



Trade &
Investment
Mine Safety

Investigation report

Investigation into the death of Jeremy Mathew Junk at the CSA Mine, Cobar NSW on 16 March 2013

Report prepared by the NSW Mine Safety Investigation Unit

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Investigation into the death of Jeremy Junk at the CSA Mine, Cobar, NSW on 16 March 2013

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Executive summary

Incident overview

At 4.42 am on 16 March 2013, 41-year-old Jeremy Mathew Junk, an employee of Macmahon Mining Services Pty Ltd (MMS), was fatally injured while working at the CSA Mine, No.1 Shaft Extension Project near Cobar. Mr Junk sustained fatal head injuries while riding in a kibble that was being raised through a dual platform stage in the No.1 shaft about 1041 metres below the surface of the mine.

At the time of the incident, Mr Junk and the shaft sinking crew were completing a 12 hour night shift. Mr Junk was the shift supervisor and was part of a four-man crew working in the shaft on the lower level of a suspended working platform known as a stage. The stage was suspended in the shaft about 15 metres below the 9240 brace level (access level to the shaft works).

The crew was in the process of lowering a kerb ring using chain blocks in preparation for the installation of hanging rods. These work processes form part of the 'blind sink' shaft sinking technique. The 'blind sink' technique was used to construct the shaft due to site specific geotechnical conditions. The blind sink technique involves repetitive work cycles of drilling, blasting, extracting earth and material, installing ground support, formwork and concreting sequences to construct a cylindrical shaft. The cycles are repeated until the shaft reaches the required depth.

During the works the shaft crew used the stage signalling system to communicate with the winder driver to lower the kibble into the shaft. A kibble is a large steel bucket designed to extract earth and material from the shaft and when it is empty it is commonly used as a man riding conveyance. The kibble and stage design used in this shaft sinking project enabled the kibble to traverse through the centre of the stage via a 'kibble well'.

The winder driver lowered the kibble into the shaft and through the stage's kibble well to the lower platform of the stage where Mr Junk climbed into the kibble. Workers reported that Mr Junk intended to be raised in the kibble to the 9240 brace level to obtain hanging rods (threaded steel rods used to secure the kerb ring in place).

Workers reported that Mr Junk signalled the winder driver to raise the kibble by ringing three bells from the communication system inside the kibble. This signal was reciprocated by the winder driver in accordance with signalling procedures and the winder driver began raising the kibble.

While the kibble was being raised through the stage's kibble well, workers reported seeing Mr Junk extend his head over the side of the kibble to communicate with a shaft worker on the stage. As the kibble approached the stage's upper platform, workers reported seeing Mr Junk's head impact between the kibble and the upper platform of the stage.

One of the workers used the signalling system located on the lower platform of the stage to stop the kibble. The worker climbed a ladder to the upper platform of the stage where he attempted to communicate with Mr Junk but the kibble was too high for him to see into. The worker called out to Mr Junk but there was no reply. An emergency response was activated by contacting the winder driver via the voice communication system on the stage.

The winder driver activated the mine's emergency procedures and followed instructions to raise the kibble to the 9240 brace level where MMS workers rendered first aid and removed an unconscious Mr Junk from the kibble. Mr Junk was transported to the surface of the mine in the No.2 shaft man riding cage. Ongoing first aid was rendered to Mr Junk by his colleagues, mine rescue personnel and the NSW Ambulance Service. Mr Junk was conveyed via ambulance to Cobar Hospital where he was pronounced dead at 6.06 am.

The events leading up to and after the incident were captured by CCTV cameras positioned throughout the 9240 brace level. The point of impact in the shaft was not in view of the CCTV cameras and was not captured on the footage.

Investigation observations

The Mine Safety Investigation Unit (IU) conducted an investigation into the cause and circumstances of this incident. At the time of writing, the investigation identified a number of system failures relating to the management and control of the specific risks associated with riding in the kibble and the hazardous pinch points in the kibble well of the dual platform stage.

In this case, an administrative risk management control known as the 'Man Riding in Kibble Procedure' was exclusively used to control the risks associated with riding in the kibble. This procedure was ineffective in this and other instances, and failed to prevent Mr Junk from being exposed to a risk to his health and safety. The inadequate nature of the procedure was exacerbated by the absence of hard barriers such as elimination, substitution and engineering risk management controls to prevent persons from exposing their body parts to hazardous pinch points.

The following observations were made during the investigation:

- The use of the kibble for man riding, the use of the dual platform 'Ballarat' design stage, and significantly the interaction between the kibble and stage during the shaft sinking process created an environment in which workers were exposed to risks.
- The design of the kibble and stage created hazardous pinch points in the stage's kibble well.
- An administrative control was used to manage the risks associated with riding in the kibble in lieu of more effective risk management strategies to prevent people from exposing their body parts to hazardous pinch points in stage's kibble well.
- There were no elimination, substitution or engineering controls in place to prevent a person from exposing their body parts to hazardous pinch points while riding in the kibble.
- The shaft signalling system in place at the time of the incident consisted of a series of audible signals (bells). This primary form of communication did not contain a signal which identified when persons were riding in the kibble as per recommended industry practice.
- The CCTV cameras used by the winder driver to monitor the winding systems did not capture images in the shaft.
- Insufficient training was provided to workers in relation to the use and operation of the dual platform stage before the incident.
- The mine operator permitted the contractor to undertake the shaft sinking works without approving the contractor's safety management plan.
- The lighting fixed to the upper platform of the stage was not operational at the time of the incident.
- The shaft sinking project roster system and hours of work were likely to contribute to worker fatigue.

Foreseeable risk

In October 2012, a MMS employee breached the 'Man Riding in Kibble Procedure' by climbing out of the kibble before it was safe to do so at the surface of the No.1 shaft. The kibble had stopped below the brace due to a winder fault. The incident was the subject of a MMS investigation and the employee was the subject of disciplinary action. The employee's behaviour highlighted the inadequate nature of the 'Man Riding in Kibble Procedure' to prevent a person from extending their body parts outside the kibble. Nevertheless, the MMS investigation did not

result in the implementation of more effective risk management controls to prevent a reoccurrence of this behaviour.

In November 2012, an independent safety audit conducted for MMS highlighted the existence of pinch points in the stage. In December 2012, a gap analysis risk assessment was also undertaken by representatives of the mine operator and MMS to identify the risks associated with the change in shaft sinking technique. During this process the risks associated with pinch points between the stage and the kibble were identified. But, the 'Man Riding in Kibble Procedure' was exclusively used to control the risk.

Remedial safety measures

Following the death of Mr Junk, MMS undertook 12 separate risk assessments in relation to specific aspects of personnel riding in the kibble and its interaction with the dual platform stage. These risk assessments involved consultation with employees and shaft workers. The risk assessments identified a range of controls to manage the risks associated with riding in the kibble when traversing through the stage.

MMS implemented the following risk management controls after the incident:

- Introducing a physical barrier in the form of webbing material attached to the kibble to prevent people from extending their body parts outside the kibble.
- Introducing mandatory kibble holding points requiring the kibble to stop one metre below each pinch point in the kibble well in the dual platform stage.
- Reducing the kibble speed to a maximum speed of 0.2 metres per second when traversing through the stage kibble well.
- Introducing warning lights on the stage to alert workers about the movement of the kibble through the kibble well and proximity of pinch points.
- Appointing a shaft signalman on each shift to oversee the use of the kibble for man riding and be responsible for the use and operation of the kibble as a man riding conveyance.
- Introducing a 'man-on' signal to notify the winder driver about the presence of workers riding in the kibble.
- Introducing a specific induction and assessment program concerning stage familiarisation and hazard awareness.
- Reviewing and enhancing the kibble riding procedure to incorporate the additional risk control measures implemented after the incident.
- Reviewing and updating training regarding the man riding in kibble procedure.
- Prohibiting the use of the stage and kibble simultaneously in the shaft. This significant operating change ultimately eliminated the hazardous pinch points associated with the interaction between the kibble and stage.

Recommendations

This incident highlights the importance of an effective risk management program in relation to shaft sinking activities. The following recommendations are advanced to improve industry safety and in turn reduce the likelihood of similar incidents occurring in the future:

Recommended practice for industry

1. Specific risks associated with shaft sinking projects, the use of conveyances, and the interaction of conveyances with other shaft sinking equipment must be identified, assessed and effectively controlled.
2. Shaft sinking stage designs should provide adequate clearances for kibles and eliminate potential pinch points.

3. Where practicable, suitably constructed man riding cages should be used in lieu of a kibble as a form of shaft conveyance.
4. Administrative/soft controls should not be exclusively used to manage shaft sinking risks.
5. Workers should be adequately trained in the use and safe operation of all shaft sinking equipment.
6. Shaft signalling systems should contain a specific signal to identify when people are riding in shaft sinking conveyances.
7. Human factors such as fatigue, hours of work and human error should be considered when reviewing shaft sinking risks.
8. Mine operators should ensure that contractor's safety management plans are approved and are consistent with the mine operator's safety management plan.
9. Lighting on shaft sinking equipment should be used at all times to enhance the working environment and heighten situational awareness.

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1. Purpose of report

This report concerns the death of Mr Junk at the CSA Mine, Cobar on 16 March 2013.

It documents the mining workplace incident investigation conducted by the department's Mine Safety Investigation Unit into the cause and circumstances of the incident and contains recommendations based on the analysis of information gathered during the investigation.

2. Investigation parameters

The department's Investigation Unit

The Investigation Unit investigates the nature, circumstances and cause of major accidents and incidents in the NSW mining and extractives industry.

