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Investigation report

Serious injury of a worker at Thuddungra Mine

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Executive summary

A 54-year-old mine worker suffered a chest injury when he fell into the entry chute of a conveyor and became buried by mined product about 3pm on 10 August 2021. The incident occurred in the photometric plant at Thuddungra Mine, which is at Thuddungra, near Young NSW. The mine is operated by Young Mining Company Pty Limited.

The plant consists of a series of interconnected conveyors, scrubbers and crushers. A contractor and another worker had just repaired the PS7 conveyor and a decision was made to test it by operating it under load. This required rock product to be fed through the plant which included the PS25 conveyor and the PS24 reciprocating feeder, The feeder was a motorised plate that moved back and forth, shifting material from the hopper above into the conveyor chute.

The worker who became injured started the plant but noticed that the conveyor belt was not moving. He thought that this was because of a build-up of product on the belt. Blockages were common throughout the plant and the worker usually used a high-pressure hose to loosen clogged product causing plant stoppages. The worker obtained a hose and began walking toward the blocked chute to clear it. He tried to activate the conveyor's emergency stop by pulling on its lanyard. However, the lanyard was stretched and the emergency stop did not activate. The feeder continued to operate.

The other worker entered a loader to transfer product from a nearby stockpile into the hopper. He was unaware that the belt was not moving. The contractor remained near conveyor 7 and both he and the other worker lost sight of the worker who became injured as he approached the chute.

The worker who became injured walked up on some built-up product at the side of the conveyor and onto some loose material on the top of the conveyor guard. He slipped on the material and fell forward into the conveyor chute. He tried to stand up, but the feeder that was in operation knocked him down. He landed on his back and became covered in the product feeding from the hopper above.

The other worker heard the injured worker's screams and went to his aid. The injured worker was completely buried by product except for his head and one hand. The other worker pulled the emergency lanyard on the side of the conveyor. However, the emergency stop did not activate and the feeder continued to move product onto the injured worker. The other worker went to an isolation point beneath the feeder and switched it off. The other worker and a contractor dug the injured worker out by hand. It took more than 15 minutes to free him.

Shortly after, the injured worker drove himself to Young Hospital despite offers of assistance from his colleagues. After being assessed, he was transferred to Wagga Wagga Base Hospital where he was admitted for 3 days with injuries to his chest, abdomen and ribs.

Investigation findings

The investigation identified that the incident occurred because of the following:

- A poor hopper design caused product to spill into adjacent areas during loading.
- Continued production during wet periods caused product processed in the plant to become sticky - leading to blockages.
- Poor housekeeping resulted in loose material building up around the conveyor.
- Failing to assess and manage risks associated with the operation of plant meant that the injured worker did not have an appreciation of the dangers associated with the work he was performing.
- Poor practices regarding plant pre-start inspections resulted in the plant being operated despite the existence of known mechanical and electrical faults.
- Failing to develop safe procedures resulted in workers developing ad hoc methods to clear blockages in the plant.
- Failing to isolate plant energy sources resulted in the feeder loading product on to the worker after he fell into the chute.

- Failing to maintain emergency stopping systems caused the feeder to continue operating despite the efforts of a responding worker to stop it.
- Failing to connect sensors to the plant's programmable logic controller (PLC) resulted in the continued operation of the conveyor and feeder during the incident.
- Ineffective supervision resulted in workers performing tasks in an unsafe manner.

Recommendations

Mine operators are reminded of their duty to identify hazards and manage risks to health and safety in accordance with the provisions of the *Work Health and Safety Act 2011* and *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and Regulations.

Mine operators

Mine operators should:

- ensure they have identified and assessed all hazards associated with using conveyor systems
- review mechanical principal control plans to ensure that risks to health and safety associated with the use of conveyor systems are eliminated wherever reasonably practicable, or minimised if the risks cannot be eliminated
- ensure control systems are correctly configured to ensure the controlled plant comes to a safe stop in the event of an emergency
- ensure fixed guarding is in place on conveyors to prevent access to, and contact with, moving parts. Guarding should comply with AS/NZS 4024.1 Safety of machinery series
- ensure emergency plant stop devices are maintained and tested regularly
- ensure the areas around conveyor systems are well maintained and effectively drained
- ensure that pre-start checks to be undertaken on plant are undertaken regardless of whether plant is to be run for normal operation or testing only
- provide adequate information, training and instructions to protect workers from risks to health and safety while working near conveyor systems
- effectively supervise workers when working near dangerous plant and equipment such as conveyors and reciprocating feeders
- regularly consult with workers to identify if dangerous practices are being used.

Workers

Workers should:

- ensure guarded plant and equipment is fully isolated before guards are opened or removed
- never climb on or near conveyor systems
- ensure positive communication is maintained whenever dangerous tasks are being undertaken
- always maintain situational awareness when working near moving mining equipment and fixed plant
- effectively isolate energised plant when performing maintenance.

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1. Purpose of the report

This report describes the mining workplace incident investigation conducted by the NSW Resources Regulator into the cause and circumstances of an incident where a worker suffered serious injuries at Thuddungra Mine on 10 August 2021.

2. Investigation overview

2.1. Major Safety Investigations

The Regulator investigates critical workplace incidents in the NSW mining, petroleum and extractives industries. The Regulator carries out a detailed analysis of incidents and report its findings to enhance industry safety and to give effect to its 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*. The Regulator has also delegated some additional functions to investigators, including exercising the power to obtain information and documents for the purposes of monitoring compliance with these Acts.

2.3. Regulator response

The incident was reported to the Regulator on 11 August 2021. The Regulator deployed mine safety inspectors and investigators to the mine and an investigation commenced.

On 15 September 2021, the Regulator published an Investigation Information Release (IIR21-11) to provide information concerning the incident and recommendations to the mining industry.

