

On 3 July 2018, the afternoon shift deputy reported that while in production (sequence 5) in the 808N panel, power was lost due to rib spall hitting electrical equipment.

8.5. Mudstone

Workers had one day of training on the mine's strata failure management plan. This training was aimed at helping workers to identify mud-stone and what impacts it may have on mining operations. The training Powerpoint consisted of 108 pages of complex information regarding geology and its behaviour, as well as several TARPs and training regarding strata support.

The mine was aware that mudstone had poor adhesion qualities and was a major hazard. It was possible the training package caused some confusion among workers. The training provides information on TARP triggers, with mudstone being point 2 under normal roof types, which does not require any strata support. However, the presence of mudstone, regardless of location, quantity or thickness, had not been included under the moderate and poor roof triggers.

8.6. Rib monitoring program

In 2016, a rib monitoring program was conducted throughout the 700, 800 and 900 series panels. Depth fracturing, which was defined as locations where movement of greater than three millimetres was observed, was measured at depths further than 0.5 metre into the rib. This was consistent at all monitoring sites. This movement suggests rib slabs greater than 0.5 metres were likely to be present throughout the panels.

8.7. Shuttle car panel weekly strata audit

During the dayshift on 3 May 2018, a strata audit was conducted in the panel. The audit was signed by the undermanager and production manager. The audit identified moderate rib conditions.

During the dayshift on 24 June 2018, a strata audit was conducted in the panel. The audit was signed by the undermanager and production manager. The audit indicated there was no deputy in the panel at the time of the audit. It was also noted that the production manager's signature was dated before the date of the audit. The audit notes, in reference to the ribs said:

> '*Loose supporting in high areas – more area will need to be done as we cut forward.*'

During the dayshift on 28 June 2018, a strata audit was conducted in the panel. The audit was signed by the undermanager and production manager. The audit identified moderate rib conditions.

During the dayshift on 4 July 2018, a strata audit was conducted in the panel. The audit was signed by the undermanager and production manager. It was likely this audit was conducted after the incident, given the undermanager had not been underground before the incident occurred.

9. Hierarchy of controls

The mine has a duty to eliminate risks to health and safety, so far as is reasonably practicable, and if not reasonably practicable, minimise risks in accordance with the hierarchy of controls. If a risk cannot be eliminated, the mine must have consideration to substitution, isolation or implementation of engineering controls. If a risk still remains, consideration must then be given to administrative controls.

Information obtained during the investigation indicates the mine implemented mainly administrative controls, in the form of training and guidance material, to minimise risks associated with rib spall.

Whilst engineering controls, such as mesh and bolting, were available to workers, it was left to their discretion to identify deterioration in rib strata, triggering rib support installation. Information obtained during the investigation indicates the first level of control was for workers to identify and bar down ribs.

The investigation found when workers failed to identify rib issues, and a rib incident occurred, they were counselled for their failure to identify deteriorating strata. This process occurred on a number of

occasions following the May 2018 incident. Despite the incident report recording soft strata conditions, the root cause of the incident was determined to be:

> *'operator had not identified soft rib conditions & bar down rib prior to standing to operate CM'.*

As a result of an incident on 12 July 2016, several workers were counselled for failure to recognise rib strata hazards. Documents related to that incident note:

> '*Issue toolbox talk to remind employees when working in areas of FCT/DMU where restricted clearance to ensure immediate working area is free from risk of rib spall*.'

The investigation found evidence to indicate that the mine's controls, to prevent injuries to workers from the risks of rib failure, were heavily reliant on the subjective opinion of a worker to identify poor rib strata, and instigate requests for rib support, escalated through the deputy and ultimately the undermanager.

10. Measures to prevent incident

During the investigation, a number of adjacent panels to the incident site were inspected and were found to have 1.2 metre mesh and bolt rib support installed (Refer to Figure 12). The installation of similar support, combined with the roof support installed at the incident location, may have been a reasonably practicable measure to prevent this incident.

Figure 12 Upper rib support observed by investigators in 821 panel

11. Cause of incident

The investigation determined the likely cause of the incident was a combination of:

- overdrive of roof height, which exceeded three metres
- barring down slabs of coal from the ribs forming an overhang of material comprising coal and mudstone on the upper section of the rib/roof
- the presence of mudstone, layered between the coal and sandstone roof, with known low adhesive quality
- a lack of or inadequate control measures to prevent rib spall.

12. Recommendations

Mine operators should ensure:

- ribs are adequately supported, especially in areas where workers are required to operate in close proximity to ribs
- mapping of ribs, including the extent and thickness of mudstone roof, to assist with managing risks to the health and safety of workers
- a review of rib related TARPs to ensure they are current and appropriately accessible to workers
- all hazards associated with mining operations are managed in accordance with the hierarchy of controls.