Its role is to carry out a detailed analysis of incidents and report its findings to enhance industry safety and to give effect to the department's Enforcement Policy.

The unit is autonomous within the department and reports directly to the Secretary on all matters in relation to an investigation. It is located separately from the department's Mine Safety Inspectorate and is not involved in the activities of the inspectors, or the day-to-day inspection of mines.

Investigation scope

In accordance with departmental policy, the incident automatically resulted in an investigation by the unit because the incident involved the death of a mine worker.

The investigation was conducted under the *Work Health and Safety Act 2011* (WHS Act). The unit had authority to conduct an investigation into this matter because the incident occurred at a mining workplace regulated by the department.

The investigation focused on:

- identifying the cause and circumstances of the incident,
- identifying whether the WHS Act and Regulations have been complied with, and
- identifying how similar incidents of this nature can be prevented in the future.

Legislative authority to investigate

Under the WHS Act, the regulator of a mining workplace or a coal workplace is the head of the department. The head of the department is the Secretary.

A mining workplace is defined by the WHS Act to mean a place of work to which the *Mine Health and Safety Act 2004* (MHSA) applies. The MHSA is administered by the Minister for Resources and Energy and the department.

A mining workplace includes 'any place where the extraction of material from land for the purpose of recovering minerals or quarry product is carried out.' The CSA Mine at Cobar is situated on consolidated mining lease No.5 and is a mine to which the MHSA applies.

The MHSA provides for the appointment of government officials to have oversight of mines. A person who is appointed as a government official under the MHSA is deemed to be an inspector for the purposes of the WHS Act. An inspector has powers and functions, including the function of investigating contraventions of the WHS Act.

Investigators are appointed as government officials under the MHSA and are therefore deemed to have been appointed as inspectors for the purposes of the WHS Act and have the powers of an inspector under that Act in relation to mining workplaces.

The department's response to the incident

The department's Mine Safety inspectors attended the incident scene on 16 March 2013. The Cobar Inspector of Mines worked with NSW Police attached to the Darling River Local Area Command and NSW Police Forensic Services Group officers to analyse the incident scene.

As the incident resulted in a fatality, the matter was automatically referred to the IU in accordance with departmental procedures. The IU attended the mine on 18 March 2013 and began a formal investigation into the incident.

Investigation Unit information release

The IU published an Information Release on 20 March 2013. The information release drew attention to the inadequacy of administrative controls to manage risk and highlighted the importance of more effective controls, such as eliminating the hazard, substituting, isolating, or implementing engineering controls wherever reasonably practicable. It also recommended the use of purpose built man riding cages in lieu of kibbles as a form of conveyance during shaft sinking operations.

Figure 1. Photograph of a purpose-built man riding cage.



3. The deceased worker

Mr Junk began work at the CSA Mine on 5 September 2011. At the time of the incident Mr Junk was a shift supervisor and was responsible for the supervision of MMS 'Shift Crew A'.

Mr Junk was part of a fly in-fly out workforce employed by MMS during the CSA Mine shaft sinking project. These working conditions required Mr Junk to travel from his place of residence to Cobar. In his role as a shift supervisor, Mr Junk worked 12-hour shifts on a 14/7 rotating roster. The roster required Mr Junk to work seven day shifts and seven night shifts before having seven days off. Mr Junk was the subject of numerous medical examinations during his mining career that deemed him fit to work underground.

4. The CSA mine

The mine

The CSA mine is situated about 10 kilometres north-west of Cobar and is accessed via Louth Road. It is a metalliferous mine and extracts copper ore from the mining lease.

The CSA mine website provides the following information about the mine:

“The mine initially started in 1871 with an erratic production history until 1964, when Broken Hill South Ltd began large scale production. The mine passed to CRA in 1980 and then to Golden Shamrock Mines in 1992. The mine was closed in 1997/8 following its acquisition by Ashanti Goldfields and was reopened in 1999 by Glencore.

Since 1965 the mine has extracted substantial quantities of zinc, lead, silver and copper, but today, CSA Mine focuses on mining copper, with a silver co-product.

Our underground mine produces over 1.1 million tonnes of copper ore and produces in excess of 185,000 tonnes of copper concentrate per annum. The concentrate contains approximately 29% copper metal and is exported to smelters in India, China and South East Asia.

Operating 24 hours a day, seven days a week, CSA Mine provides direct employment for over 350 people, the majority of whom are based in the local township of Cobar”.

The CSA mine operates a conventional long-hole open stop mining method with all extracted ore being hauled along drives to a crusher underground. Once the ore is crushed it is transported to the surface via the No.2 shaft using a friction winder. The ore is then processed to produce copper concentrates, which are transported via rail network to Wollongong for export.

The mine has two shafts that are referred to as the No.1 and No.2 shafts. The No.2 shaft comprises the mine’s primary operational haulage shaft. The No.1 shaft was not operational at the time of the incident as it was undergoing substantial refurbishment and was in the process of being extended to a depth of 1500 metres with the objective of bringing the shaft into production.

The mining lease

The CSA mine is situated on consolidated mining lease (CML05) which is held by Isokind Pty Ltd. CML05 comprises several mining leases including ML4, ML17 and ML121. CML05 was granted on 2 December 1993, renewed on 8 March 2007 and expires 24 June 2028.

CML05 encompasses an area of 2474.1 hectares. The mine holder also holds two mining purpose leases identified as MPL 1093 and MPL 1094 for water storage dams, and two exploration leases EL 5693 and EL 5893.

5. The companies

Cobar Management Pty Ltd

Cobar Management Pty Ltd (CMPL) is the nominated mine operator in respect to CML05 (CSA Mine). Departmental records identify that CMPL was appointed as the nominated operator of the mine by the mining lease holder Isokind Pty Ltd on 2 April 2008.

CMPL is wholly owned by Glideco Pty Ltd and is a subsidiary of Glencore International AG. In its capacity as mine operator, CMPL has the ultimate responsibility for the day to day control of the mine. This control includes the power of an employer to direct employees and the power of a principal to direct the activities of a contractor.

The mine operator has a number of important duties under the *MHSA*. These include establishing a management structure, mine safety management plan, contractor management plan, system for dealing with emergencies and incident notification requirements.

Macmahon Mining Services Pty Ltd

Macmahon Mining Services Pty Ltd (MMS) is a mining contractor based in Perth that focuses upon national mining projects. MMS offer underground drilling and ground support services to the coal and metalliferous mining sectors and to key infrastructure projects.

In August 2011, MMS was contracted by CMPL to undertake the No.1 shaft extension project between 9240 level and 8740 level, a total of 500 metres.

Macmahon Holdings Limited

MMS is part of the Macmahon group, and is a wholly owned subsidiary of Macmahon Holdings Limited (MHL). Companies in the Macmahon group are managed on a group basis. The affairs of MMS are partly managed by key management personnel of MHL.

6. The shaft sinking project

The contract

The contract between CMPL and MMS was executed on 16 August 2011.

The contract engaged MMS to “engineer, procure and construct a system that achieved the requirements” set out in the contract.

A summary of the contract requirements include:

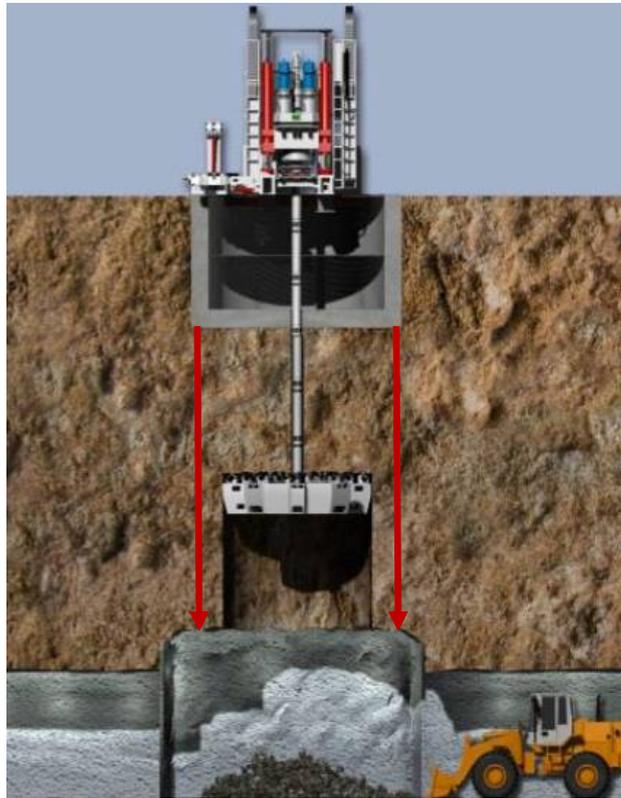
- Excavation of the No.1 shaft to a depth of 1500 metres.
- Installation and commissioning of a tower-mounted Koepe winder system capable of hoisting 350 tonnes of ore per hour to the surface from the 8787mRL with man riding capacity and platforms at the 9 Level, 11 Level and 8840mRL.
- Installation and commissioning of man riding and ore handling conveyances with each having a capacity of 18 tonnes.
- Installation of shaft infrastructure, steelwork, furniture and services.
- Installation and commissioning of a rock breaker, ore handling and crusher system.

The shaft sinking technique

At the outset of the project it was planned to construct the No.1 shaft extension using a raise bore and shrink strip and line technique. These works were intended to take place between the 9240 level and the 8740 level, a total of 500 metres to be undertaken in two 250 metre sections. This technique involved the drilling of a 1.5 metre diameter pilot hole using a raise bore technique. The shaft is then stripped and lined by drilling and blasting the walls of the shaft to

the required diameter beginning at the top of the shaft. During the drilling and blasting processes the cuttings and materials fall down the pilot hole to the bottom of the shaft where they are removed by a front end loader known as a 'bogger' or load haul dump. The following diagram depicts the raise bore, strip and line and bogging out process.

