

INVESTIGATION REPORT

REPORT INTO THE DEATH OF MR QUINTON MOORE

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Document control

Published by NSW Resources Regulator

Title: Report into the death of Quinton Moore at Bengalla mine 3 November 2018

First published: June 2020

Authorised by: Acting Chief Investigator/ Major Safety Investigations

CM9 reference: DOC20/464870

AMENDMENT SCHEDULE

Date	Version	Amendment
June 2020	1	First published

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Executive summary

On 3 November 2018, Mr Quinton Moore, aged 37, suffered fatal injuries while washing a large earth moving tyre at Bengalla Mine (the mine) approximately 4 kilometres south west of Muswellbrook. At the time of the incident, Mr Moore was employed by Marathon Tyres as a tyre fitter. Marathon Tyres was contracted by the mine to provide, among other things, tyre fitting services.

At about 7.20 pm, Mr Moore was operating a tyre handler to replace a damaged earth moving tyre from a water cart. The tyre and rim assembly weighed approximately 2.2 tonnes. During the tyre replacement process, Mr Moore conveyed the tyre to the mine's heavy vehicle wash bay for the purpose of cleaning the tyre assembly.

A Marathon Tyres co-worker (the co-worker) remained in the tyre bay fitting area and observed Mr Moore using a fixed high-pressure water cannon to clean the tyre rim. The co-worker observed the tyre in a fixed vertical position within the grabs of the tyre handler.

The co-worker went to complete other duties and a short time later heard a noise, which caused him to look towards the wash bay. The co-worker was unable to see Mr Moore and noticed the tyre was not in the grabs of the tyre handler. The co-worker walked to the wash bay, where he saw Mr Moore lying face down on the concrete pad of the wash bay, trapped under the tyre in front of the tyre handler. The co-worker called an emergency on his two-way radio and a response was activated. Several mine workers attended the wash bay to assist Mr Moore, however, it was apparent that his injuries were fatal. Emergency services and the NSW Resources Regulator were notified and attended the scene.

Causal Factors

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

- The wash bay was occasionally used to clean tyres, however, a risk assessment had not been undertaken and there were no safe work procedures in place for cleaning tyres at the wash bay.
- The tyre was suspended with insufficient pressure applied to maintain the tyre within the grabs.
- High-pressure water was introduced to the suspended tyre, causing it to become unstable.
- The fitter entered the restricted work zone.

Recommendations

Mine Operators and contractors must:

- focus on identifying, implementing and enforcing restricted work zones regarding the operation of tyre handlers
- inform all workers of the risks associated with working in proximity to suspended loads
- ensure safe systems of work associated with cleaning tyres are identified, implemented and communicated to all workers.

Workers must:

- remain a safe distance from any suspended load and consider potential fall zones
- never enter a restricted work zone while a tyre handler is supporting a load – unless in strict accordance with an approved safe system of work
- comply with safe work procedures.

Designers and manufactures of plant and equipment must ensure:

- tyre fitting attachments are designed and manufactured to be without risk to the health and safety of people who, at a workplace, use the plant for the purpose for which it was designed or manufactured
- adequate and current information on the design, including operational manuals and safety information is provided to all persons who purchase the plant.

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1. Purpose of the report

This report describes the incident investigation conducted by the NSW Resources Regulator into the cause and circumstances of the death of Mr Quinton Moore at Bengalla Mine on 3 November 2018.

2. Investigation overview

2.1. The Regulator

We investigate major workplace incidents in the NSW mining, petroleum and extractives industries. We carry out a detailed analysis of incidents and report our findings to enhance industry safety and to give effect to our [Compliance and enforcement approach](#).

2.2. Legislative authority to investigate

Investigators are appointed as government officials under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* (WHSM Act) and are deemed to be inspectors for the purposes of the *Work Health and Safety Act 2011* (WHS Act). 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 the WHS Act.

2.3. Regulator response

The incident was reported to the Regulator on 3 November 2018. We deployed inspectors and investigators to the mine to commence an investigation.

On 13 November 2018, we published an [investigation information release](#), reinforcing the requirement for all mine operators to ensure they identified hazards and managed risks associated with suspended loads and lifting equipment in accordance with the provisions of the WHS Act the WHSM Act and associated regulations.

3. Parties involved

3.1. Mr Quinton Moore

Mr Moore was an experienced tyre fitter having worked at the mine for several years in various roles for both the Bengalla Mining Company and Marathon Tyres. At the time of the incident, Mr Moore was supervising a trainee tyre fitter.

Mr Moore was a qualified tyre fitter, having completed a Certificate II Automotive Mechanic (Tyre Fitting Heavy) in 2008. In 2017, Mr Moore completed a Statement of Attainment for tyre related skills.

3.1.1. Cause of death

On 12 November 2018, an autopsy was conducted at the Forensic and Analytical Science Services, Department of Forensic Medicine Newcastle. The report concluded that Mr Moore died on 3 November 2018 at the Bengalla Mine in Muswellbrook and the direct cause of death was multiple injuries.

3.1.2. Toxicology

A number of screening and quantitative tests were conducted. It was concluded there were no traces of alcohol or drugs in Mr Moore's body.

3.2. Co-worker

The co-worker was a trainee tyre fitter employed by Marathon Tyres. The co-worker had been working at the mine for approximately three months prior to the incident. The co-worker held a national licence to perform high risk work and was certified to operate the tyre handler.

3.3. Mine operator and holder

Bengalla Mining Company Pty Ltd (ACN: 053 909 470), a joint venture with New Hope Group (40%), Wesfarmers (40%), Mitsui (10%) and Taipower (10%), is the colliery holder of Bengalla Mine.

The mine is located approximately 4 kilometres south west of Muswellbrook NSW. The mine supplies international markets with thermal coal and is approved to extract 15 million tonnes of run-of-mine coal per annum. The mine employs 420 permanent employees and approximately 380 contractors.

Figure 1 Bengalla Mine site



3.4. Marathon Tyres

Marathon Tyres Pty Limited (ACN: 082 184 923) is based in Sandgate in NSW. They employ workers to provide services to the mine, including repair and fitting of 'off the road' (OTR) tyres. The services are provided in accordance with a contract between Bengalla Mining Company Pty Limited and Marathon Tyres Pty Ltd.

3.4.1. Service contract

On 8 August 2016, the mine and Marathon Tyres entered into a contract for the supply of services, contract No. BMC-16-08-09. The contract was due to expire on 23 March 2019. Schedule A of the agreement states Marathon Tyres is responsible for the supply, repair, installation and maintenance of all tyres and rims, in accordance with 'best practice' safety standards in tyre fitment, handling and operation.

Properly trained and qualified tyre fitters were to be supplied by Marathon Tyres. All tyre fitters were required to be competently trained in the operation of the various items of plant and equipment.

At least one fully trained tyre fitter was required to be present during a shift and Marathon tyres were responsible for ensuring at least 15 safety interactions were completed each month.

Schedule D of the agreement which related to site conditions applied to all contractors at the mine and provided that Marathon Tyres must have its own safety management system supported by safe work procedures. All tyre fitters were required to complete the mine's site induction before commencing at the mine, and the mine was responsible for ensuring supervision by statutory personnel. In addition, Marathon Tyres was required to provide a competent person to ensure their workers were adequately supervised.