3. The incident

3.1. The mine

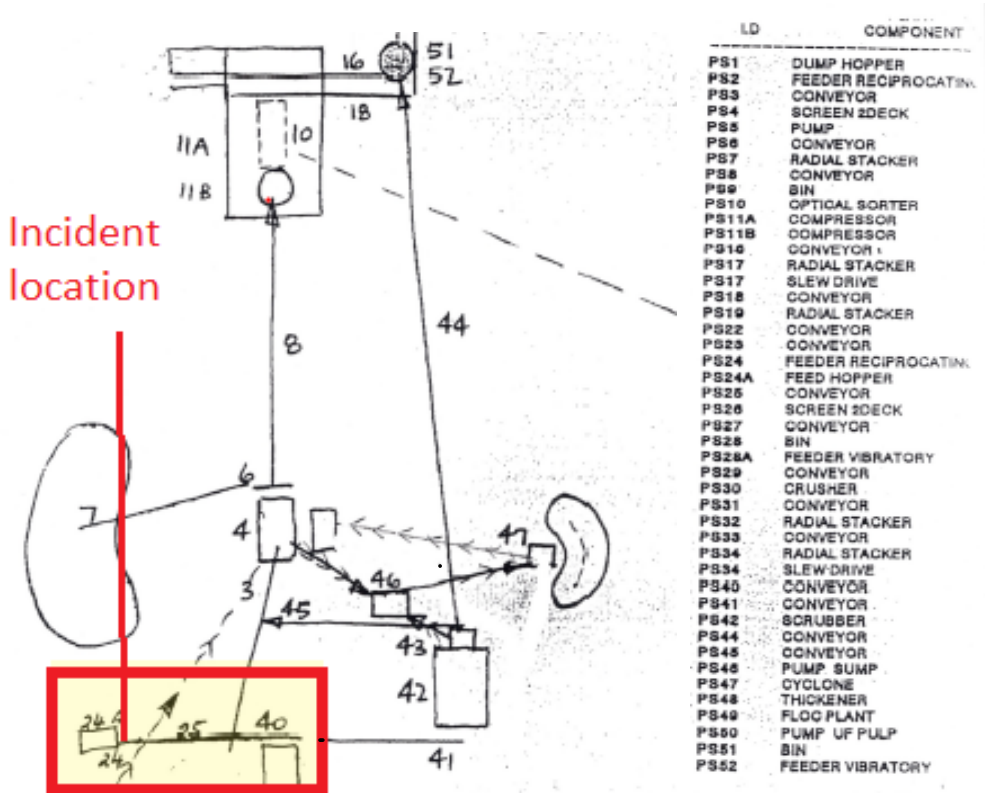
Thuddungra Mine is a magnesite mine near Thuddungra, about 28 kilometres north-west of Young, NSW. The mine operator uses open cut mining methods to strip overburden and extract magnesite. The mined material is screened and processed at the mine and conveyed to a facility in Young where it is prepared for sale.

Figure 1 - Overview of Thuddungra Mine

3.2. The incident location

The incident occurred at the PS25 conveyor at the southern end of the mine's photometric plant. The plant is controlled from a panel in a control room about 75 metres from the hopper.

Figure 2 - Excerpt from mine operator's conveyor layout diagram showing the location of the PS25 conveyor



3.3. Key parties

3.3.1. Mine operator and holder

The nominated operator of the mine and the person conducting the business or undertaking (PCBU) controlling the work that was taking place at the time of the incident is Young Mining Company Pty Ltd. All workers involved in the incident, including the injured worker, were employed by the mine operator except for one contractor.

3.3.2. Injured worker

The injured worker was 54 years old. He commenced employment at the mine as an ore sorter around 12 months before the incident and did not have any previous mining experience. At the time of the incident, the injured worker was the person primarily responsible for operating the plant.

3.3.3. Quarry manager

The quarry manager worked as an electrician at the mine for about 3.5 years. He was nominated by the mine operator's managing director to be the quarry manager on 19 July 2021. He did not hold a quarry manager's practicing certificate but was permitted to undertake this role for limited periods pursuant to the Quarry Manager Instrument of Exemption 2015. The exemption permitted mining operations to continue in the absence of a qualified quarry manager, subject to certain conditions being met.

3.3.4. The other worker

The other worker had worked at the mine as a machine operator between August 2020 and February 2021 while employed by a labour hire company. He was employed by the mine operator as a maintenance and machine operator on 1 July 2021. He is a boiler maker by trade and his primary duties included fitting, welding and metal fabrication.

3.3.5. The contractor

The contractor provided maintenance services at the mine, typically working on larger scale projects such as the modification of the plant's conveyor systems and repairs to broken down equipment. At the time of the incident, he generally worked at the mine 2 days each week.

3.4. Plant involved in incident

The conveyor was the first in a series of conveyors at the mine that moved mined product through the plant's processing machinery. A Caterpillar 966 front end loader was used to feed product into the PS24A feed hopper above the conveyor. The PS24 reciprocating plate feeder was beneath the hopper. It consisted of a motorised plate that moved back and forth shuffling product from the hopper into the conveyor chute. The mine operator stated that the hopper was fabricated in 2020. The conveyor and feeder were installed between 1998 and 2005. The mine operator was unable to provide any evidence of risk assessments undertaken in respect to the design of the hopper, conveyor or chute.

Figure 3- Hopper and feeder locations

Figure 1 - Conveyor chute

Figure 2 - Conveyor chute when cleared

3.5. Lead up to the incident

3.5.1. Shift commencement

The workers started their shift about 8am on 10 August 2021. The plant was not expected to operate that day. The PS7 conveyor needed to be repaired to enable the plant to operate. The crew participated in a pre-start meeting and then carried out work unrelated to the incident.