Figure 2. Diagram of a raise bore and bogging out process.



It is important to note that this technique does not involve the use of a kibble and it was intended that the strip and line technique would be undertaken from a single platform shaft sinking stage.

In January 2012, following the completion of the upper 250 metre section pilot hole, the hole appeared to be self-mining. Self-mining is a term that indicates the pilot hole was expanding to an unknown diameter with unintended material falling down the pilot hole resulting in a blockage. A risk assessment was conducted that determined that the only way to eliminate self-mining was to leave the pilot hole full of material in a static state.

It was later determined that the shrink strip and line technique was not viable due to the geological and geotechnical conditions in the shear zone below the base of the existing No.1 shaft column.

The project subsequently converted to a tandem 'blind sink' technique. The 'blind sink' technique involved the use of shaft sinking equipment consisting of a dual platform shaft sinking stage, a kibble and three winders to sink the shaft.

There were to be two 'blind sinks' completed concurrently, each consisting of 250 metre sections. The two portions were:

- Upper section- the initial 250 metres extending from the former 11 Level down to 8980 Level (where the incident occurred). These works would take place from a brace at the 9240 level.
- Lower section- the 8980 level to the 8740 level (final 250 metres).

The 'blind sink' technique consists of conventional drill, blast, bogging, ground support, formwork and concreting sequences to construct a cylindrical shaft, as summarised below. These cycles alter depending upon variables such as ground conditions, environment, equipment maintenance and available time before scheduled blasting times.

The drilling sequence

During the drilling sequence the shaft crew drill holes in the shaft floor using a drill pattern marked out to suit the ground conditions. Drilling is carried out using hand-held drilling machines. The depth of each hole and the number of holes vary depending upon the ground conditions. Once the drilling is completed the holes are cleared using compressed air.

The blasting sequence

During the blasting sequence explosives and detonators are transported down the shaft in the kibble where they are positioned according to the designated blast plan. A detonator cord is laid out and connected to the detonators. A firing line is lowered into the shaft and two electronic detonators are connected to the detonator cord in preparation for firing. The shaft crew vacate the shaft and remove excess explosive materials. The explosives or shots are fired at designated firing times. The shaft is then checked for misfires and deemed safe to re-enter.

The bogging sequence

Once the shaft has been cleared for re-entry by the shaft crew, a mini excavator is lowered into the shaft using the kibble winder. Rock (muck) from the blast area is removed from the base of the shaft by loading the kibble with the mini excavator. The muck is hoisted in the kibble to the brace level where it is tipped into a chute and removed from the shaft. The drill, blast, and bogging cycles are repeated until there is approximately 3.5 - 4 metres of ground exposed.

The ground support sequence

Once the excavated area is about 3.5 metres below the previous concreted shaft lining, the process of installing ground support commences. Shaft crews transport bolting equipment and shotcreting equipment to shaft bench (base) using the stage and kibble. Shotcrete and ground support (bolts and steel mesh) are installed around the perimeter of the shaft walls before lining the shaft walls with concrete.

The formwork sequence

Purpose built formwork is used to construct the shaft concrete lining support. The formwork consists of a "kerb ring" (the main supporting ring at the bottom of the formwork) and the formwork "barrel". The barrel is a tank like structure that forms the final shape of the shaft. For all concrete cycles, the kerb ring and barrel are lowered separately in the shaft by workers on the shaft stage using chain blocks. These works are undertaken by shaft crews from the dual platform stage suspended in the shaft in the following manner:

- The shaft crew, equipment and stage are lowered into the shaft. Once at the required depth, wall brackets are installed and chain blocks are attached to the brackets.
- The chain blocks are lowered and attached to the kerb ring and the tension is taken up on the chain blocks.
- The kerb ring is detached from the main barrel formwork by removing the kerb bolts, scribing bars and the hanging rod nuts.
- The tension is released from the chain blocks and the kerb ring is broken away from the formwork and lowered about 1 metre to allow the scribing ply and sand bags to be removed.
- The kerb ring is lowered to the required depth to support the main barrel formwork.

- Threaded steel hanging rods are fed through the holes in the kerb ring and connected to the previous concrete pour hanging rods. The kerb ring is then levelled.
- The formwork barrel is broken away from the previous concrete pour, lowered and secured to the kerb ring.

The concreting sequence

Once all formwork is in place and secured the concreting cycle is then completed. This process is completed by pouring concrete from an agitator truck into a hopper at the brace level which travels down a slick line where shaft crews pour the concrete into the formwork. The concrete is vibrated and sets resulting in a 300 millimetre thick 40mpa concrete shaft lining. These cycles are continuously repeated until the shaft is sunk to the required depth.

Commencement of the blind sink technique at the 9240 level

MMS began the blind sink technique at the 9240 level in December 2012. Installation of blind sink infrastructure including access and storage areas, winders, dual platform stage, kibble and other infrastructure occurred during the previous months.

The excavation diameter of the shaft was required to be about 5 metres to provide for a final lined shaft diameter of 4.36 metres.

Project management structure

At the time of the incident, both CMPL and MMS had designated project management structures in place to manage and coordinate the shaft extension project.

Project risk assessments

Formal risk assessments were conducted by CMPL and MMS before the start of the 'blind sink' technique. In November 2012, an independent safety audit conducted for MMS highlighted the existence of pinch points in the stage. In December 2012, a gap analysis risk assessment undertaken by representatives of CMPL and MMS identified the risks associated with the change in shaft sinking technique. While these risk assessments identified risks associated with riding in the kibble and the pinch points in the stage, the primary form of risk management control implemented was an administrative control known as the 'Man Riding in Kibble Procedure'.

Man riding in kibble procedure

The 'Man Riding in Kibble Procedure' contained written procedures for riding in the kibble. The document stated "*Caution: Keep body parts inside the confines of the kibble*". This statement was not given any emphasis in the procedure. The procedure did not link this behaviour to personal safety, but rather to equipment or property damage. Additionally, the one page assessment task attached to the procedure did not specifically test workers' knowledge about the importance of keeping body parts inside the kibble.

The procedure also documented a situation where it was necessary for personnel in the kibble to look over the edge of the kibble to ensure the stage or shaft bench was clear before lowering the kibble. These practical differences made the procedure ambiguous.

Administrative controls such as this are considered to be a 'soft control' and are not as effective as other hierarchical risk management controls. It is undesirable to have an administrative control as an exclusive risk management strategy.

Termination of contract

On 6 June 2013, CMPL terminated its contract with MMS. This action resulted in the retrenchment of the majority of the CSA Deeps workforce. CMPL's reasons for terminating the contract are unknown. The termination of the contract is the subject of civil action between CMPL and MMS.

7. The shaft sinking equipment

The shaft sinking winder operations

The 'CSA Deeps' project comprised substantial infrastructure including a winder control room, winders, pentice assembly and sheaves situated on the 11 level. The 11 level is about 30 metres above the 9240 level. The winder driver operated the shaft sinking stage and kibble winders from the 11 level. In this position the winder driver had no direct line of sight to the shaft sinking works and relied upon a shaft signalling system and signals relayed from shaft crews. The winder driver also relied on CCTV cameras on the 9240 level that were relayed to a monitor in the winder control room. The winder driver could not see into the shaft using these CCTV cameras.

The 9240 level comprised the brace area, shaft sinking equipment and primary working areas from which the shaft sinking works were undertaken. The 9240 brace was also known as the 9240 plat however, the term brace has been used in this report. The shaft sinking works were separated from the main upper shaft by an unexcavated section of the shaft known as a pentice. The shaft opening at the 9240 brace was delineated by yellow steel hand rails and it had two large steel hydraulic doors that opened and closed to expose the shaft entrance. The brace doors provided access to and from the shaft. The following photographs depict the winder control room on the 11 level and the 9240 brace.