The agreement further required adherence to general conditions, which provided that Marathon Tyres and its workers must comply with all rules and policies of the mine. In the event of a breach, Marathon Tyres or their workers may be removed from the site. The tyre handler used by Marathon Tyres workers was to be supplied by the mine.

3.5. Cascade Australia Pty Ltd

Cascade Australia Pty Ltd (Cascade) (ACN 000 998 710) design and manufacture lift truck attachments.

3.6. Clark Equipment Australia Pty Ltd

Clark Equipment Australia Pty Ltd (Clark) (ACN 000 144 427) manufacture distribute and service equipment including lift trucks.

3.7. Plant involved in incident

3.7.1. The lift truck and tyre handler

The plant involved in the incident was an Omega lift truck model 16-12TH, designed and manufactured by Clark. It was fitted with an attached 16 – 1200 tyre handler model 176HDT21I (refer to figure 3) which was designed and manufactured by Cascade. The lift truck was identified by the mine as THL001. The tyre handler is owned by the mine and was purchased from Clark in 2005.

Figure 3 Omega tyre handler THL001



The tyre handler attachment, known as the hand and grabs, are operated from within the tyre handler cabin. The controls are located on the right of the machine operator and consist of:

- joystick operator control
- paddle controls
- clamp control.

The clamp control button is spring loaded (refer to figure 4). Depressing the left side will clamp the tyre (refer to figure 5) and depressing the right side will release the tyre (refer to figure 6). The minimum distance between the grabs is 1450 millimetres and the maximum distance is 4500 millimetres. The only method available for operators to ensure a tyre was securely maintained in the grabs were visual cues observing bulges in the side wall of tyres.

Figure 4 Clamp control in THL001



Figure 5 Clamping pressure

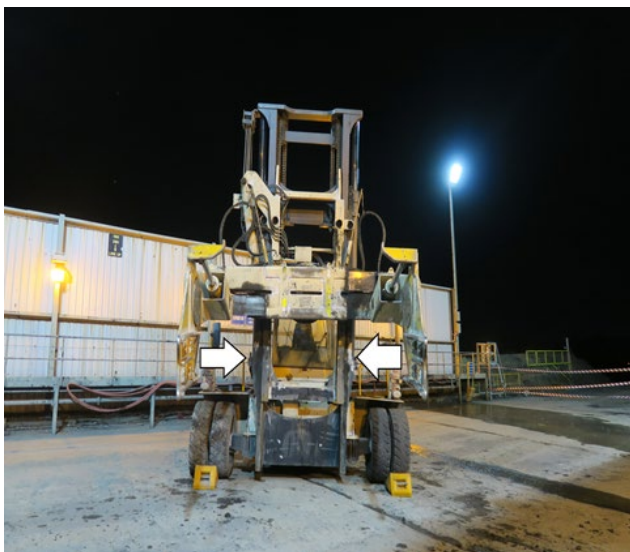
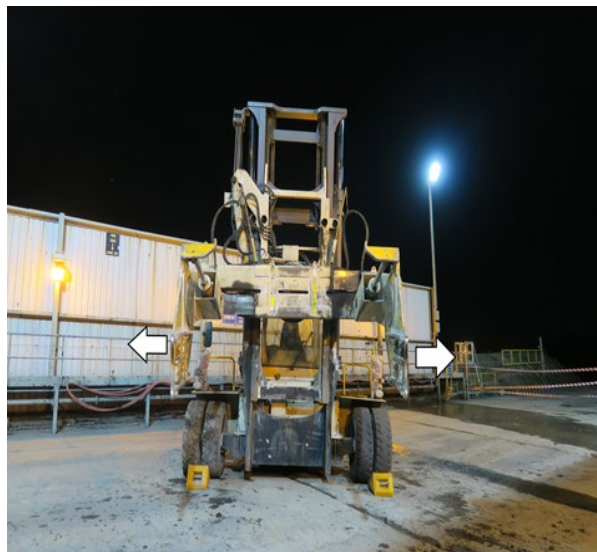
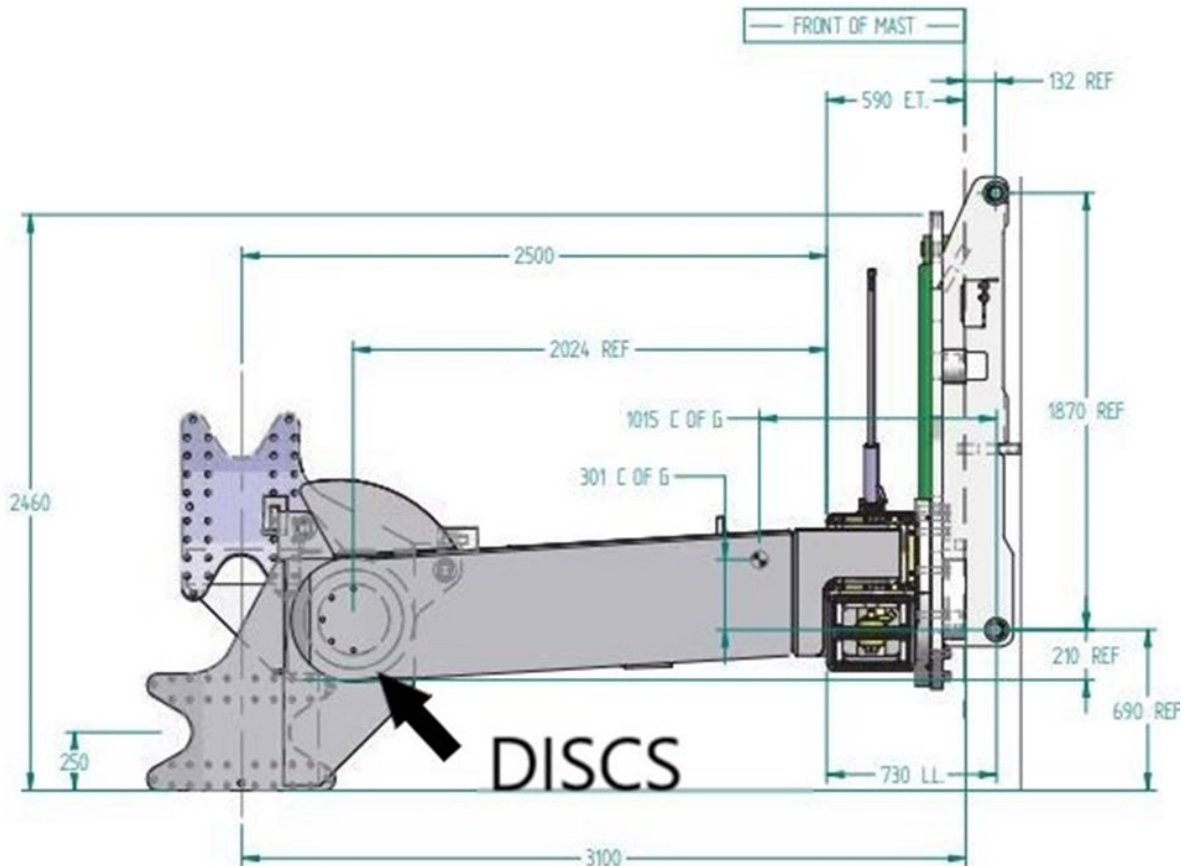


Figure 6 Releasing clamp pressure



The grabs (refer to figure 7) are capable of rotating 90 degrees. The tyre handler attachment, including the grabs, are hydraulically operated. They have a lifting capacity of 8,000 kilograms. The tyre handler was last serviced by Crowne on 9 August 2018, with no repairs or rectifications being reported. In 2008, the grabs and teeth supplied by the OEM were changed by the mine to the grabs and teeth on the tyre handler at the time of the incident. The mine was unable to identify or locate any documentation regarding why or who made these modifications.