3.5.2. Conveyor 7 repair

The other worker and the contractor began repairing conveyor 7 about 2pm. The quarry manager left the mine with another worker around this time. When the repairs on conveyor 7 were complete, the workers decided to operate it to assess its performance. This required the plant to be started and product fed through the conveyor system.

3.6. Circumstances of incident

3.6.1. Plant operation

The other worker advised the injured worker that the plant needed to be started up and asked him to prepare for this shortly before 3pm. The injured worker said he looked at the plant and felt that it was 'ready to go'. He did not undertake a documented pre-start inspection when making this assessment. He went to the control room and started the section of the plant that encompassed conveyors 7 and 25. There was no product on the conveyor at that time but there may have been some inside the hopper or on the feeder.

3.6.2. Isolation

Energy sources to the machinery were not isolated before or during the repair and maintenance work conducted on the plant during the incident.

3.6.3. Conveyor stoppage

The conveyor and feeder operated normally when the worker who became injured started the system. At this point, the other worker went to the loader to transfer product into the hopper and the contractor remained near the tail drum of conveyor 7 to monitor it. After starting the system, the worker who became injured returned to the conveyor when he saw that its motor was operating but the conveyor belt was not moving. He thought that the weight of the product on the belt was preventing it from moving.

In addition to the weight of the product, it was common for the belt to stop moving as a result of:

- material becoming caught between the tail pulley and the inside of the belt, and
- slippage occurring between the belt and head pulley.

This was most common when the product was wet, making it heavier and stickier.

Notably, a practice had developed at the mine in which workers applied water pressure around the conveyor chute to remove dirt and mud from the product, permitting it to move more freely.

The worker who became injured collected a hose and walked to the eastern side of the conveyor where an emergency stop lanyard was located. He said his intention was to sit at the side of the chute and use his foot to push the blocked material through it, enabling him to dig the material out from the side of the conveyor with a shovel. The worker who became injured pulled the lanyard in an attempt to activate the emergency stop on the conveyor. He did this so that the belt did not move while he cleared the blockage.

The workers knew the lanyard connected to the conveyor's emergency stop was stretched. The emergency stop was designed to activate if the lanyard did not maintain a certain level of tension. The plant was configured so that if the emergency stop activated, the entire system would stop. To restart the plant, the emergency stop's control unit need to be reset and a panel in the control room activated.

To maintain the required tension on the stretched lanyard, workers:

- tucked the lanyard beneath a metal sign on the side of the conveyor (Figure 6), and
- used cable ties to connect the lanyard to guarding on the side of the conveyor (Figure 7).

Figure 6 - Lanyard tucked behind metal sign

Figure 7 - Cable ties used to retain lanyard

3.6.4. Emergency stop operation

The worker who became injured said he believed the activation of the emergency stop would stop the conveyor, but not the feeder. This was contrary to information provided by the quarry manager, and confirmed by testing, establishing that the activation of the emergency stop ceased both the conveyor and the feeder.

The investigation determined that the poor condition of the lanyard (stretched) resulted in the injured worker being unable to apply sufficient tension to activate the emergency stop when he tried to do so. As a result, the feeder and the conveyor motor continued to operate during the incident, albeit the belt did not move. In the event the issue affecting the belt was resolved while the

conveyor was in this state, the belt would have immediately started to move. The injured worker would not have anticipated this because he believed he had effectively activated the emergency stop.

3.6.5. Incident

The worker who became injured walked along the eastern side of the conveyor and up on some product that had built up at the side of the conveyor. He was not visible to the other involved workers at this point.

Figure 8 - Approximate path walked by the injured worker

The worker who became injured walked up to inspect the chute on to some product that had built up on the top of the conveyor guard. The product was loose underfoot and as he bent forward, he lost his footing and fell head first into the chute. He put both hands out to brace his fall. As the feeder was still operating, product continued to go from the hopper into the chute.

Around this time, unaware that the injured worker was in the chute, the other worker began feeding additional product into the hopper using the loader. As the hopper was only marginally wider than the bucket of the loader, some of the product spilt over the side and landed around the worker in the chute. The product loaded into the hopper fed onto and began to cover the worker in the chute.

The injured worker tried to stand but the forward movement of the feeder knocked him onto his back. At this point, the weight of the product in the chute covered him, stopping him from moving.

The other worker saw that the belt was not moving and decided to investigate. While parking the loader, he heard the worker scream. He ran to the conveyor and saw the injured worker buried by product except for his head and one hand. The injured worker's face and hand were blue and was experiencing difficulty breathing. The contractor saw the other worker get out of the loader and assumed there was a problem. He walked towards the conveyor to investigate.

The other worker pulled the lanyard on the conveyor in an attempt to stop the feeder. However, the emergency stop did not activate and more product fell onto the injured worker. The other work ran to the feeder isolation point about 15 to 20 metres away at the rear of the hopper structure. He switched the feeder off and went back to help the injured worker. The contractor had arrived at the

area around the same time and the pair began digging the product off the injured worker with their hands and small hand tools.

It was estimated the injured worker was buried beneath 400 to 500 millimetres of product. It took the workers about 15 to 20 minutes to free him.

4. First aid response and attendance at hospital

Shortly after freeing the injured worker, the other workers assessed his condition. They did not observe any external injuries and noticed that normal colour had returned to his extremities. The workers offered to call an ambulance but the injured worker declined. After taking a short time to recover from the immediate effects of the incident, the injured worker drove the dump truck was operating earlier during the day to the office area.

The contractor offered on several occasions to drive the injured worker home but he declined. Shortly after the injured worker drove his own car from the mine and left site. The contractor tried to follow the injured worker in his own car but they became separated during the journey. The injured worker made his own way home and later drove himself to Young Hospital.