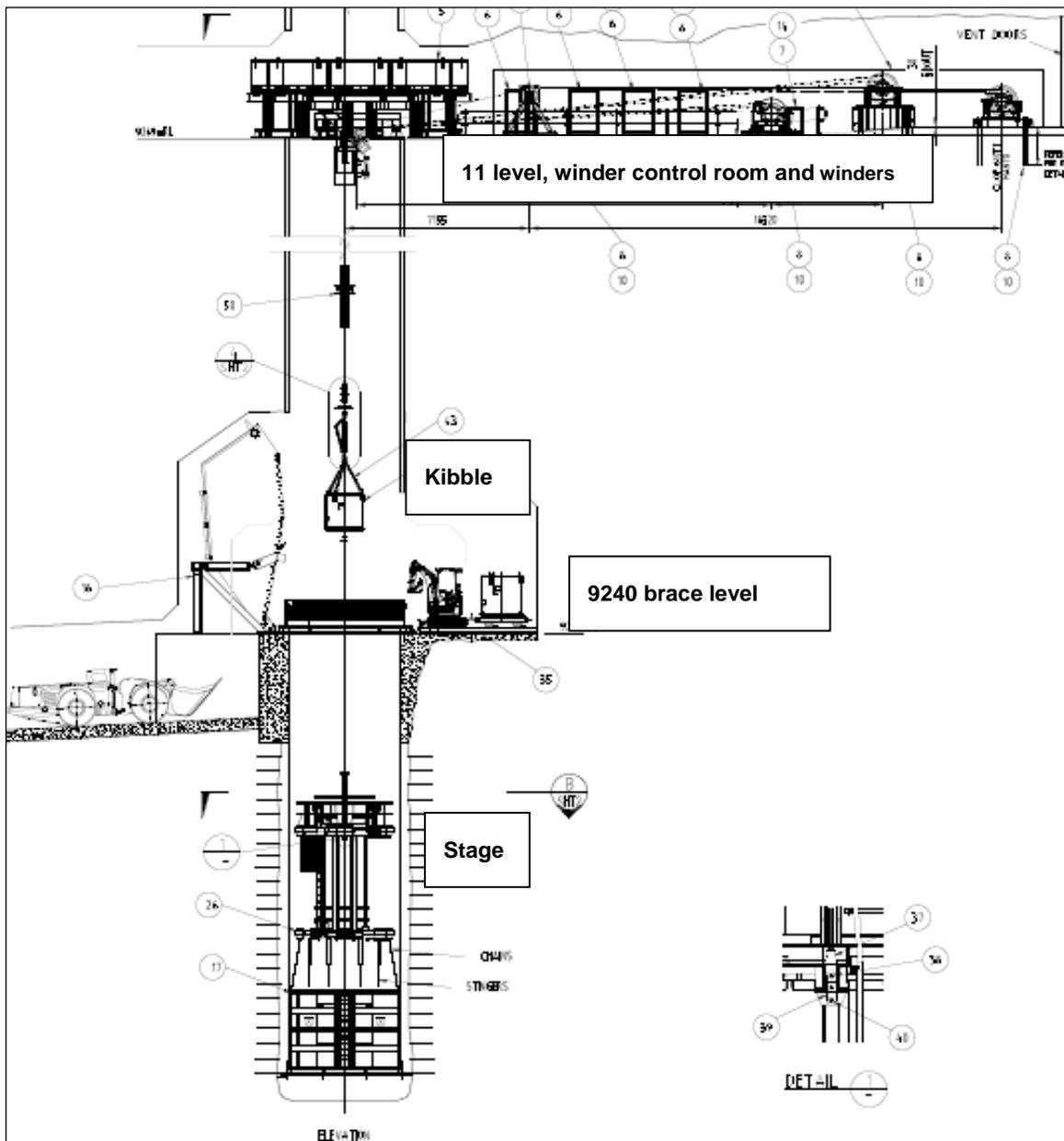
Figure 3. The winder control room on the 11 level.

Figure 4. The 9240 brace level.



The following diagram illustrates a general arrangement plan of the 11 level, 9240 brace level and shaft sinking infrastructure.

Figure 5. General arrangement plan of the 11 level, 9240 level and shaft sinking infrastructure.



The shaft sinking stage

The shaft sinking stage used at the 9240 level was a “Ballarat” design dual platform stage. The stage was cylindrical in shape and consisted of upper and lower platforms (or decks). The total height of the stage was 7.87 metres and the distance between the upper and lower platforms was 4.0 metres. The outside diameter of the stage was 3.79 metres. The stage design incorporated a funnel-like void surrounded by guide rails known as a kibble well that enabled a shaft sinking kibble to traverse through the centre of the stage. The inside diameter of the kibble well was 1.68 metres. The stage was suspended in the shaft via two steel cables that were controlled by individual winders that operated in unison. The upper platform of the stage was primarily designed to provide overhead protection to workers but was also used as a work platform. The following images depict the stage used at the incident site.

Figure 6. Diagram of Ballarat design stage.

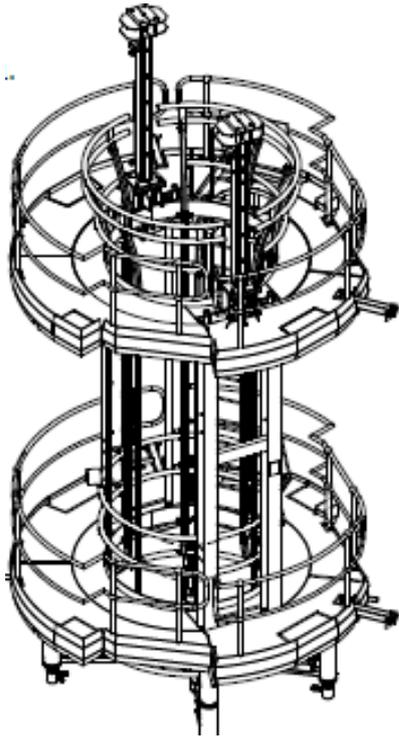


Figure 7. The stage on the 9240 level brace.



The “Ballarat” design stage had been used on two previous mining projects, one in Victoria and the other in South Australia. These stages were not used by MMS personnel. Before the CSA Deeps Project, Mr Junk had not undertaken shaft sinking work using this type of dual platform stage.

Shaft sinking kibble

During shaft sinking operations, kibles are commonly used as a form of conveyance. The shaft sinking kibble used in this project was manufactured in July 2006. It comprised a heavy duty steel bucket designed to extract earth and materials from the shaft. It had a capacity of 4.5 tonnes and weighed about 1.1 tonne when empty. It was 1.63 metres in height and had a diameter of 1.61 metres. Three chains secured it to the kibble winder cable. According to MMS’s procedures, people were permitted to ride in the kibble. A maximum of five people were permitted to ride in the kibble at any time. The following photographs depict a man positioned in the kibble and the kibble traversing through the upper platform of the stage.

Figure 8. A man standing in kibble at the 9240 level brace. Figure 9. The kibble traversing through stage’s kibble well.



Interaction between the stage and the kibble

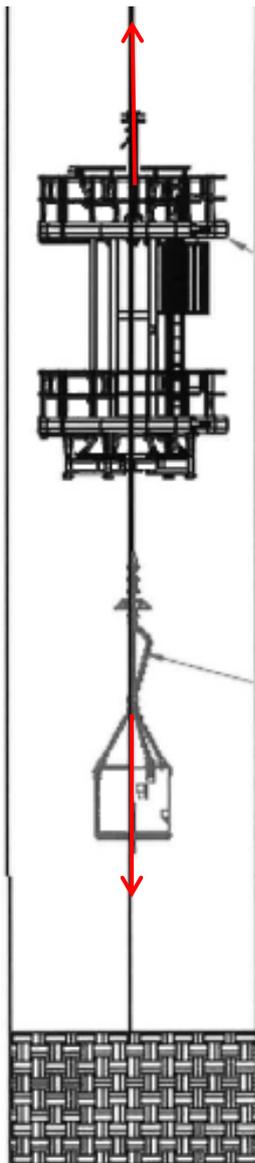


Figure 11. Diagram of ability of kibble well to traverse through the stage.

The diagram (left) demonstrates the ability of the kibble to traverse through the stage's kibble well vertically. This enabled the stage and kibble to be used in the shaft at the same time. The interaction between the kibble and stage was a significant factor in the investigation. The design dimensions of the Ballarat dual platform stage and the dimensions of the kibble provided very small clearances when the kibble traversed through the kibble well. These small clearances resulted in the creation of three hazardous pinch points in the kibble well. These were identified as the lower platform bell mouth, centre core bracing and upper platform of the stage. These pinch points were highlighted in several risk assessments before the 'blind sink' began. According to the design specifications of the stage and kibble there was a total of 70 millimetres clearance between the kibble and the inside diameter of the kibble well. Investigators measured clearances between the inner lip of the kibble and the upper platform of the stage to range between zero and 150 millimetres. These clearance distances varied depending upon the swing of the kibble on the kibble rope. The following photograph depicts the proximity of the kibble to the upper platform of the stage.

Figure 10. Clearance between kibble and stage.



The shaft sinking winders

The kibble winder used in the shaft sinking project was known as the Man 78 winder. This winder was originally commissioned at the 11 level in February 2012 for use during the strip and line shaft sinking technique to operate a single platform stage. This winder was subsequently commissioned as the kibble winder for the 'blind sink' technique.

The stage winders used during the 'blind sink' technique were known as the Man 69 and Man 70 winders. These winders were programmed to operate in unison to raise and lower the Ballarat design dual platform stage in the shaft. All three winders were controlled electronically via programmable logic controller settings. These settings monitor the winder operations and shut down the system if faults or system errors are detected. Examples of such system errors include overwind, over speed, slack rope, communication and other safety-related faults.

The winders used in the project were required to comply with electrical and mechanical technical standards and guidelines for winding systems. A departmental assessment determined that the

winding systems did not meet the design guidelines however, they were assessed as having met an equivalent level of safety and were therefore granted exemptions in December 2012. These exemptions were subject to numerous safety-related conditions. The following photograph depicts the winders on the 11 level.

Figure 12. Winders situated on the 11 level.