Figure 7 Grabs on tyre handler THL001



Responsibility for checking the teeth on the grabs rested with the tyre handler operator and was recorded in the tyre handler's prestart book prior to operation. In September 2018, workers reported issues with the grabs not rotating in sync, and in October 2018, eight days prior to the incident, workers were required to tighten the hex screws to the discs of the grabs after they became loose. The use of the tyre handler is supported by an operation and maintenance manual. Tyre handlers were not to be parked on a grade, without wheel chocks being applied. A copy of the operator safety warning plate, located inside the cabin of the tyre handler stated, 'no person should stand or pass under load of lifting mechanism.' Instruction No. 19 provides that the lifting mechanism should be fully lowered and wheels chocked when leaving the tyre handler. It warns a failure to follow these instructions can cause serious injury or death.

3.7.2. The tyre

The tyre removed from water cart WC004, and involved in the incident, was a Michelin XDR with rim size 27.00R49. The tyre and rim assembly weighed approximately 2.2 tonnes. The tyre diameter was approximately 2.55 metres and the tread pattern and side wall were observed to be worn and damaged.

4. The incident

4.1. Incident location

The incident occurred at the mine's heavy vehicle wash bay located approximately 30 metres from the Marathon Tyres' work area, known as bay 7 (refer to figure 8).

4.2. The wash bay

The heavy vehicle wash bay is generally used by both the mine and Marathon Tyre workers to clean heavy vehicles, including tyres, prior to completing planned and breakdown maintenance work. The wash bay consists of a large concrete bunded pad, with a slight grade sloping south to north. Located on the northern and southern sides of the wash bay are walkways with permanently mounted high pressure water cannons (the cannons). Two red flexible handheld hoses are located at the wash bay and are generally hung along hooks secured at both the northern and southern platforms.

Figure 8 Bengalla mine – Marathon tyre work area and heavy vehicle wash bay



Figure 9 Heavy vehicle wash bay platform with water cannon and red handheld hose



To activate the high-pressure flow of water to the cannons and the red hoses, a small control box is located near the steps to the northern platform. The control box's green button activates the pump which provides high pressure water flow. The red button de-activates the pump, reducing the pressure.

Figure 10 Pump activation control at heavy vehicle swash bay



There was no specific induction for workers to operate the cannons despite the following warning, 'Read operating instructions before use'.

Figure 11 water cannon operating instructions



4.3. Start of shift

About 6.18 pm on 3 November 2018, Mr Moore arrived at the mine to start his shift. Upon arriving at work, Mr Moore underwent an alcohol and drug screening test, both returning a negative result. Workers, including Mr Moore, attended a pre-shift toolbox talk for workers from the mine and Marathon Tyres. During pre-shift discussions, Mr Moore raised a safety focus issue relating to suspended loads.

Marathon Tyre workers, including Mr Moore and his co-worker, then conducted an end of shift handover. During the handover Mr Moore was made aware of an unplanned maintenance task which required two damaged tyres on watercart WC004 be replaced.

The mine's planned maintenance supervisor gave work instructions to complete the tyre changes on the watercart as an 'important job.' There was no evidence to establish there was any undue pressure placed on Mr Moore or his co-worker for this task to be completed within a specific time period or urgently

Between 7.20 pm and 7.30 pm, the mine's break down supervisor made a call to Mr Moore to inquire when the job would be completed. Mr Moore did not respond to the call.

4.4. Removing the tyre

Mr Moore, as the senior tyre fitter, operated the tyre handler while his co-worker was tasked to assist. The assistant's role predominantly involved ensuring all tools and equipment to complete the task were available and completing other tasks that do not involve operating the tyre handler. Mr Moore and his co-worker began work to remove the tyre involved in the incident.

Information obtained during the investigation supports that this process was completed in accordance with safe work procedures (SWP), in particular, SWP 4-04-018 'unbolt and bolt off tyre and wheel on the front or rear of a caterpillar OTR truck using a FLTH'. Mr Moore and his co-worker each completed a take-5 personal risk assessment regarding the tyre removal task.

Figure 12 Photo of watercart WC004 in situ



4.5. Cleaning the tyre rim

After removing the tyre from the water cart, Mr Moore trammed the tyre in the grabs of the tyre handler to the heavy vehicle wash bay (refer to figure 13) with the tyre in a horizontal position. Mr Moore did not complete a take-5 personal risk assessment regarding the task of washing the tyre at the wash bay.

Figure 13 path taken by Mr Moore in tyre handler to wash bay



The co-worker observed Mr Moore on the northern wash bay platform using a high-pressure water cannon to clean the tyre, which was maintained vertically in the grabs. The co-worker had witnessed Mr Moore use the wash bay to clean tyres on previous occasions.

Information obtained during the investigation supports other workers had also observed Mr Moore wash tyres using the heavy vehicle wash bay facility, prior to the incident. However, Mr Moore had on these occasions lowered the tyre, placing it flat on the ground before hosing it down.

The co-worker turned away from the wash bay and went to complete other duties. After a short time, he heard a loud noise, causing him to look back towards the wash bay. The co-worker could not see Mr Moore or the tyre in the tyre handler and immediately walked towards the wash bay.

The co-worker found Mr Moore lying face down on the concrete surface, trapped under the tyre in front of the tyre handler. The co-worker formed the view that Mr Moore's injuries were fatal and called an emergency on his two-way radio.

4.6. Responding workers

After hearing the radio call, several Bengalla mine workers immediately attended the wash bay. It was apparent Mr Moore had sustained fatal injuries. Workers observed the tyre handler, which was found to be idling and the wheels not chocked. Workers activated the emergency stop located outside the operator's cabin and isolated the tyre handler. The incident scene was preserved and emergency services and the Regulator were notified.

5. The investigation

5.1. Examination of incident scene

The incident scene was examined by both NSW Police and the Regulator. The examination confirmed Mr Moore was wearing all required PPE, and in particular, disposable ear plugs at the time of the incident. The red hand-held hose, ordinarily stored along hooks of the wash bay's walkway, was located under Mr Moore, with the nozzle in proximity to his left hand. Mr Moore was observed under the tyre directly in front of the tyre handler.

5.2. The heavy vehicle wash bay

The investigation confirmed Mr Moore had been using the high-pressure water cannon to wash the tyre/rim at the time of the incident. There is no specific training or induction to use the wash bay facility. An examination and testing of the wash bay established that between 7.34 pm and 7.38 pm on 3 November 2018, the pump and flow of water had operated for approximately two to three minutes.