5. Injuries sustained by the worker

The injured worker was assessed at Young Hospital and transferred to Wagga Wagga Base Hospital. He suffered a crush injury to the right side of his chest, which resulted in rib fractures and mild pulmonary contusions (bruising to the lungs). The injured worker also continues to experience back pain at the time of publication.

6. Investigation findings

The investigation determined that the following factors contributed to the cause the incident:

6.1. Poor hopper design

The investigation determined that the hopper was poorly suited for use with the loader. The width of the loader's bucket and the hopper were 3280 millimetres and 3510 millimetres respectively. When product was released from the bucket during loading, a portion would spill over the sides of the hopper and onto the conveyor and surrounds. The spillage contributed significantly to the material that built up around the conveyor. The spillage could have been considerably reduced if the hopper was wider or if suitably designed 'hungry board' panels were fitted across the sides of the hopper. If a comprehensive design risk assessment was undertaken, it would have identified the risks associated with spillage.

Figure 9 - Product spilling from the bucket of the loader

6.2. Continued production during wet period

During the first 8 months of 2021, the mine experienced consistent rain that caused the product to become sticky. The machinery in the plant was not suited for processing sticky materials. As a result, blockages in the hopper and chute became common, as did stoppages and slippages on the belt. Despite these issues creating unsuitable conditions for processing, the mine continued to process product during wet periods without any modifications being made to the plant.

6.3. Poor housekeeping

6.3.1. Resource issues

Housekeeping in the plant was poor. The investigation determined that this was a result of poor resourcing. In the year before the incident, the number of workers at the mine had reduced from 21 to 4. The remaining workers were expected to fulfill the mine's production, maintenance, compliance and rehabilitation requirements. Based on interviews with workers, investigators determined that the mine operator emphasised production as a priority. Having regard to this, and the design and access issues described below, there were not enough workers employed to effectively maintain and clean the plant.

6.3.2. Design and access issues

Although the mine's production levels decreased before the incident, the poor design and condition of the plant meant that disproportionate levels of housekeeping were required to maintain it in good working order. No provision was made for capturing spillage around the conveyor. As a result, spilt product tended to collect around the conveyor and its tail pulley.

A skid-steer loader, which was used to assist with housekeeping in the plant, was out of service for a considerable period. Even when it was operational, the poor design of the plant meant it could not access many of the areas where housekeeping was required. As a result, workers were required to climb under the hopper structure and use hand tools such as picks and shovels to manually clear material. Workers said this was arduous because it had to be done while bending over because of the limited access near the tail pulley. The access issues were recognised by the mine operator in its safe work method statement for the task. (see Section 6.7.2)

Figure 10 – Access issues under the conveyor

6.3.3. Key areas

Poor housekeeping practices at the following key locations directly contributed to the incident.

6.3.3.1. Tail pulley

At the time of the incident, the tail pulley was partly covered in material and water. The material around the tail pulley appeared to have been there for some time because it was compacted. It was believed that part of the reason that the belt did not move before the incident was that material was caught between the inside of the belt and the tail pulley.

The belt was not tracking correctly around the tail pulley and there was no tracking protection fitted to it. The amount of material that was around the tail pulley is evident in Figures 11 and 12 that show the area before and after the material was cleared. The water that partially covered the tail pulley at the time of the incident had subsided before the photographs were taken. The investigation determined the conveyor was often operated with its tail pulley partially covered in material.

Figure 11 – Buried tail pulley – inside of belt covered in material

Figure 12 – Tail pulley when cleared

6.3.3.2. The top and sides of the conveyor

As shown in Figure 8, there was a large build-up of material on the eastern side and across the top of the conveyor. This was largely because product spilled over the sides of the hopper during loading. However, some of the material was deposited by workers when they used hand tools to clear blockages around the conveyor. The built-up area provided the injured worker with a convenient means of accessing the top of the conveyor. It would have been more difficult for him to access that area if the built-up material was removed. The loose consistency of the material at the top and sides of the conveyor created a significant risk of slipping when the worker walked on it.

6.4. Failure to address drainage issues

The worker's boots were packed with mud when he slipped and fell into the chute. Drainage in the plant was poor, and before the incident there were large areas of wet, clay material throughout the plant. The topography of the location resulted in water naturally being directed towards the hopper structure. Although muddy conditions were experienced for a considerable period, no effective drainage work was undertaken near the conveyor. At the time of the incident, the ground was wetter and muddier than the conditions depicted in Figures 13 and 14.

Figure 13 – Conveyor structure 11 Aug 2021

Figure 14 – Conveyor and hopper 11 Aug 2021

6.5. Failure to assess and manage risks

The mine's safety management system (SMS) did not provide clear guidance about how to conduct risk assessments. For example, a 'Safety Handbook' described what a job safety analysis was but did not stipulate how they should be completed. Its risk assessment policy stated:

> '*Risk assessments must be conducted on new ventures and activities, including new deposits, processes, systems and commercial activities to ensure that these are aligned with YMC objectives and goals.*'

Workers were not required to undertake personal risk assessments (e.g., SLAM, Take 5) and workers at the mine did not undertake them. Job safety analyses were sometimes done for larger-scale projects, such as removing an ore sorter and installing sheeting inside the hopper. They were not undertaken for smaller tasks such as digging out tail pulleys and clearing blockages.

The mine operator failed to provide sufficient training to workers about the risk assessment process. The quarry manager had never seen a risk assessment procedure at the mine. The injured worker had never undertaken a risk assessment while working at the mine, nor been shown how to do one.

No risk assessments were conducted regarding the work that was being undertaken by the injured worker immediately before, or at the time of, the incident. The following are examples of some of the risks that could have been easily identified and managed through a simple risk assessment process:

- Entanglement – operating conveyor with guards removed
- Crush – inadequate guarding around feeder
- Fire – operating conveyor whilst tail pulley buried
- Slips, trips and falls – loose ground and wet muddy conditions
- Isolation of energy sources – belt moving when stoppage was cleared
- Fall from heights – falling into chute.