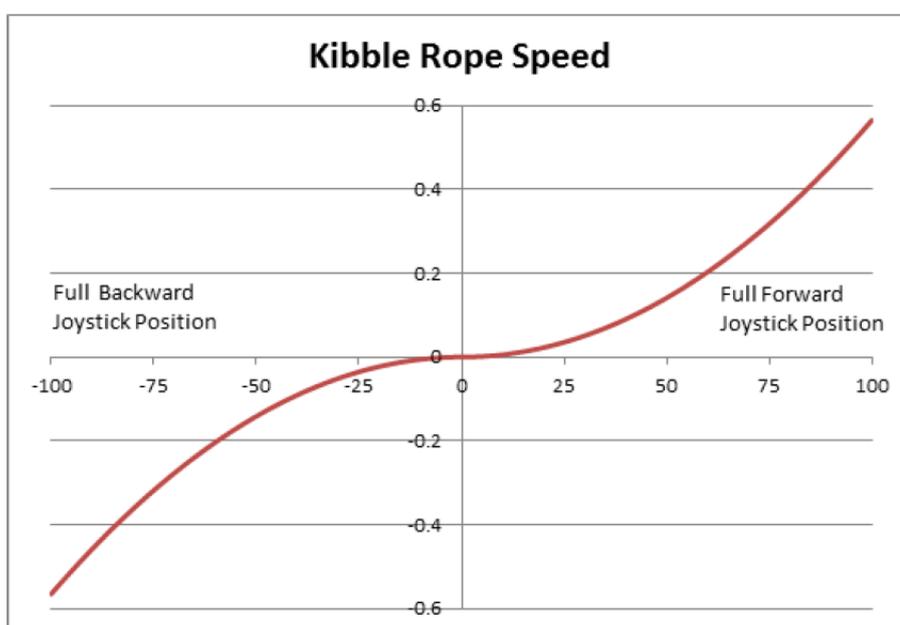


Kibble winder speed settings (Man 78)

The kibble winder (Man 78) had a maximum speed of 1.13 metres per second or 1485 rpm on the motor. At the time of the incident, the kibble winder speed was reduced by MMS to a maximum speed setting of 0.55 metres per second in both the raise and lower functions.

The winder driver could also control the speed of the winder using a variable speed joystick to increase the speed proportionate to the joystick position. The following graph illustrates the variable speed of the kibble winder depending upon joystick location up to the maximum speed setting.

Figure 13. Kibble winder (Man 78) variable speed range.



The above diagram highlights that the kibble winder could be operated at any speed up to its maximum speed of 0.55 metres per second. The investigation did not determine the exact speed of the kibble winder when the incident occurred, but shaft workers reported that the kibble speed appeared normal. Subsequent testing of the winder system by investigators found the system to be functional and there was no evidence of winder system error or malfunction.

Stage winder speed settings (Man 69 & 70)

The stage winders (Man 69 & 70) controlled the Ballarat shaft sinking stage. The stage winders had a maximum speed of 0.46 metres per second or 700 rpm on the motor. At the time of the incident, the stage winders' speed had been reduced by MMS to a maximum speed setting of 0.12 metres per second in both the raise and lower functions. As was the case with the kibble winder, the winder driver could control the speed of the stage winders using a variable speed joystick to increase the speed proportionate to the joystick position.

At the time of the incident, the stage winders were isolated as the programmable logic controller settings did not permit the stage winders and the kibble winder to operate simultaneously. Accordingly, when the kibble was being raised or lowered the stage was suspended in the shaft in a static position.

Both the kibble and the stage winders had dead man switches on the variable speed joystick controls to prevent unintended operation of the winders.

The following photographs depict the kibble and stage winder controls in the winder control room on the 11 level.

Figure 14. Kibble winder (Man 78) controls.



Figure 15. Stage winder (Man 69 & 70) controls.



The shaft signalling system

Shaft signalling systems are commonly used as primary forms of communication in shaft sinking projects. Such signalling systems use a series of bells or horns to communicate between shaft crews and winder drivers. Each signal has a specific meaning. The following photograph depicts the shaft signals that were in effect at the time of the incident.

Figure 16. Shaft signal signage at the 9240 brace level.



The shaft signalling system did not encompass a specific signal identifying when people were riding in the kibble in accordance with recommended industry practice. Accordingly there was no way for the winder driver to know that Mr Junk was in the kibble when the incident occurred.

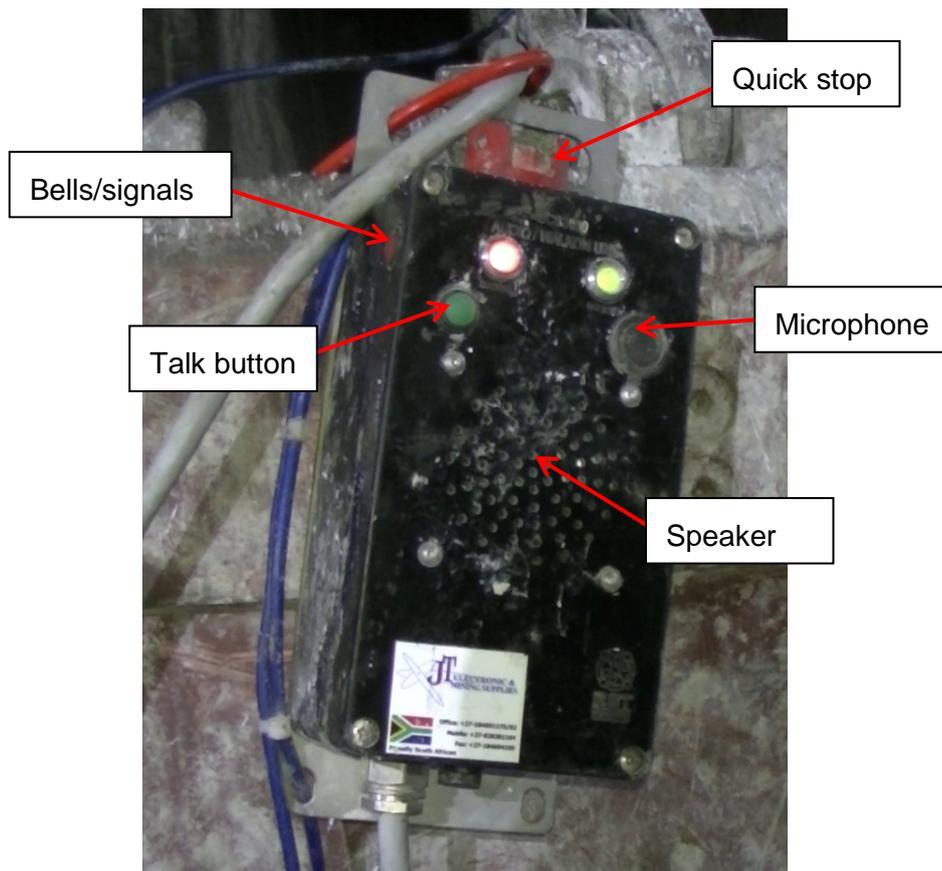
Shaft communication systems

The winder control room, dual platform stage and the kibble were fitted with JT Communication systems. These electronic communication systems were equipped with:

- A bell signalling system.
- A quick stop device.
- A voice communication system.

The JT communications system was only installed in the kibble when it was being used as a man riding conveyance. Any fault with the JT communication system would cause a winder fault and stop the winder. The investigation confirmed that the JT communications 'walk on unit' was installed in the kibble when the incident occurred. There were no communication faults reported during the shift when the incident occurred. However communication-related faults were common occurrences during the project. The following photograph depicts the kibble's JT communications 'walk on unit'.

Figure 17. The kibble's JT communications 'walk on unit'.



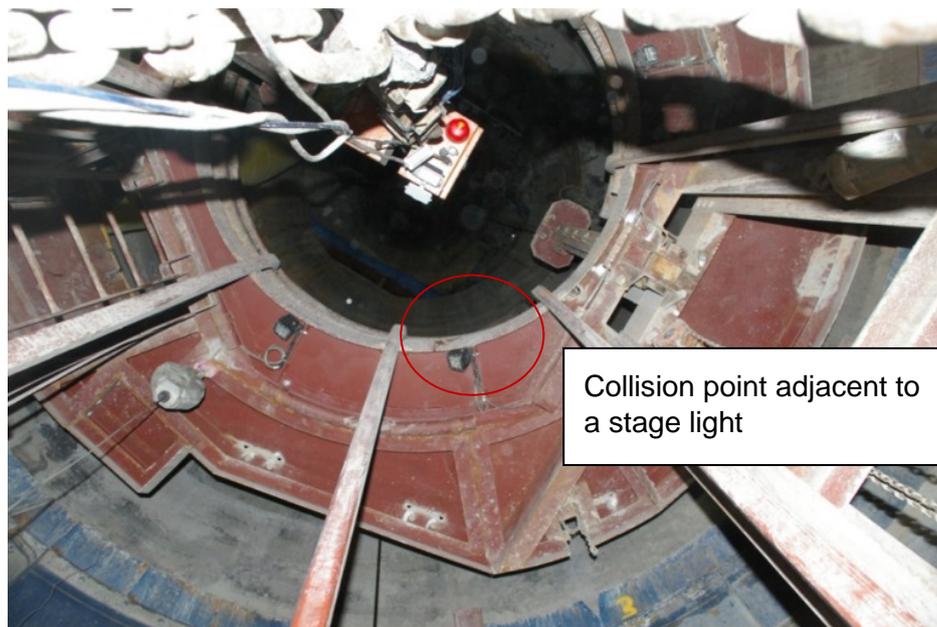
Stage lighting

The stage was equipped with four LED lights that were fixed to the underside of the upper platform of the stage. These lights were aimed at the lower platform of the stage. The purpose of these lights was to provide additional lighting while working on the lower platform of the stage. This lighting was installed by MMS at the request of shaft sinking crews to complement the lighting provided by their cap lamps. This was the first time MMS had installed electrical lights on a stage.

The lights were powered by a 12 volt battery (80 Ahr). MMS estimated that the four LED lights were rated at a total of 6.67 amps and were capable of projecting 480 lux of lighting onto the lower platform of the stage. MMS also estimated that a battery was sufficient to power the stage lights for 12 hours and allow for a full shift of work.

The collision point where Mr Junk's head hit the upper platform of the stage was directly adjacent to one of the stage lights.