5.3. Mechanical Inspection of tyre handler

During the investigation, information was received regarding potential issues relating to the failure of bearing plates, causing the grabs to unintentionally fall forward. Cylinder issues were also identified in a safety alert issued by the (then) Queensland Department of Natural Resources and Mines on 27 October 2005. As a result of that information, and to determine if any mechanical issues may have contributed to the incident, Delta V Experts were engaged to conduct an examination of the tyre handler. Visual and mechanical examinations were conducted with no mechanical issues identified. The examination determined the bearing plates to be in serviceable condition with no worn and or damaged components.

5.4. Hydraulic testing of tyre handler

5.4.1. ASPEC Engineering

ASPEC Engineering were engaged to examine and report on the operation of the tyre handler's hydraulic operation, independently from the original equipment manufacturer (OEM) tests.

On 28 November 2018, ASPEC inspected the tyre handler THL001 involved in the incident with the following tests conducted:

- operational and dimensional
- clamp force pressure
- tyre handling
- clamp function
- hand tilt
- oil sampling and analysis
- hydraulic supply pressure
- operational.

The examination report by ASPEC concluded, among other things, the following:

- visual inspection did not indicate significant damage or obvious flaws in the hydraulic system
- hydraulic oil in the reservoir was normal

- functionality and load holding capacity of the hand tilt mechanism displayed no signs of creeping nor malfunction
- during operational testing, minimal relaxation of tyre clamping force was observed either visually or in the detailed pressure testing conducted over various five to 10-minute test periods. With 'typical' gripping force applied, the integrity of the tyre grip was as expected, with no relaxation of the tyre deformation nor observed creeping of the clamp cylinder.

5.4.2. Testing by Clark

Clark were invited to participate in testing the tyre handler, with a scope of inspecting and examining the Omega lift truck, for the purpose of reporting if it complied with the original or modified (if any) specifications. A representative from Clark attended the mine on the 28 November and on the 6 December 2018 and 18 December 2018. A report regarding their inspection and examination of the tyre handler was completed on the 17 January 2019. The report concluded the functional performance and operation of the lift truck to be acceptable and consistent with the age (14 years) and usage (10,470 hours). Clark identified the following minor issues during their assessment of the tyre handler which did not affect the operation of the tyre handler at the time of the incident.

5.4.2.1. Hydraulic hoses

The hydraulic hoses were reported to be ex-factory, and while no issues were identified, it was recommended they be replaced due to the number of operational hours.

5.4.2.2. Oil label

The lift truck was missing its hydraulic oil label, which may potentially lead to the inadvertent use of the incorrect oil type recommended by the OEM. This may result in hydraulic pressure issues. Samples of oil from the tyre handler were obtained during the investigation and were later examined. It was determined oil specifications recommended by the OEM were being used.

5.4.2.3. The clamp switch

The clamp switch located inside the cabin, which controlled the clamp pressure and release, was determined to be non-OEM. The investigation considered the possible activation of this switch by Mr Moore, which may have led to a reduction in clamp force pressure, while tramming the tyre from the tyre pad to the wash bay. The report determined this was shown to be difficult and not an action that would be achieved inadvertently.

5.4.2.4. Oil pressure

The hydraulic auxiliary circuit at the valve bank, which controls the Cascade tyre grab attachment, was tested. The oil pressure supplied by the lift truck should be approximately 210 bar (3050psi), however, it was only measuring 148 bar (2046psi). This resulted in a clamp force cylinder pressure of 123 kilonewton. The likely cause of this was reported to be either a defective/incorrectly fitted relief valve or pump wear.

5.4.3. Cascade

Cascade was invited to participate in testing the tyre handler, with a scope of inspecting and examining the tyre grab attachment for the purpose of determining if the attachment complied with the original or modified (if any) specifications. Representatives from Cascade Australia and Cascade Engineering (USA) attended the mine on 28 November and 6 December 2018.

Several functionality tests were conducted, measuring hydraulic pressure applied by the grabs. Tests were conducted on ports (pressure taps) 1, 3, 4 and 5. These tests were conducted to determine if the grabs were operating as designed.

Cascade used both a clamp force pressure bar and a tyre of similar measurements (refer to figure 14) to conduct seven functionality tests. Measurements were recorded and analysed by Cascade.

The examination determined there was no loss of clamp force pressure, regardless if the truck was idle or shut off.

Cascade's report concluded hydraulic pressure supplied to the grab attachment was not likely to be a potential cause of the tyre dislodging from the grabs.

Figure 14 Clamp force pressure test on THL001 by Cascade



5.5. Safety management systems

5.5.1. Bengalla mine

The mine had a documented health and safety management system. The system applied to all workers and contractors. The overarching guidance document was the Occupational Health and Safety Management System SYS-0009.

SYS-0009 identifies 17 elements, grouped into Plan, Do, Check and Review stages. The system introduces principle hazard and control plans, in addition to hazard identification and risk management, training competency and awareness and contractor management.

Element 1 discusses the 'golden rules', which the mine had identified, if breached, could lead to a serious injury or fatality. A breach of the rules could lead to serious disciplinary action and possible termination of employment. Point 3 of the 'golden rules' states 'never position yourself under a suspended load'.

Element 2 introduces supervision arrangement. The system indicates the level of supervision at the mine is determined by the competence, experience and risk exposure of an employee.

Element 3 which relates to hazard identification and risk management, identifies risk assessments conducted at the mine, dividing risk levels into three stages. In accordance with level 1, a personal take-5 assessment is required to be completed prior to all tasks being performed.

In addition to the overarching WHS document, Mr Moore had been trained in the procedures outlined below.

5.5.1.1. Hazard Identification and risk management PRO-0515

This procedure applied to all workers at the mine, including contractors. The procedure introduces workers to various levels of risks assessments, including take-5's and job hazard analysis.

Responsibilities of workers included completing level 1 risk assessments (take-5's), which were required to be completed prior to commencing a task and involved five steps; stop, think, identify, plan and proceed. For each identified hazard, control measures were required to be identified and recorded.

5.5.1.2. Isolation rules PRO-0068

The purpose of this procedure is to prevent injury to personnel from potentially hazardous energy sources, with a scope to define systems for the isolation and management of hazardous energy sources on all plant and equipment.

An energy source is described and includes gravitational forces. All sources of potentially hazardous energy were required to be isolated before any work was to begin.

5.5.1.3. Isolation including live testing WI-0014

This work instruction was to complement isolation rule PRO-0068. Its purpose is to prevent injury to personnel from potential hazardous energy sources. The framework of the instruction includes identification and control of hazardous energy sources.

In accordance with PRO-0068 an energy source includes gravitation. The work instruction provides guidance as to when isolation is required and includes when a worker enters the footprint or articulation area of mobile plant/equipment.

The footprint of mobile equipment was defined as an area in the vicinity of articulation zones and machine attachments. The work instruction provides examples of a footprint for several pieces of plant but does not include a tyre handler.

5.5.1.4. Protective equipment program PRO-0064

The purpose of this procedure is to ensure consistent processes at the mine for standards and use of personal protective equipment (PPE). The procedure applies to all workers, however contractors have to supply their own PPE.

It is the worker's responsibility to comply with the requirements of the procedure, which includes, where appropriate, wearing high visibility clothes, hard hat, safety glasses, safety boots, protective gloves and hearing protection.