6.6. Poor practices regarding pre-start inspections

The investigation determined that the pre-start inspection process developed by the mine operator for use in the plant was poorly designed and not regularly followed. There were no documented procedures that explained the process. The mine's 'Plant feeding procedure' stated that workers should 'Always ensure prestart has been completed and plant is safe to operator.'

The pre-start process required workers to inspect the plant using a pro-forma checklist. The checklist contained a list of faults ranked as high, medium and low. It stated that machinery with 'high' faults needed to be tagged out of service. 'High' faults included issues relating to guarding, tail drums, lanyards and emergency stops.

The mine operator was only able to produce 3 completed checklists relating to the plant in the 6 months before the incident. The mine's quarry manager did not require pre-start checklists, which were template documents titled 'Fixed Plant – PM Prestart Check Sheet', to be completed for much of that period between February and July 2021 because he was unaware that they existed.

The investigation determined that on previous occasions when checklists were completed more regularly, little or no action was taken to address the issues identified by them. In practice workers were told to file completed pre-start checklists containing 'high' faults without corrective action being taken. The same 'high' faults were recorded almost daily in checklists obtained between November 2020 and January 2021. There was no information recorded on these checklists about repairs undertaken or machinery being tagged out of service.

Before the incident, the injured worker did not often complete pre-start checklists. On the occasions that he did complete checklists, the information he recorded was unreliable. For example, on 30 July 2021 he recorded there were no faults at all in the plant despite its poor condition and him being fully aware the stretched lanyard was affecting the operation and activation of the emergency stop.

If the checklist was competently completed on the day of the incident, more than half of the items contained on it should have been recorded as faults, including 8 out of the 12 'high' fault items. The injured worker said he did not conduct a checklist on the day of the incident because he could not see the point as the plant was to be operated for 30 minutes.

6.7. Failure to develop safe procedures to clear blockages

The mine operator identified that blockages were occurring in the conveyor chute and material was building up under the feeder. In an attempt to address the issue, the mine operator developed safe work method statements for 'digging out 25 chute' and 'digging under plate feeder' (the SWMS). The mine's 'Plant feeding procedure' did not provide any guidance about preventing blockages and stoppages.

The investigation identified that the SWMSs were deficient because they introduced serious risks, provided little practical guidance to workers and heavily relied upon lower order controls such as PPE. It was beyond the scope of this report to describe all deficiencies contained within the SWMS, but some key issues are outlined below.

6.7.1. SWMS – Digging out 25 chute

The injured worker had never seen this SWMS before the incident. It outlined the following steps as shown in the figure 15 excerpt below:

Figure 15 – Digging out 25 chute SWMS excerpt

Step	Procedure (in steps)	Hazards	Risk Ranking (H/M/L)	Controls
1.	Isolate and Tag Out, tag and pull lanyards on 44 and 45	Electrical	H	Caution, Isolation Tags on 44 and 45
2.	Use Correct tools to undo bolts on gate	Grazing Knuckles	M	Use correct PPE
3.	Use Pick and Shovel to clean out chute	Straining back, hit elbows	M	Caution, correct lifting methods
4.	Re- bolt Gates	Grazing Knuckles	M	Use correct PPE
5.	Remove isolation tags	Electrical	H	Use Caution

While step 3 provided that a pick and shovel should be used, the SWMS did not contain any information about where workers should stand while undertaking the task, the way they should use the pick and shovel and what they should do with the material they removed from the blocked chute. It also ignored the fact that the chute was unguarded and built at height. The most practical way to dig out the chute using a pick and shovel was to stand on top of the conveyor guard where the injured worker fell, thereby introducing the risk of falls from heights.

Figure 16 - Elevated position of conveyor chute

6.7.2. SWMS – Digging under plate feeder

All steps in this SWMS were identical to the SWMS for digging out the conveyor chute, except for number 3, which was '*Use shovel to dig out under tail of 25 and plate feeder*'. It identified hitting head, straining back, small space (kneeling)' as the relevant hazards and '*use proper PPE, caution shovel and lift correctly*' as the appropriate controls.

This SWMS provided no guidance to workers about what PPE was required, what 'caution shovel' meant and how workers were meant to 'lift correctly' in circumstances where they were operating with limited access. The impracticality of this SWMS was evident from Figure 17, which shows a worker attempting to dig under the feeder.

It should be noted that at the time the photograph in Figure 17 was taken, a significant amount of material had been previously dug out beneath the feeder and access would ordinarily be even more difficult than depicted.

Figure 17 - Worker digging under structure

6.8. Other unsafe practices used to clear blockages

As a result of the failure to develop safe and effective procedures to deal with the constant blockages and stoppages that occurred on and near the conveyor, workers developed various ad hoc methods to deal with these issues. These methods were not adequately risk assessed and resulted in new risks to health and safety being introduced.

6.8.1. Hopper

Up until several months before the incident, workers used metal bars to separate sticky product in the hopper. Workers would either get into the hopper or stand on a buckled fence next to the hopper and reach into it as shown in Figure 18. This introduced risks of falls from heights and entrapment.

Figure 18 - Workers reaching into hopper

6.8.2. Application of water into hopper

The then quarry manager was concerned about the above practice used by workers in and around the hopper around June 2021. He considered that applying a high-pressure spray into the hopper would be a safer and more effective means of clearing blockages than working with hand tools.

A high-pressure hose was connected near Conveyor 7 and polyurethane sheeting was installed on the inside of the hopper. It was hoped that this would assist the product to slide down the sides of the hopper and move freely onto the conveyor.

This was the first time that water was used to prevent or clear blockages. No risk assessment or change management processes were followed in respect to this change (although a risk assessment was undertaken in relation to installing the sheeting).