Figure 18. Photograph of stage lighting looking upward toward collision point.



CCTV footage confirmed that the stage lighting was not operating when the incident occurred. The non-operational stage lighting had the capacity to project 480 lux onto the stage work environs. The absence of this lighting created a working environment with limited peripheral illumination and likely impaired situational awareness.

Pre-start checks

At the time of the incident MMS had a procedure in place for conducting pre-start checks on shaft sinking equipment. According to the pre-start procedure, pre-start checks were required to be carried out before the equipment was used or operated. The procedure also required a record of the inspection to be documented. MMS was unable to produce pre-start checks for the kibble and stage for the shift when the incident occurred. However, MMS did provide pre-start checks for a number of shifts before the incident.

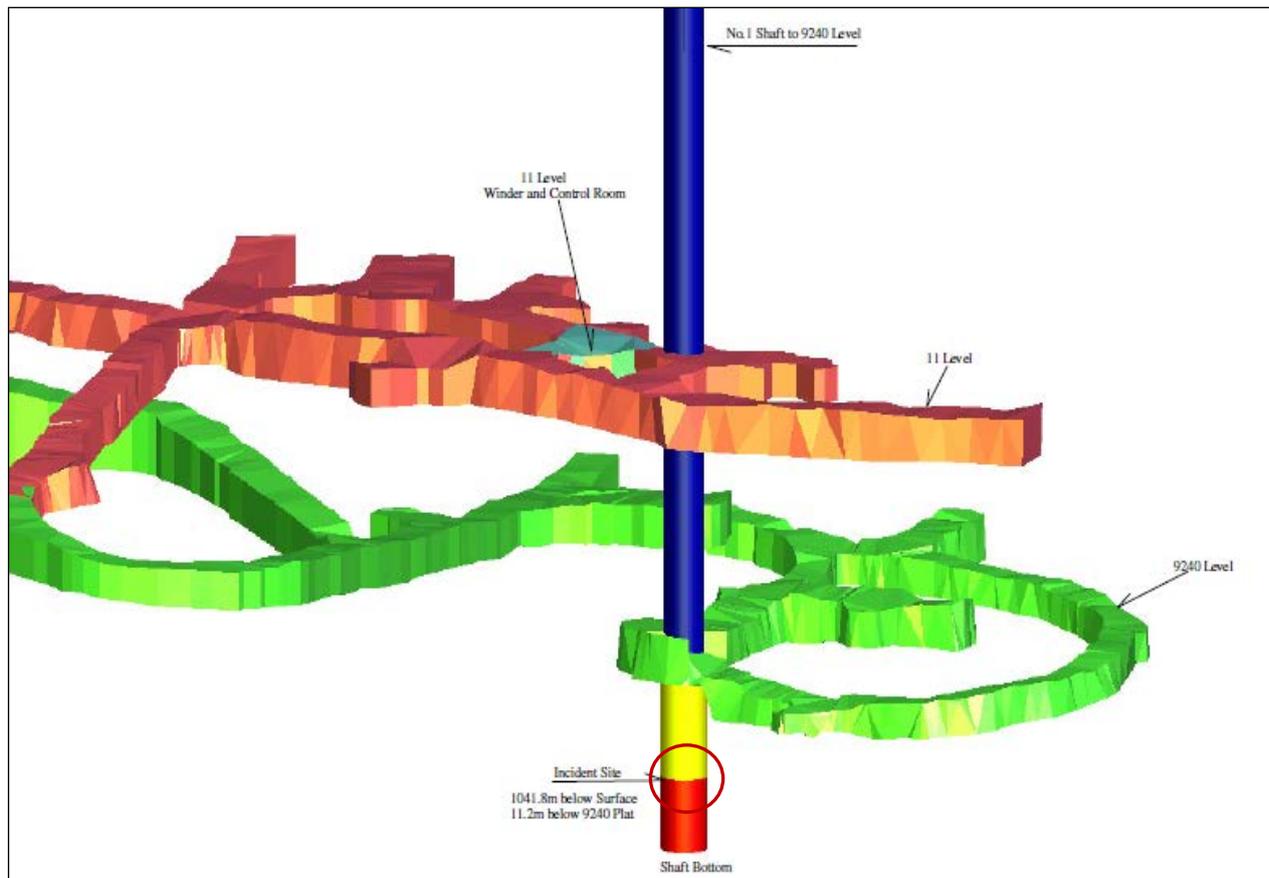
8. The incident site

The incident site in relation to the No.1 shaft

The incident occurred during the work process of 'lowering the kerb ring' in the No.1 shaft. This work process was part of the blind sink 'formwork sequence' outlined in chapter 6.

The incident site was identified by investigators to be situated in the No.1 shaft, 1041.8 metres below the surface of the mine. The following diagram depicts the mines No.1 shaft and incident site in relation to the 11 Level and 9240 level.

Figure 19. CSA mine plan depicting location of incident site in the No.1 shaft.



9. Circumstances of the incident

The incident

At 4.42 am on 16 March 2013, Mr Junk was fatally injured while working at the CSA Mine, No.1 Shaft Extension Project near Cobar. Mr Junk was the shift supervisor and was part of a four-man crew which was working in the shaft on the lower platform of the stage. The stage was suspended in the shaft about 15 metres below the 9240 brace level.

The shaft crew was in the process of lowering a kerb ring using chain blocks in preparation for the installation of hanging rods. During the works the shaft crew used the stage signalling system to communicate with the winder driver to lower the kibble into the shaft. The winder driver lowered the kibble into the shaft and through the stage's kibble well to the lower platform of the stage where Mr Junk climbed into the kibble. Workers reported that Mr Junk intended to be raised in the kibble to the 9240 brace level to obtain hanging rods (threaded steel rods used to secure the kerb ring in place).

Workers reported that Mr Junk signalled the winder driver to raise the kibble by ringing three bells from the communication system inside the kibble. This signal was reciprocated by the winder driver in accordance with signalling procedures and the winder driver began raising the kibble.

While the kibble was being raised through the stage's kibble well, workers reported seeing Mr Junk extend his head over the side of the kibble to communicate with a shaft worker on the stage. As the

kibble approached the stage's upper platform workers reported seeing Mr Junk's head impact between the kibble and the upper platform of the stage.

One of the workers used the signalling system on the lower platform of the stage to stop the kibble. The worker climbed a ladder to the upper platform of the stage where he attempted to communicate with Mr Junk but the kibble was too high for him to see into. The worker called out to Mr Junk but there was no reply. An emergency response was activated by contacting the winder driver via the voice communication system on the stage.

The winder driver activated the mine's emergency procedures and followed instructions to raise the kibble to the brace level where MMS workers rendered first aid and removed an unconscious Mr Junk from the kibble. Mr Junk was transported to the surface of the mine in the No.2 shaft man riding cage. Ongoing first aid was rendered to Mr Junk by his colleagues, mine rescue personnel and the NSW Ambulance Service. Mr Junk was conveyed via ambulance to Cobar Hospital where he was pronounced dead at 6.06 am.

At the time of the incident, Mr Junk was wearing personal protective equipment, including high visibility clothing and a hard hat. During the impact with the upper platform of the stage Mr Junk's hard hat was crushed and dislodged from his head. Investigators found Mr Junk's hard hat on top of the upper platform of the stage. The following photograph shows the damage to the hard hat.

Figure 20. Mr Junk's hard hat.



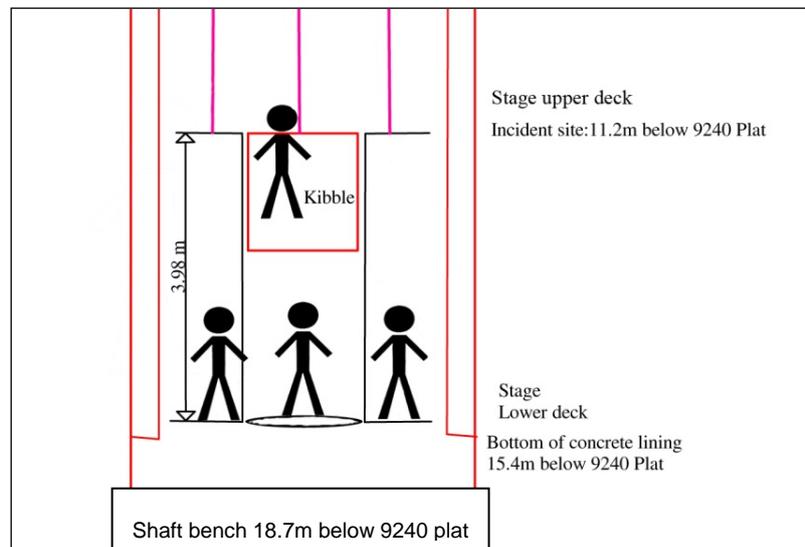
Incident site

The incident occurred while the kibble was being raised through the stage's kibble well. Survey plans identified that the incident occurred 11.2 metres below the 9240 brace level. At the time of the incident the concrete shaft lining ended 15.4 metres below the brace and the shaft bench (base) was 18.7 metres below the 9240 brace level.

Location of workers

The following illustration identifies the approximate location of shaft workers in relation to the stage and kibble at the time of the incident.

Figure 21. Position of workers in relation to the stage and kibble at time of incident (not to scale).



Retrieval of other shaft workers

Following the emergency response and transport of Mr Junk via ambulance away from the 9240 level, the kibble was reconnected to the kibble winder and lowered into the shaft to retrieve the other three shaft workers from the stage. The three workers climbed into the kibble and were transported to the 9240 brace. The CCTV footage shows one of the workers leaning over the edge of the kibble with his arms extended outside the perimeter of the kibble before it was lowered onto the brace. These actions further demonstrate the lack of physical barriers to prevent such actions and are indicative of the inadequacy of the kibble riding procedure to prevent this behaviour. The following screen capture of the CCTV footage highlights this point.