5.5.1.5. Barrier and barricading PRO-0530

The purpose of this procedure is to provide guidance to workers and contractors on the minimum requirements for barricading and barriers associated with hazards. The procedure relates to all activities at the mine and provides guidance to workers on when to erect barricades.

The procedure requires barricades to be erected where a hazard exists within any work area, which includes the heavy vehicle wash bay. The purpose of erecting a barricade prevents personnel from making contact with an identified hazard and prevents access to an area containing a hazardous condition or activity.

Section 6.2 of the procedure provides examples of when barricades should be erected, which includes but is not limited to, during crane lifting operations external to workshop environments where people could walk into the area where loads are being raised or lowered.

5.5.2. Marathon Tyres

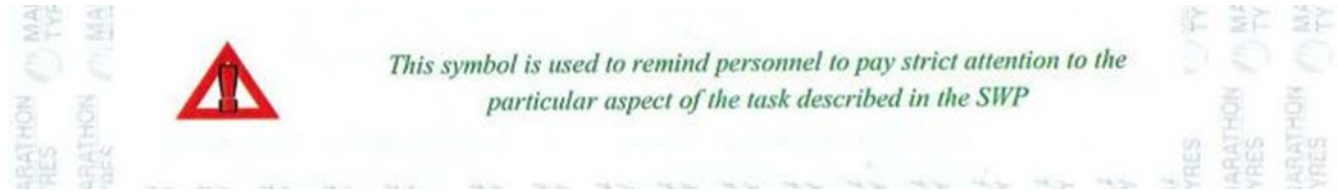
The predominant safety management system documents that relate to the incident are Marathon Tyres Safe Work Procedures (SWP) and the OTR (off the road) training manual.

5.5.2.1. SWP

The SWP procedures were available to workers on site and formed part of a worker's induction and training with Marathon Tyres. The SWP procedures were well known to Marathon Tyre workers. During several interviews conducted as part of the investigation, workers were able to identify what SWP related to the task of changing and cleaning a water cart tyre.

The SWP procedures are prescriptive. In addition to the steps to be followed for each task, information regarding required safety, PPE and tools is provided. Attention was drawn to specific aspects of the task that require strict attention with the use of a triangular warning symbol (refer to figure 15).

Figure 15 Marathon Tyres SWP



SWP 4-04-008 Establishment and Management of Tyre Work Area and Restricted Work Zones, states a person must not operate the forklift tyre handler while any person is in the forklift tyre handler's restricted work zone (RWZ), and required a risk assessment for any deviation from the SWP.

The SWP advised 'No personnel enter the Restricted Work Zone of the tyre handler when the handler is not isolated as per procedures contained within this procedure'.

The RWZ (refer to figure 16) was required to be maintained while the tyre handler was in use and was defined among other things as:


'the fall zone of the tyre from the tyre grabs in any situation – be aware that tyres are designed to roll. Consideration must be given to the potential for the tyre to roll if the forklift tyre handler operator were to lose control of the tyre.'

A worker was permitted to enter an RWZ if 6 rules of entry had been complied with. Rule 2 required the tyres to be positioned on the hub of a truck or laid flat on the ground.

SWP 4-04-018 Unbolt and Bolt of the Tyre and Wheel on the Front of Rear of a Caterpillar OTR Truck Using a Forklift Mounted Tyre Handler, related to the task of replacing tyres on plant such as the water cart involved in the incident.

The SWP provided that a person must not operate the tyre handler while any person is in the RWZ and that a designated work pad must be used for the task. Under the heading 'Requirements', the SWP drew workers' attention to SWP4-06-003 for cleaning tyres and rims.

Figure 16 Marathon Tyres SWP 4-04-008



WORKING SAFELY WITH TYRES

your tyre specialist for the long run

Definition

RWZ areas:

1. the area between or under the grabs of the Forklift Tyre Handler whilst tyre handling is in progress, or
2. the area between the tyre and the equipment involved in the tyre change, or
3. the Forklift Tyre Handler travel path, or
4. the fall zone of the tyre from the tyre grabs in any situation – be aware that tyres are designed to roll. Consideration must be given to the potential for the tyre to roll if the forklift tyre handler operator were to lose control of the tyre
5. is demarcated by hard barriers

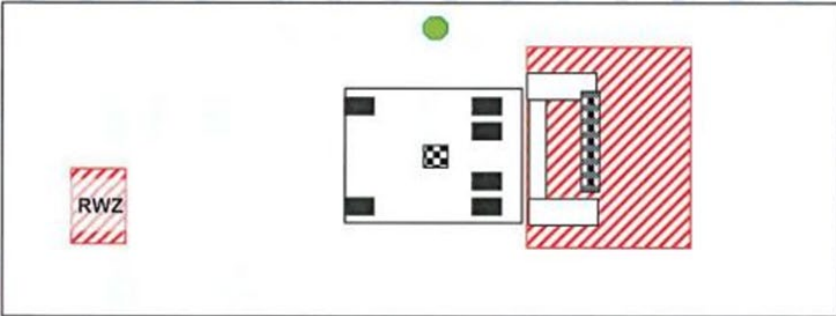




Fig 1.3 Schematic detailing the typical layout of the RESTRICTED WORK ZONE

Legend;  operator's position  serviceman's position

The procedure required a take-5 personal risk assessment be completed and an inspection of the work area, to ensure all hazards were eliminated or controlled.

Under the heading 'Energy Isolation and Equipment Preparation', the worker's attention was drawn to a warning to have the vehicle washed if necessary, to remove loose material. However, there is no information as to how to complete that step.

SWP procedures 4-04-001 and 4-04-002 provide guidance to workers in the process of removing tyres and/or rims from plant at the mine. In accordance with both SWP procedures, tyres and or rims once removed, must be placed flat on the ground and outside of the immediate work area, including the RWZ.

SWP 4-06-003 Cleaning and Inspection of Wheels, Rims Componentry and Hubs, provides that a person can conduct the work alone, but must complete a risk assessment if there was a deviation from the SWP.

The SWP under the heading 'Requirements' identifies tools for the task as, air operated tools, wire brushes or a scraper, and reference is made to SWP 4-04-008 (p.23). The SWP requires all wheels and rims must to be clean and free of debris.

SWP 1-07-003 Major Hazards and Their Controls, draws workers' attention to suspended loads and states, 'personnel are prohibited from positioning themselves under a suspended load' and 'the operators of any lifting device MUST NOT permit personnel to pass under or position themselves beneath a suspended load.'


5.5.2.2. OTR training manual

The training manual applies to all Marathon Tyre workers performing tyre fitting duties. The manual states its objective is:

'To assist trainees, employees, trainers, maintenance personnel and operators of rubber tyred machinery in ensuring the safety of personnel working on or in the vicinity of tyres, wheels and rims.'

The manual does not replace or override the requirements of site specific SWP. Section 1.02 provides information on hazard identification and assessing risk. A work example is provided with a completed risk assessment worksheet, complemented by Appendix 1, which identifies hazards and controls. For the purpose of the example, water is identified as a hazard (refer to figure 17) and may cause rubber tyres and steel rims to become slippery. The control measure requires workers to appropriately assess risks for their workplace.