6.8.3. Application of water into chute

About 3 weeks before the incident, the injured worker began standing on the top of the conveyor guard and applying water into the chute to loosen the material on the feeder. It was common knowledge at the mine that the injured worker would spend hours doing this while the plant was operating. No risk assessment or change management processes were undertaken or followed in respect to identifying and managing the risks to health and safety associated with this introduced work practice.

6.8.4. Construction of unsafe platforms above chute

The injured worker spent so much time hosing into the chute from the top of the conveyor guard, that he asked the other worker if he could build something on top of the guard for him to sit on.

The quarry manager approved the construction of a small metal platform on top of the conveyor guard for this purpose (see Figure 22). The other worker also installed a triangular metal platform at the worker's request to enable him to be able to stand over and see into the chute. The platform was suspended between some guarding and a buckled fence rail (see Figures 19 and 20). The platform could only be accessed by scaling an uneven pile of material next to the fence (see Figure 21). There were no handrails or other barriers attached to the platform. There was no guarding between the chute or feeder and the platform or seat.

The seat and the platform were installed on 30 July 2021. The other worker recorded the addition of the seat and platform in the mine's 'Record of maintenance work'. No risk assessment or change management processes were undertaken or followed in respect to the seat or platform. The use of the seat and platform in the manner described above carried a significant risk of falls from heights. No controls were implemented to manage that risk.

Figure 19 - Metal platform attached to buckled fence rail

Figure 20 – Section of metal platform attached to guarding

Figure 21 - Access point to platform

Figure 22 – Location of seat, chute and platform

6.9. Failure to guard conveyor chute

Despite it being commonly known that the injured worker was accessing the top of the conveyor to clear blockages, no guarding was installed above the conveyor chute. Effective guarding at this location could have prevented the injured worker falling into the chute and becoming buried. (Note: Irrespective of the presence or absence of this guarding, the practice of accessing the top of the conveyor guard created a risk of falling from height. For example, falling off the side of the conveyor guard to the ground.)

6.10. Failure to isolate energy sources

The injured worker did not isolate the conveyor or the feeder before inspecting the chute. He believed that by pulling the lanyard, he was effectively isolating the conveyor. This was based on information provided by other workers.

The injured worker was not provided with sufficient training about isolating equipment using a personal lock and did not make any attempt to isolate the feeder. Had the injured worker effectively isolated the feeder, it would not have been in operation and he would not have been buried in product when he fell into the conveyor.

The isolation points for the conveyor and the feeder were in unsafe and impractical locations. The conveyor's isolation point was about 2.1 metres above ground level. There were no safe means for workers to access that point. At the time of the incident, the injured worker was unaware of the location of the conveyor's isolation point.

Figure 23 – Conveyor's isolation point

The isolation point for the feeder was in an obscure location beneath the feeder at the rear of the hopper structure. It was adjacent to rotating drive belts that were unguarded. To reach the isolation point, workers had to reach through a gap made in a section of guarding. Workers accessing the feeder's isolation point risked being entangled by the drive belts.

Figure 24 - Feeder isolation point

The location of the feeder's isolation point was not easily identifiable or sign posted and information about its location was not provided as part of the mine operator's training. There was a significant risk that workers at the mine would not know how to access it in the event of an emergency. It was fortunate in this instance that the injured worker had previously told the other worker where the isolation switch was located.

6.11. Failure to install and maintain emergency stopping systems

6.11.1. Feeder

The feeder was not fitted with an emergency stop. If an emergency stop was fitted near the feeder, it would have provided a readily accessible means of ceasing the machinery, which would have prevented additional product landing on the injured worker.

6.11.2. Conveyor

If the conveyor's emergency stop was in a serviceable condition, the feeder would have stopped when the lanyard was activated. Although the worker may still have fallen into the chute, he would not have been buried by material fed from the hopper.

It was common knowledge among workers that the lanyard on the emergency stop was stretched.

In the 18 months before the incident, the mine's electrician made 2 separate written requests to a former quarry manager requesting that replacement lanyards be obtained for the mine's conveyors. The former quarry manager denies this although recalls submitting purchase orders for replacement lanyards when they were required. Having regard to the condition of the lanyard on the conveyor, the investigation determined that it was unlikely that the lanyard on the conveyor had been replaced in the 18 months before the incident.

6.12. Failure to connect roller speed monitoring sensor to PLC

The conveyor was fitted with a speed monitoring sensor that detected the rate at which the conveyor's rollers were moving. The sensor was designed to connect to the plant's program logic controller (PLC). The PLC was a control system used to automate the operation of various machinery.

At the time of the incident, the sensor on the conveyor was not programmed into the PLC. The PLC was commissioned around March 2018. At that time, the mine's electrician and a contracting engineer were unable to locate the wire that connected the sensor to the PLC. The electrician later located the wire but no arrangements were made for the sensor to be programmed into the PLC.

If the sensor had been programmed into the PLC, the system would have detected that the conveyor's motor was on but the belt was not moving. The PLC would have then stopped the motors on the conveyor and the feeder, preventing the worker from becoming buried when he fell into the chute.

6.13. Inadequate supervision

Having regard to the fact that the worker had been accessing locations above the unguarded conveyor chute for some time before the incident, the investigation determined that the supervision of the operation and maintenance of the plant provided at the mine was not effective.

The quarry manager said he was approached by the mine operator's managing director about being nominated as the 'competent person' around the time that the previous quarry manager ceased working at the mine. The quarry manager said he did not know enough about the mine's safety management system to be able to run and implement it but agreed to the nomination. He said he was not provided with any additional training about the mine's safety management system, although he had been shown parts of it by the previous quarry manager.

Other workers at the mine had seen that the quarry manager found it difficult to issue instructions and demonstrate leadership with respect to work health and safety.