Figure 22. CCTV Footage of three shaft workers being raised in kibble after the incident occurred.



Post mortem examination

A post mortem examination occurred at 9 am on 20 March 2013. The post mortem determined that the direct cause of death was 'head injuries'. The post mortem further determined that the head injuries sustained by Mr Junk were consistent with having arisen as a result of blunt force trauma and the injuries were fatal. There was no alcohol, drugs or toxins detected.

10. Examination of the working conditions

Hours of work at the CSA Deeps Project

At the time of the incident, MMS shaft crews worked a 14/7 roster, consisting of seven days on, seven nights on and seven days off. Each shift comprised 12 hours of work. These working conditions involve a fly-in-fly-out workforce with many workers travelling from other states. These workers are accommodated at motels and facilities in the Cobar area. Typically, Mr Junk flew in to Cobar on his first day of work and flew home on his first day off.

On the day of the incident, Mr Junk was working his second night shift in the panel and was completing his ninth of 14 shifts. He had completed seven day shifts and had 24 hours off before starting the night shifts. Mine gate entry records identify that Mr Junk had worked about 110 hours over the nine shifts when the incident occurred. Mine gate entry records also identify that Mr Junk's working hours had exceeded the 12-hour shift times on six of the preceding eight shifts. The following table sets out the hours of work (time upon the mine site) of Mr Junk and other shaft crew workers for the shift panel leading up to the incident.

Figure 23. Shift hours worked until the time of incident.

March 2013	Wed 6	Thur 7 Day	Fri 8 Day	Sat 9 Day	Sun 10 Day	Mon 11 Day	Tue 12 Day	Wed 13 Day	Thur 14 Night	Fri 15 Night
Mr Junk	N/A	FIA 8.5	14.5	11	13.5	13	13	13.5	13	10*
	Day	Day	Day	Day	Day	Day	Day	Night	Night	Night
Shaft Worker 1	DIA 9.25	12.5	14	11	13.25	12.25	12.25	12.25	12.25	15.5
Shaft Worker 2	FIA 9	12.5	14	10.5	13.25	12.5	12.5	12.5	12.5	15.25
Shaft Worker 3	FIA 8.75	12.5	12.25	12.25	12.5	12.5	12.25	12.5	12.25	15.5
Shaft Worker 4	FIA 8.75	12.25	14	10.5	13.25	N/R	N/R	12.5	12.5	15.5

Further analysis of the working conditions of Mr Junk in the months leading up to the incident identifies:

- In January 2013, Mr Junk worked 22 shifts, commuted on three flights and had nine days off.
- In February 2013, Mr Junk worked 20 shifts, commuted on three flights and had eight days off.
- In March 2013, Mr Junk worked nine shifts, commuted on one flight and had six days off.

The hours of work and potential for fatigue

In order to determine whether fatigue was a contributing factor in an incident it is necessary to determine (a) the likelihood that an individual would be fatigued and (b) the likelihood that the error that contributed to the incident was consistent with a fatigue-related error.

Mr Junk and other shaft crew members worked extremely long hours in the nine days preceding the incident. The shift sequence involved a rapid transition from day shift to night shift after seven days. Risk assessment of this pattern of work would typically suggest a significant reduction in sleep opportunity and a significantly elevated likelihood of fatigue.

This likely increase in fatigue would have been further exacerbated by the reduced alertness (elevated fatigue) typically experienced during the low point in the body's daily circadian rhythm. The low point in the 'circadian rhythm' occurs between 2 am and 6 am. At the time of this incident (4.20 am), Mr Junk was at the lowest point in the circadian rhythm and as a result, his alertness would be significantly reduced above and beyond the typical reduction due to the long shifts worked leading up to the accident.

These two factors (circadian rhythm low point and increased sleep debt) are likely to have interacted to increase fatigue even more than the individual effects of accumulated sleep debt and time-of-day. In this case, Mr Junk had limited sleep opportunity and likely sleep debt, transitioning to a sequence of night shifts. His level of alertness would have been further reduced by the fact that the transition to night shift would have required him to sleep during the day preceding the shift in which he died. Daytime sleep immediately following the transition to night shift occurs at a biologically and socially inappropriate point in the body clock rhythm and is typically associated with reduced duration and restorative value for that sleep. There is a significant body of research indicating that the physical and mental recovery value of sleep at a biologically inappropriate time (when the body is geared to being awake) will shorten sleep by 1.5 - 3 hours on average and disrupt the normal pattern of sleep and provide less recovery.

As a result, these working conditions combine three key biological indicators (reduced sleep opportunity due to extended work hours, poor sleep due to inversion of the sleep wake cycle and working at the lowest point in the daily cycle of alertness/sleepiness) combining in a way that maximizes the likelihood the individual was fatigued in the shift(s) immediately preceding and at the time of the incident.¹

Fatigue related error and situational awareness

The second aspect of assessing the likelihood that an incident is fatigue-related is to determine whether the error that leads to the fatality was consistent with a fatigue-related error. From a human factors perspective, the proximal event that led to the fatality was Mr Junk's decision to communicate with a co-worker and to put his head outside the kibble exposing it to a pinch point hazard while being raised through the dual platform stage.

The circumstances surrounding this incident would suggest that Mr Junk may have experienced a state of reduced situational awareness and that the need to communicate with the co-worker distracted him from the potential risks associated with placing his head outside the kibble.

¹ A report prepared by Professor W.A. (Drew) Dawson, Director of CQUniversity's Appleton Institute, March 2014.

There has been considerable research over the last few decades that clearly associate (a) an elevated probability of reduced situational awareness and (b) attentional tunnelling (increased focus on proximal events (in time and space) associated with elevated levels of fatigue. The error associated with this fatality is clearly consistent with a fatigue-related error.²

Hours of sleep

Mr Junk's hours of sleep for the 96-hour period leading up to the incident cannot be determined. However, it is noted that in some fly-in-fly-out mine operations, the social environment in which the worker is accommodated during the non-work period can mitigate the likelihood of fatigue. This is attributed to reduced social and family obligations that potentially enable them to allocate a greater proportion of the sleep opportunity period to sleep than their residential counterparts.³

Fatigue management

This incident reinforces the importance of fatigue management in mining workplaces. It also highlights the importance of conducting detailed risk assessments in relation to fatigue, roster systems and hours of work during shaft sinking operations.

Differences between CMPL and MMS working conditions

At the time of the incident, the CMPL roster system was significantly different to the MMS roster system. The CMPL roster system consisted of a range of shift types. An analysis of the CMPL roster system identified that the maximum number of consecutive 12 hour shifts was 12 day shifts followed by nine days off.

In relation to a combination of 12 hour day and night shifts, CMPL's roster system provided for a maximum of a five by five roster. This roster consists of five day shifts, five days off, five night shifts, five days off and so on. CMPL's roster also provided for eight-hour day, afternoon and night shifts on a rotating basis.

11. Causal factors

Risk control measures – pre incident

The WHSA requires a duty holder to eliminate risks to health and safety, so far as is reasonably practicable and if it is not reasonably practicable to eliminate such risks, to minimise them.

The MHSR sets out further obligations to control a risk to health or safety (in any case in which the elimination of the risk is not reasonably practicable). Specifically, it requires the following measures to be taken (in the order specified) to minimise the risk to the lowest level reasonably practicable:

- first, substituting the hazard giving rise to the risk with a hazard that gives rise to a lesser risk,
- second, isolating the hazard from the person put at risk,
- third, minimising the risk by engineering means,
- fourth, minimising the risk by administrative means (for example, by adopting safe working practices or providing appropriate training, instruction or information),
- fifth, using personal protective equipment.

A combination of the above measures is required to be taken to minimise the risk to the lowest level reasonably practicable if no single measure is sufficient for that purpose.

² A report prepared by Professor W.A. (Drew) Dawson, Director of CQUniversity's Appleton Institute, March 2014.

³ A report prepared by Professor W.A. (Drew) Dawson, Director of CQUniversity's Appleton Institute, March 2014.

The obligations to assess and eliminate or control risk imposed by the MHSR are in addition to and do not detract from the obligations of an employer under the WHSA.

The investigation identified a number of system failures in regard to the management and control of specific shaft sinking project risks as set out below.

Man riding in kibble procedure

The 'Man Riding in Kibble Procedure' contained documented procedures to exclusively control the risks associated with riding in the kibble and the hazardous pinch points in the kibble well of the stage. The document stated "*Caution: Keep body parts inside the confines of the kibble*". This statement was not given any emphasis in the procedure. Further, the procedure did not link this behaviour to personal safety, but rather to equipment or property damage.

Additionally, the one-page assessment task attached to the procedure did not specifically test workers' knowledge about the importance of keeping body parts inside the confines of the kibble.

The procedure also documented a situation where it was necessary for personnel in the kibble to look over the edge of the kibble to ensure the stage or shaft bench was clear before lowering the kibble. These practical differences made the procedure ambiguous.

Administrative controls such as this are considered to be 'soft controls' and are not as effective as other hierarchical risk management controls. It is undesirable to have an administrative control as an exclusive risk management strategy.

This procedure was ineffective in this and other instances, and failed to prevent Mr Junk from being exposed to a risk to his health and safety. The inadequate nature of this procedure was exacerbated by the absence of hard barriers such as elimination, substitution and engineering risk management controls to prevent people from exposing their body parts to hazardous pinch points in the stage's kibble well.