Figure 17 Marathon Tyres OTR training manual hazard ID worksheet

 MARATHON TYRES		OTR TRAINING MANUAL <i>your tyre specialist for the long run</i>
Hazard	Consequence	Control Measures
Unplanned Movements	Equipment moves and damages people or equipment	Always ensure that equipment isolation has been effective – “test for dead”.
		Always ensure that personnel are clear prior to moving load-lifting equipment.
		Always use safety clips on air hose couplings.
		Always report unplanned movements.
Water	Makes rubber, (tyres), and steel, (rims), slippery to hold.	Always include controls for the effects of water in the workplace in your risk assessment.
	Reduces the traction of mobile equipment, such as forklift tyre handlers.	
	Loosens material that is hung up on vehicle frames and bodies.	Inspect vehicle for loose material and have cleaned off
	Makes walking conditions slippery.	
	Can be introduced into the work area by weather and by general activities such as dust suppression or cleaning.	

Section 2.02 provides information regarding procedures for moving tyres and a warning (refer to figure 18) that failure to follow procedures could result in serious or fatal injuries.

Figure 18 Warning to workers in OTR course material



The module learning outcomes provide information regarding the dangers of crush and pinch points, and state that no personnel are permitted to stand under a suspended load.

This statement is repeated several times throughout the document. Several subsequent learning outcomes provide further information regarding the weight of the tyre being handled and its ability to inflict crush injuries, if a worker places themselves in the tyre’s fall path. A crush zone is described as an area between a tyre being handled and the ground.

Section 3.04 provides information regarding cleaning and inspection of rims. The learning outcomes of this section requires a worker to demonstrate the various methods of cleaning wheels and rims.

The learning materials section states ‘before a tyre is mounted on to a wheel/rim it is essential that the rim base and components are cleaned and inspected thoroughly.’

Section 3.04 does not provide any guidance on the methods of cleaning a tyre, however, as previously stated, the manual does not override site specific SWP. Marathon Tyres SWP 4-06-003 provides guidance for the cleaning of rims.

5.6. Training and instruction

5.6.1. Bengalla Mine

As a result of having worked on and off at the mine on several occasions, Mr Moore completed the mine’s initial induction training on four separate occasions. The first induction training took place on 12 November 2001 and the most recent on 20 October 2015.

The mine conducted a site familiarisation walkaround with Mr Moore on 15 October 2017. As Mr Moore was employed by Marathon Tyres, the mine did not ordinarily require tyre fitters to be re-inducted due to their familiarity and frequency at the site.

The investigation identified Mr Moore had been trained in all the SMS procedures noted in 5.5 above. In addition, Mr Moore was trained and deemed competent to operate the Omega tyre handler on 18 September 2017.

In being deemed competent to operate the tyre handler, Mr Moore completed a challenge test assessment to operate the forklift tyre handler, which he had completed on three previous occasions. The purpose of the test was described as:

- the safe operation of the equipment being trained on, thereby providing a safe workplace
- awareness of environmental matters that result in optimum protection of the workplace and surrounds
- effective and efficient operation of the equipment resulting in maximum utilisation and productivity
- re-enforcement of the Bengalla Mining Company’s reputation for delivering world class performance in the mining sector.

Mr Moore was deemed competent in all seven assessment criteria, including operation of the tyre handler (locate tyre handler in centre of tyre) and stop and park tyre handler (isolation procedure). Mr Moore also held a current national licence to perform high risk work which expired on 7 June 2020.

5.6.2. Marathon Tyres

Mr Moore was first employed as a tyre fitter with Marathon Tyres between 5 November 2001 and 27 November 2013. Between 2013 and 2017, Mr Moore was employed at the mine as a haul truck operator. On 12 September 2017, Mr Moore resumed employment with Marathon Tyres.

Mr Moore underwent re-induction training upon returning to Marathon Tyres on 12 September 2017. Information obtained during the investigation identified Mr Moore was reassessed on numerous SWP procedures including:

- SWP 4-06-003 Cleaning and inspection of rims, rim componentry and hubs
- SWP 01-07-006 Isolation of mobile equipment
- SWP 04-07-002 Chocking Wheels of mobile equipment
- SWP 01-07-003 Major hazards and their controls
- SWP 04-04-008 Forklift mounted tyre handler – establishing and management of tyre work area and restricted work zone.

5.7. Supervision

Marathon Tyres supervisors attended the mine on ten occasions between 29 July 2018 and 30 October 2018, while Mr Moore was performing tyre fitting duties. The days of the week varied and were all between the hours of 6am and 5pm. There were no Marathon Tyres supervision activities on night shifts.

The investigation identified supervisors, while on site, had discussions about work related duties and conducted three safety act observations, while observing Mr Moore undertaking tyre fitting duties. No issues were raised as a result of those observations. Marathon Tyres denied having any knowledge that their tyre fitters, including Mr Moore, were using the heavy vehicle wash bay to clean tyres.

Mr Moore received two written safety related warnings. The first warning letter, dated 8 June 2010, related to two separate safety incidents involving non-reporting of a self-inflicted minor injury on 3 May 2010, and for failing to make positive contact with the mine open cut examiner to gain permission to enter a restricted area, placing himself in a stationary position dangerously close to the high wall on 31 May 2010.

A second written warning letter, dated 25 May 2012, was issued as a result of an investigation regarding failure to follow a safe work procedure on 21 May 2012. The second warning letter resulted in remedial action requiring Mr Moore to review SWP procedures.

Supervision by the mine was predominantly conducted by the maintenance and break down supervisors at the commencement and periodically during a shift. Between 1 August and 11 October 2018, the mine

had conducted approximately nine safety and environment interactions with Mr Moore. All interactions were positive with no issues being recorded.

The investigation found the mine did not prohibit Marathon Tyre workers from using the wash bay. The mine's supervisors were aware tyre fitters were using the facility to clean tyres/rims. Over several years, this became a routine work practice for some tyre fitters, despite this practice not complying with Marathon Tyres' SWP procedures relating to cleaning tyres and rims and the absence of a risk assessment to use the facility. The practice of washing tyres in the wash bay did not raise any safety concerns with the mine's supervisors, as they reported when this practice did occur, the tyres were placed on the ground and released from the grabs.

5.8. Effectiveness of controls

5.8.1. The mine

To eliminate the hazard associated with tyres falling from grabs, the mine relied on workers following Marathon Tyres' SWP 4-04-008, which required workers to place a tyre flat on the ground before alighting from the tyre handler.

To isolate workers from hazards associated with suspended loads, the mine required workers to follow Marathon Tyres' SWP 1-07-003 'Major Hazards,' which prohibited workers from positioning themselves under suspended loads, complimented by the mine's No. 3 'Golden Rule', warning workers against entering or operating near suspended loads.

To manage risks and ensure compliance with procedures, the mine relied on the supervision of workers, which involved safety and environment observations, along with training workers, including contractors in the mine's procedures, relevant to a worker's position. Workers operating plant were also subjected to practical challenge assessments, which included their knowledge of safe operating instructions for plant and equipment including the tyre handler.

5.8.2. Marathon Tyres

To ensure the safety of workers involved in tyre fitting operations, Marathon Tyres adopted a number of SWP procedures which identified suspended loads as a hazard to workers. Training workers in the procedures, practical assessments and supervision controls, were adopted to reduce the risks associated with the hazard.