7. Other factors

The investigation identified other uncontrolled risks that were relevant to the work activity being conducted at the time of the incident but not causally related. They included:

7.1. PPE

The worker was not wearing a hard hat at the time of the incident. He said this was because he had been operating a truck for most of the day and that the plant was only expected to operate briefly. The investigation determined that workers commonly failed to wear hard hats while working in the plant. Although it does not appear that the worker hit his head when he fell into the chute, his failure to wear a hard hat increased his chances of sustaining a head injury during the incident.

7.2. Plant guarding

The guarding around the conveyor and hopper structure was inadequate. Apart from the deficiencies identified elsewhere in this report (Section 6.9 - area above chute and Section 6.10 – feeder isolation point), several other concerns were noted relating to guarding.

7.2.1. Side of hopper structure

The side guard of the hopper structure was attached by a hinge. The hinge broke some time ago and it was not repaired. As a result, the guard had to be lifted on and off the structure when access around the tail pulley was required. Because of the ongoing issues with the build-up of material around the tail pulley, access was constantly required. The workers often failed to replace the guard and operated the conveyor without the guard in place. This is evident in Figure 11, which shows the guard on the ground covered in material. Operating the conveyor without the guard in place exposed the workers to the risk of becoming entangled between the belt and tail pulley.

7.2.2. Motors

The belts that drove the plate feeder (Figure 24) and conveyor (see Figure 25) rotated at high speed when operating. Neither was effectively guarded.

Figure 25 – Unguarded drive belt on the conveyor's head pulley

7.2.3. Conveyor return

The underside of the conveyor was not guarded. Workers walked under the conveyor while it was operating, exposing themselves to the risk of being entangled by rotating parts and the moving belt.

Figure 26 -Underside of conveyor

7.3. Hopper

Other mechanical and electrical issues that were identified with respect to the hopper included:

- Protective barriers around the hopper were bent.
- Its base and part of its supports were buried under material.
- There was evidence of cracking and rust.
- There was no electrical bonding between the conductive surfaces of the hopper, conveyor and feeder.

7.4. Feeder

Other mechanical and electrical issues that were identified with respect to the feeder included:

- Missing isolator pips from isolator enclosure thereby compromising the ingress protection of the enclosure.
- The motor was missing hold down bolts
- Electrical warning signs were missing.
- Sections of the power supply cable were not mechanically protected.
- There was inadequate cable termination.
- There was a loose bung under the cable termination box - compromising ingress protection.

7.5. Conveyor

Other mechanical and electrical issues that were identified with respect to the conveyor included:

- Electrical warning signs were missing from the motor termination box.
- Power supply cables were buried in material.
- Sections of the power supply cable were not mechanically protected.

- Isolator pips were missing from the enclosure.
- There was inadequate cable termination.
- The emergency stop mechanism was out of reach and there was no safe access.
- Screws were missing from the emergency stop enclosure.

7.6. Communications and emergency response

The responding workers did not try to contact each other or ask for additional assistance when the incident occurred.

The mine's emergency principal control plan stated emergency communications could be made 'via two-way radio, mobile telephone or landline telephone'.

It was well known that mobile phone coverage at the mine was limited and very unreliable. The mine operator had a mobile phone policy that required all personal mobile phones to be kept in the administration area while operating machinery and mobile plant. The only landline available at the mine was in the administration area.

Workers did not use radios in the plant (including at the time of the incident) and the radios at the mine were generally in poor condition. The mine's principal emergency control plan stated that two-way radio units were available in vehicles but most of the mine's mobile plant fleet did not have an operational radio fitted. Workers sometimes carried portable radios as a substitute when operating mobile plant.

The mine's emergency procedure did not refer to radio communications and the mine operator did not require workers to carry radios. The mine's training materials contemplated calling an emergency using a radio system. Before the incident, the injured worker had never seen the mine's emergency procedure.

8. Deficiencies in other parts of plant

Unsafe work practices and equipment were also identified in other parts of the plant. They included:

- redundant electrical equipment left in place
- workers accessing walkways and platforms while safety gates were cable tied in the open position
- inadequate guarding and guards being left in the open position
- power supply cables buried and not mechanically protected
- inadequate cable termination
- poor housekeeping and build-up of materials
- safety lanyards for activation of emergency stops not installed correctly
- incorrect tension on safety lanyards
- inadequate cable routing
- missing signs and labelling
- isolator pips missing
- exposed energised low voltage terminations
- isolator being installed out of reach
- incorrect phasing and evidence of arcing
- electrical components and circuits not labelled
- fault current limit fuses were changed
- earth leakage protection not fully installed and not operational

- back-up emergency stop protection on control room panel was not fully installed and not operational.

An independent mechanical survey conducted after the incident identified that the 'processing plant has guards on almost all of its belt conveyors' and that some of the guards 'are in relatively good working condition', however the guarding on the majority of the conveyors at the mine required repair or replacement.

An independent electrical survey conducted after the incident also identified that all of the conveyors in the plant that were inspected did not meet the requirements of relevant Standards. Some of the issues that were identified during the survey included:

- isolators not being accessible
- pull wire not installed to standard
- seized lanyard.

9. Relevant risk

The investigation identified the relevant risks to health and safety associated with the incident were serious injury or death of a worker due to:

- falling from the top of the conveyor guard, and
- becoming buried in feeding product.

10. Controls

The investigation identified the mine operator failed to adequately control the relevant risks. In addition to the controls referred to in sections 3, 6 and 7 of this report, the mine operator also attempted to manage the relevant risks with the following:

10.1. Standard operating procedure – working at height

The mine operator had a draft standard operating procedure for working at height dated 10 October 2017. A review due in 2019 was not undertaken. The draft procedure stated:

> '*Fall arrestors or restraints must be utilised when personnel are required to be within 3 metres from a vertical edge with a drop of 1 metre or more, in areas that do not have approved fall protection barriers.*'

The top of the conveyor guard, seat and platform were all located within 3 metres from a vertical edge with a drop of more than one metre. There were no fall protection barriers installed in these areas.