Previous breaches of the man riding in kibble procedure

In October 2012, a MMS employee breached the 'Man Riding in Kibble Procedure' by climbing out of the kibble before it was safe to do so at the surface of the No.1 shaft. This behaviour exposed the employee to a risk of falling down the shaft. The incident was the subject of a MMS investigation and the employee was the subject of disciplinary action. The employee's behaviour highlighted the inadequate nature of the procedure to prevent a person from keeping their body parts inside the kibble. Nevertheless, the MMS investigation did not result in the implementation of more effective risk management controls to prevent a reoccurrence of this behaviour.

Control of foreseeable risk

In November 2012, an independent safety audit conducted for MMS highlighted the existence of pinch points in the stage. In December 2012, a gap analysis risk assessment was also undertaken by representatives of CMPL and MMS to identify the risks associated with the change in shaft sinking technique. During this process the risks associated with pinch points between the stage and the kibble were identified.

Shaft sinking stage design

The design of the stage created three pinch hazardous points in the stage kibble well identified as the lower platform bell mouth, centre core bracing and upper platform of the stage. The design of the stage did not provide adequate clearances to eliminate potential pinch points, nor did it incorporate any form of physical barrier in the kibble well to prevent persons riding in the kibble from exposing their body parts to these pinch points. The design of the stage and absence of elimination, substitution or engineering controls to prevent persons from exposing their body parts to hazardous pinch points is a key contributing factor in this incident.

This unique dual platform stage design had not been previously used by MMS personnel for shaft sinking projects. Training records for 'Shaft Crew A' indicate that no training was provided to workers about the use of the stage or the stage design prior to the incident occurring.

The kibble design

The kibble design used in the project is considered to be a standard type of shaft sinking kibble, which is widely used in the industry. It did not incorporate any form of physical barrier to prevent a person riding in the kibble from extending their body parts outside confines of the kibble. While this kibble design complied with the current guidelines, its interaction with the shaft sinking stage created hazardous pinch points. The absence of elimination, substitution or engineering controls to prevent persons from extending their body parts outside the kibble is a key contributing factor in this incident.

Shaft signalling system

The shaft signalling system in effect at the time of the incident did not encompass a specific signal identifying when people were riding in the kibble. Accordingly there was no way for the winder driver to know when people were riding in the kibble. Shaft sinking signalling systems must incorporate man riding signals to clearly identify when people are riding in the kibble.

Stage lighting

CCTV footage of the incident identifies that the lighting installed on the stage was not operating when the incident occurred. This lighting was installed at the request of shaft crews to complement cap lamp lighting. The pinch point at the upper platform of the stage was directly adjacent to the stage lighting. Adequate lighting in underground mining workplaces is paramount to enable workers to be able to function and perform tasks safely and effectively.

When operating machinery or performing maintenance or assembly tasks recommended lighting levels should range between 200 and 800 lux. Inadequate lighting impairs one's ability to identify peripheral hazards and judge movement and speed of equipment. A miner's cap lamp provides limited range and limited peripheral illumination.

The non-operational stage lighting had the capacity to project 480 lux onto the stage work environs. The absence of this lighting created a working environment with limited peripheral illumination and likely impaired situational awareness.

Fatigue management

The hours of work and roster system in effect at the shaft sinking project created working conditions which were conducive to fatigue. Mr Junk worked extremely long hours during the shifts preceding the incident. His working hours exceeded the 12 hour shift times on six of the preceding eight shifts. His working conditions reduced sleep opportunity and inverted his sleep cycle during the transition from day to night shifts. Further, the incident occurred during the low point in the body's circadian rhythm and the nature of the incident was consistent with a fatigue related error. These factors suggest that fatigue was likely to have been a contributing factor in this incident.

12. Remedial actions

Risk control measures post-incident

Following the incident, MMS undertook 12 separate risk assessments in relation to the use of the dual platform stage and kibble during shaft sinking operations. These risk assessments involved consultation with MMS employees.

The risk assessments resulted in the identification of risks associated with the use of the dual platform stage and kibble during shaft sinking operations. The risk assessments also identified a range of controls to manage the identified risks. A number of these controls were implemented by MMS post incident. These controls are outlined below.

Update the kibble riding procedure

Following the incident MMS made significant amendments to the 'Man Riding in Kibble Procedure' placing a particular emphasis upon personal safety. The procedure was enhanced to highlight the importance of keeping body parts inside the confines of the kibble. The procedure also incorporated a range of additional risk control measures implemented after the incident. The training and assessment tasks relating to the procedure were also updated to incorporate these changes. Nevertheless, the procedure remained an administrative control and was therefore reliant upon behavioural compliance with the procedure.

Install kibble webbing barrier

A physical barrier in the form of webbing material was designed and manufactured to be attached to the kibble and chains to prevent people from extending their body parts outside the kibble. According to MMS the mesh barrier was intended to prevent people from inadvertently extending their body parts outside the kibble. Further, MMS reported that the mesh barrier was a temporary measure until specialised man riding kibles were designed and implemented at the site. The following photograph depicts the kibble webbing barrier affixed to a kibble at the surface of the No.1 shaft at the CSA Mine.

Figure 24. Webbing barrier affixed to kibble at the CSA Mine



Appointment of shaft signalman

A new procedure was developed by MMS that required each shift supervisor to nominate a designated shaft signalman at the start of each shift. This procedure was implemented to ensure that only one suitably trained person had control of a conveyance (such as a kibble) at any one time so as to ensure the following:

1. That the kibble was in a safe location before a person entered or exited the kibble well of the stage.
2. That the kibble travelled through hold points in a safe manner.
3. That all personnel riding in/on the kibble and/or a conveyance generally were following correct protocol in relation to travelling in/on a kibble / conveyance.
4. That kibble protection barriers (webbing) were in place and correctly fitted prior to moving the kibble/a conveyance when two conveyances were in use in the shaft at the same time.

This procedure placed a direct responsibility upon the shaft signalman to have oversight and responsibility for the operation of conveyances during the shaft sinking project. In order to be appointed as a shaft signalman the worker must have completed signalman training and be deemed to be competent in order to undertake the position.

Introduce mandatory kibble holding points

Mandatory kibble holding points were introduced by MMS requiring the winder driver to stop the kibble one metre below each hazardous pinch point in the kibble well of the dual platform stage. These mandatory stops enabled the shaft signalman to ensure people in the kibble were properly contained in the kibble before signalling the winder driver to raise the kibble.

Reduce kibble speed

MMS reduced the kibble winder speed to 0.2 metres per second when traversing through the stage's kibble well. A flashing warning light was also introduced to warn workers about the movement of the kibble in the stage's kibble well.

Update shaft signalling system

MMS amended the shaft signalling system to include a signal identifying when people were riding in the kibble. The 'Man-On' signal (four bell signal) was introduced to notify the winder driver about the presence of people in conveyances such as the kibble. This signal would alert the winder driver to adhere to mandatory hold points when raising or lowering the kibble through the stage's kibble well and limit winding speeds to no greater than 0.2 metres per second.

Stage induction program

MMS developed a specific training, induction and assessment program concerning the use and operation of the dual platform stage. This program included practical competency based assessment tasks at the work site. According to MMS workers this induction program required the completion of an on-site stage familiarisation and hazard awareness process.

Elimination of kibble and stage interaction

MMS issued a Manager's Instruction on 4 April 2013, which prohibited the use of the stage and kibble simultaneously in the 9240 shaft. The instruction stated *"At no time will there be both conveyances in the shaft below the shaft doors. The two deck stage will be stored in the sky shaft when the kibble is being used... and vice versa when the stage is being used."*

This risk management control prevented both conveyances interacting in the shaft and eliminated the risks associated with the riding in the kibble and the hazardous pinch points in the

kibble well of the dual platform stage. Elimination controls are the most effective form of risk management control.

13. Conclusion

The hazardous pinch points associated with the interaction of the kibble and the stage during the shaft sinking process were not effectively managed or controlled. These pinch points were identified in several risk assessments before the incident. However, an administrative control was exclusively used to control the identified risk.

This administrative control failed in this and other instances to prevent persons from keeping their body parts inside the confines of the kibble. The absence of elimination, substitution or engineering controls in combination with other causal factors highlighted in this report created an environment whereby workers were exposed to these hazardous pinch points.

A number of more effective risk management controls were implemented after the incident which included elimination, engineering and supervision controls. These controls could have been implemented before the 'blind sink' technique began.

14. Recommendations

This incident highlights the importance of an effective risk management program in relation to shaft sinking activities. The following recommendations are advanced to improve industry safety and reduce the likelihood of similar incidents occurring in the future:

Recommended practice for industry

1. Specific risks associated with shaft sinking projects, the use of conveyances, and the interaction of conveyances with other shaft sinking equipment must be identified, assessed and effectively controlled.
2. Shaft sinking stage designs should provide adequate clearances for kibbles and eliminate potential pinch points.
3. Where practicable, suitably constructed man riding cages should be used in lieu of a kibble as a form of shaft conveyance.
4. Administrative/soft controls should not be exclusively used to manage shaft sinking risks.
5. Workers should be adequately trained in the use and safe operation of all shaft sinking equipment.
6. Shaft signalling systems should contain a specific signal to identify when people are riding in shaft sinking conveyances.
7. Human factors such as fatigue, hours of work and human error should be considered when reviewing shaft sinking risks.
8. Mine operators should ensure that contractor's safety management plans are approved and are consistent with the mine operator's safety management plan.