Marathon Tyres did not have any control over the tyre handler involved in the incident, however, confirmed workers had been certified by the mine in its safe operation by obtaining copies of workers practical challenge assessments.

5.8.3. Cascade

Cascade hold the view that the design and manufacture of the tyre handler attachment complies with their WHS obligations and duties. Cascade also rely on their operating instruction manual to ensure additional hazards were not introduced by the tyre-handling process.

5.8.4. Engineering controls

Prior to the incident, the mine was not aware of any engineering controls available, which could prevent a tyre falling from the grabs of a tyre handler.

Australia Coal and Research Program (ACARP) commissioned a report regarding the safety of current commercially available grabs, with a focus on a tyre's ability to slip from the grabs. A study was conducted (refer to section 7) with a recommendation of a new grab design, however, the design was never commercially adopted.

Since the incident, the mine became aware of an engineering design by Imac Ventures (FMA Industrial S.A.), located in Santiago Chile, being developed to prevent tyres falling from the grabs if unintentionally released. However, further inquiries revealed this product is not currently commercially available.

6. Identified hazard

The hazard identified during the investigation, which posed a risk to workers, including Mr Moore, was the act of suspending the tyre off the ground while being retained in the grabs of the tyre handler.

6.1. Risk to workers

Risks to workers, including Mr Moore, regarding suspended loads was well known to all parties and the mining industry in general. Safety management systems identified suspended loads were dangerous hazards and posed risks to workers, including serious injury or death.

7. ACARP report

Australian Coal and Research Program (ACARP) is a collaboration between the coal mining industry and research institutions to solve technical issues addressing the industry, with safety being a key focus.

In 2009, ACARP commissioned and published a report titled 'Improved Safety of Tyre Handling Equipment', ACARP project No. 15032, which was conducted and authored by engineers from CMP Engineering Pty Ltd.

The objects of the project were to examine:

- security of a tyre being manoeuvred
- interaction of personnel and the tyre handler while aligning the tyre for mounting.

The investigation identified that neither the mine nor Marathon Tyres were aware of the report. In examining the security of tyres while being manoeuvred, one of the study's objectives was to increase the security of the tyre grip, especially while the tyre was maintained in the vertical position. Figure 19 represents the current OEM design at the time of the report, which the authors claimed lacked sufficient tyre surface grip.

Figure 19 Photo depicting current OEM design



The grabs on tyre handlers (refer to figure 20A and 20B) owned by the mine were fitted with the same shaped OEM grabs referred to in the ACARP report, however, the teeth pattern was found to be modified. The area represented by shaded white, indicates the portion of the grabs, with what the report claims, reduces a grab's gripping surface area on tyres.

Figure 20A & 20B Grab of tyre handler from M04 and grab from tyre handler THL001



Six issues affecting the grip of a tyre were reported to be:

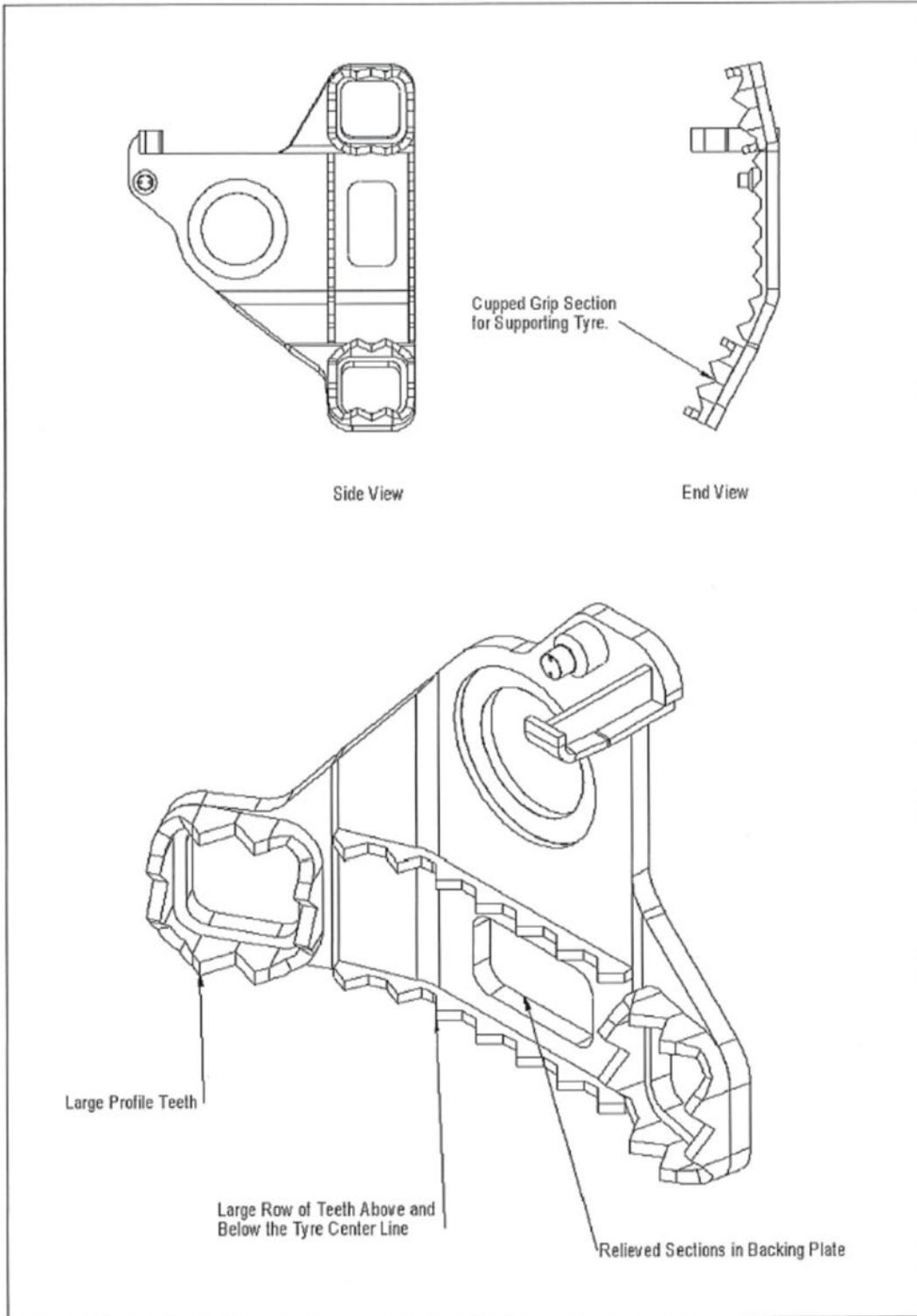
- geometry of the grab to provide vertical support
- increasing the current length of the grab hands to ensure tyres are supported from below
- positioning of the grip teeth for horizontal tyre support
- ensuring deep teeth pattern on lower portion of grabs that support tyres
- teeth profile and size
- consideration of teeth size and spacing to a more aggressive teeth profile to improve tyre support.

The study found that teeth size and spacing is important, especially when clamping wet tyres. Increasing clamp force pressure on a wet tyre, with grabs that have insufficient teeth length and spacing, would not provide better support.