The investigation determined the draft procedure was not followed at the mine. The worker was regularly accessing the top of the conveyor guard where a readily foreseeable fall from heights risk existed. He did not, and was not, required by the mine operator to wear a fall arrestor or restraints while undertaking this task.

The investigation identified the procedure was not followed and there were unsafe practices with respect to working from heights at the mine. They included workers being hoisted in the bucket of a front-end loader in order to reach equipment located several metres above the ground.

The quarry manager had never seen the draft procedure. The mine operator was unable to produce any training records that demonstrated the injured worker was trained in the draft procedure in connection with his conveyor training. The investigation identified that some workers, including the quarry manager, had undergone working at heights training after a worker was seriously injured in a fall at the mine in January 2021.

There was no evidence identified during the investigation that the mine operator had enforced compliance with the procedure.

10.2. Standard operating procedure - isolation

The mine operator had an 'Isolation Standard Operating Procedure' (the isolation procedure) dated 27 October 2017. The isolation procedure stated that it was to be reviewed in two years (October 2019) but that review was not undertaken prior to the incident in August 2021.

The isolation procedure and the mine's training materials prescribed the use of a permit system, and personal tags and locks to isolate conveyors. However, the quarry manager was the only worker employed by the mine operator who carried a personal lock. Notably the quarry manager was not on site at the time when the conveyor was being repaired. If the procedure had been reviewed before the incident, the mine operator may have identified this deficiency in its procedure.

The isolation procedure required controls in 2 separate switch rooms to be locked out. The quarry manager said this requirement was not followed. He said if ever he needed to isolate equipment in the plant, he would use localised isolation points.

The investigation determined that workers at the mine did not follow the isolation procedure. There was also no evidence that the mine operator enforced compliance with the procedure.

The injured worker wrongly believed that activating the conveyor's lanyard was an effective form of isolation.

10.3. Change management procedure

The mine had a change management procedure dated 28 December 2017. The mine operator said it had identified that changes and practices had the '*potential to affect the health and safety of the workplace and its employees*. Again, a review due in 2019 was not undertaken. It applied to '*any alteration, modification or substitution of any item or process*.' It said change management was required to '*ensure changes do not result in unsafe conditions*.' It required changes to be identified, risk assessed, approved and implemented.

The investigation determined the procedure was not followed in the following circumstances:

- Introduction of the use of water to clear and prevent blockages.
- Accessing the area above the chute to clear and prevent stoppages.
- Installation of the seat and platform.

10.4. Mechanical engineering control plan

The mine had a mechanical engineering control plan (MECP) dated 7 July 2017. Again, a review scheduled for 2019 was not undertaken. The investigation determined that numerous controls identified in the MECP were not appropriately implemented around the time of the incident including:

- operation and maintenance of plant required to undertaken by competent personnel
- protection against fire on a conveyor managed through the maintenance of the system
- conveyor belt audits and inspections shall be carried out by appropriately trained and competent personnel
- plant guarding was designed to be of solid construction and securely mounted to resist impact or shock
- operators' controls should be located to be conveniently operated by each person using the plant and able to be locked into the 'off' position to enable the disconnection of all motive power
- when work is to be carried out where there is a risk of fall then a risk assessment must be carried out with adequate controls in place before work commences

- the MECP shall be reviewed by the quarry manager within 12 months of commencement and periods not exceeding 2 years.

11. Current status of plant operations

Inspectors attended the mine on 11 August 2021 and issued a notice prohibiting the operation of the involved plant. It required independent third parties to review:

- correct operation of electrical safety devices
- access to isolation devices
- effective guarding of rotating and moving plant including open chutes.

The notice required all non-compliances identified in these reviews to be rectified.

To address the notice, the mine operator engaged independent third-party mechanical and electrical engineers to conduct the required reviews. As identified elsewhere in this report, numerous electrical and guarding non-compliances were identified by the independent engineers.

The Regulator has not been advised that the non-compliances have been rectified and the mine operator is still subject to the prohibitions stipulated within the notice at the time of publication. The Regulator understands the mine operator is processing product at the mine using a mobile screen but not using the involved plant to which the prohibition notice applies.

12. Recommendations

Mine operators are reminded of their duty to identify hazards and manage risks to health and safety in accordance with the provisions of the *Work Health and Safety Act 2011* and *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and Regulations.

Mine operators should:

- ensure they have identified and assessed all hazards associated with the use of conveyor systems
- review mechanical principal control plans to ensure that risks to health and safety associated with the use of conveyor systems are eliminated wherever reasonably practicable, or minimised if the risks cannot be eliminated
- ensure control systems are correctly configured to ensure the controlled plant comes to a safe stop in the event of an emergency
- ensure fixed guarding is in place on conveyors to prevent access to, and contact with, moving parts. Guarding should comply with AS/NZS 4024.1 Safety of machinery series
- ensure emergency plant stop devices are maintained and tested regularly
- ensure the areas around conveyor systems are well maintained and effectively drained
- ensure that pre-start checks to be undertaken on plant are undertaken regardless of whether plant is to be run for normal operation or testing only
- provide adequate information, training and instructions to protect workers from risks to health and safety while working near conveyor systems
- effectively supervise workers when working near dangerous plant and equipment such as conveyors and reciprocating feeders
- regularly consult with workers to identify if dangerous practices are being used.

Workers should:

- ensure guarded plant and equipment is fully isolated before guards are opened or removed
- never climb on or near conveyor systems
- ensure positive communication is maintained whenever dangerous tasks are being undertaken

- always maintain situational awareness when working near moving mining equipment and fixed plant
- effectively isolate energised plant when performing maintenance.