The project's authors created a new grab design. The design process includes finite element analysis (FEA), which involves computerised testing to predict how a product reacts to forces such as vibration and heat, along with other physical elements.

Figure 21 represents an alternate grab design by CMP Engineering. The design incorporates a cupped grip section at the top and bottom of the grab for greater surface coverage of tyres, which is claimed to result in increased grip force if the tyre was to slide downwards, when in the horizontal position.

Figure 21 grab design by CMP Engineers Pty Ltd



As part of the project, CMP Engineering manufactured grabs as per their new design. The grabs are suitable to operate on the Cascade attachment without any requirement for modification.

Figure 22 Manufactured grabs as per new design



The grabs were installed on a Cascade tyre handler at the BMA Norwich Park mine in Queensland and tested by tyre fitters on large truck tyres. Tyre fitters reported improvement in retention of tyres, especially in the vertical position and improved wet weather handling.

Two issues were identified by tyre handlers, regarding reduced capability to rotate smaller tyres when remounting, and issues accessing the tyre when obstructed by guards and/or mud flaps. This resulted in minor modification to the new grab design, reducing the grab hand by 310 millimetres while maintaining the increased tyre grip design feature (refer to figure 24).

Figure 23 Profile of grabs on large truck tyre in vertical position



Figure 24 Modified grab hand



Recommendation 1 of the report concluded ‘The revised grab jaws have proved to be very effective in reducing slippage of tyres during tyre-changing operations over a wide range of tyre sizes. It is recommended that efforts now be made to commercialise it.’

The report noted the current OEM of the grabs, Cascade, declined to participate in the study. During an examination of the scene, the tyre handler grabs were found to be in the horizontal position as shown in figure 25.

Figure 25 Grabs on tyre handler as found by investigators



Information received during the investigation identified neither the mine, Marathon Tyres or Cascade Australia, prescribe an orientation the grabs should be in while handling tyres either vertically or horizontally. This was left to the determination of operators.

The ACARP report suggests grab orientation when handling tyres may affect the ability to retain a tyre within the grabs. If CMP Engineering's theory of preferred grab orientation is applied, it is reasonable to conclude the orientation of the grabs at the time of the incident did not provide the highest level of support. However, the investigation was unable to determine if this materially contributed to the tyre falling from the grabs.

8. Re-creation of incident

On 18 December 2018, tests were conducted at the mine. The purpose of the tests was to determine if a tyre could dislodge from the grabs after being exposed to high pressure water. The tyre handler and tyre involved in the incident were used during the tests. A data logging device was attached to the tyre handler to measure hydraulic pressure applied by the grabs to the tyre. The hands were set at the same distance as found by investigators at the scene following the incident. While travelling between the tyre pad and wash bay, the tyre fell from the grabs several times. The operator was asked to subjectively grip the tyre, to ensure it was secured within the grabs, before continuing to the wash bay. During the testing, the tyre handler and tyre involved in the incident were positioned in the approximate location in the wash bay, as found by investigators following the incident. The tyre was then exposed to high pressure water for a period not exceeding three minutes.

Test 1: The tyre was positioned in the grabs. The distance between the grabs were marked to replicate their width as found by investigators at the time of the incident. This allowed the tyre handler operator to ensure the test conditions were similar to those at the time of the incident.

The tyre was horizontally positioned in the grabs and rotated to the vertical position (opposite position as found by investigators at the time of the incident). The tyre was then exposed to high pressure water. The test resulted in the tyre falling from the grabs (refer to figure 26).

Figure 26 Photo of tyre location after falling from grabs during test 1



Test 2. The tyre handler was repositioned as per test 1. The tyre was held with the grabs in the horizontal orientation as found following the incident. The tyre was then subjected to high pressure water from the cannon for a period not exceeding three minutes. The tyre fell from the grabs, however the tyre remained horizontal after catching on the teeth of the grabs (refer to figure 27).

Figure 27 Photo of tyre location after falling from grabs in test 2.



Data logging measured during the tests identified that when the hands of the grabs were set at the distance measured by investigators after the incident, between 20 and 30 kilonewton (kN) of pressure was applied to the tyre. When the experienced operator assisting during the tests was asked to subjectively secure the tyre, the pressure applied was measured at 70kN, almost double the force.

9. Foreseeability of the risk and incident

9.1. The Mine

Prior to the incident, the mine considered tyres falling from the grabs as a major hazard. The risks associated with working in proximity to suspended loads was well known to the mine and the industry in general. Warnings regarding working in proximity to suspended loads were recorded in several procedures. The mine's OHS Management System SYS-0009 introduced several 'golden rules'. A breach of the rules could lead to serious disciplinary action, including termination of employment. Golden rule No. 3 warned workers about placing themselves near suspended loads. In April 2016, the mine engaged a consultant to facilitate and undertake a formal risk assessment of its plant and equipment.

The report identified risks to workers, being struck by tyres/rims due to the following:

- inadequate competency and work method
- equipment not fit for purpose
- mismatching of components
- crush from inadequate use of tyre handler
- structural failure of the arms of the tyre handler due to fatigue loading (transporting tyres into pit).

The assessment report categorised the risk of suspended loads to workers as high, with the potential for serious harm and major consequence.

9.2. Marathon Tyres

Marathon Tyres were aware of the hazards associated with tyres falling from grabs and identified controls to reduce the risks through SWP procedures, including SWP 4-04-008 – Forklift tyre handler establishment and management of restricted work zones and SWP 1-07-003 – major hazards and their controls.

In 2007, Marathon Tyres was convicted for a breach of 8 (1) of the *Occupational Health and Safety Act 2000* regarding an incident resulting in fatal injuries to a worker, after being struck by a large earth moving tyre while in the process of refitting the tyre. At the time of that incident, workers were operating tyre handling plant.

9.3. Cascade

Prior to the incident, Cascade were aware of incidents, nationally, involving tyre handler attachments, with the potential to cause serious or fatal injuries to workers.

10. Actions taken post incident

After the incident, the mine introduced a ban on Marathon Tyres workers using the wash bay for the purpose of cleaning tyres. Marathon Tyres did not make any changes to their SWP procedures.

11. Causal factors

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

- the wash bay was occasionally used to clean tyres, however, a risk assessment had not been undertaken and there were no safe work procedures in place for cleaning tyres at the wash bay.
- the tyre was suspended with insufficient pressure applied to maintain the tyre within the grabs
- high-pressure water was introduced to the suspended tyre, causing it to become unstable
- the fitter entered the restricted work zone.

12. Recommendations

Mine Operators and contractors must:

- focus on identifying, implementing and enforcing restricted work zones regarding the operation of tyre handlers
- inform all workers of the risks associated with working in proximity to suspended loads
- ensure safe systems of work associated with cleaning tyres are identified, implemented and communicated to all workers.

Workers must:

- remain a safe distance from any suspended load and consider potential fall zones
- never enter a restricted work zone while a tyre handler is supporting a load – unless in strict accordance with an approved safe system of work
- comply with safe work procedures.

Designers and manufactures of plant and equipment must ensure:

- tyre fitting attachments are designed and manufactured to be without risks to the health and safety of persons who, at a workplace, use the plant for the purpose for which it was designed or manufactured
- adequate and current information on the design, including operational manuals and safety information is provided to all persons who purchase the plant.