NSW Resources Regulator

Investigation report

Report into the serious injury of a worker at the Mt Arthur Coal Mine on 10 August 2017

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Executive summary

On 10 August 2017, a 29-year-old contract worker suffered serious burns to his face, neck, torso and arms when a fire started while he was refuelling a diesel-powered tyre handler at Mt Arthur Coal's heavy vehicle refuelling facility.

The worker had driven the tyre handler about 260 metres from a tyre-fitting bay to the refuelling station at 9.36 am. The refuelling hoses at the refuelling station were fitted with quick connect (dry break) couplings, but the tyre handler's fuel tank was not. The worker attached a free flow adapter nozzle to an 800 litre per minute refuelling hose, and in doing so defeated several safety controls in the quick connect system. The adapter did not positively connect to the tyre handler's fuel tank and did not have the capability to automatically stop the flow of diesel when the tank was full.

The worker placed the adapter into the filling neck of the tyre handler and opened the refuelling nozzle handle. He went to a switch room shed about 4 metres from the fuel tank of the tyre handler. He activated controls on the fuelling system's switchboard that caused diesel to begin flowing at an increasing rate.

As the worker returned to the tyre handler, the forces acting upon the adapter caused it to eject from the filling neck. Diesel was flowing at a rate of 400 litres a minute at this point. The worker attempted to control the fuel hose, but the forces that were acting upon it made this task very difficult. Diesel flowed at a high rate onto the tyre handler's engine cover and splashed back onto the worker. The rate of the diesel flow peaked at 791 litres a minute.

Diesel entered the tyre handler's engine bay and ignited on a hot engine surface in the vicinity of its turbocharger. The flame extended out towards the worker, igniting his clothing, head, arms and body. The worker extinguished the fire on his body by removing his shirt, running to a nearby drain and covering his affected body parts in mud.

While this was occurring, fire spread through the engine area of the tyre handler, the surrounding pad of the refuelling station and into the switch room shed. Water carts and rescue teams were able to extinguish the fire.

The injured worker sustained burns to 8% of his total body surface area, which included full thickness burns to 5% of his total body surface area. These injuries required extensive treatment including skin grafts.

Investigation findings

Risk assessment

- → The operational risk assessments undertaken by the operator and contractor each failed to identify the risks associated with refuelling the contractor's tyre handlers.
- → The contractor failed to sufficiently analyse the risks identified by its workers in their personal risk assessment tools.
- → The contractor underestimated the risks that were inherent with its workers using the adapter at the refuel facility.
- → The workers did not understand the risks associated with using the adapter and starting the fuel pump while the nozzle handle was open.

Systems of work

- → The contractor and operator did not have documented procedures for the safe and timely supply of diesel to the contractor's tyre handlers.
- → The contactor regularly experienced significant delays when obtaining diesel from the operator's service carts.
- → The operator's service cart operators encouraged the contractor's workers to access the heavy vehicle refuel facility as a means of overcoming the above delays.
- → The practice of the contractor's workers attending the refuelling facility to obtain fuel became normalised, resulting in many of the contractor's and operator's workers believing that their use of the refuelling facility was authorised.
- → The contractor did not provide training to its workers in the use of the refuel facility, as it did not regard the practice as possessing sufficient risk to warrant formal training.

Fit-for-purpose plant

- The adapter used by the worker was unsuitable for the task for which it was being used. It did not have an automatic shut off function, nor the ability to positively connect to the filling neck of the tyre handler.
- The labelling on the three fuel delivery hoses in use at the time of the incident was not sufficiently clear for an inexperienced user to identify the flow rate of any given hose.
- The 300 and 800 litres per minute fuel delivery hoses at the refuel facility were the same colour and had the same size fittings attached, increasing the opportunity for workers to confuse them.
- The use of the 300 or the 800 litres per minute fuel delivery hose in conjunction with the free flow adapter nozzle defeated several inbuilt safety functions of the fuel delivery system.

Supervision

- The contractor did not supervise its workers when they used the refuel facility. As a result, the contractor's managers were unaware that the adapter was being used.
- The operator did not have systems in place to supervise the use of the refuel facility. It did not have sufficient controls to prevent unauthorised access.
- The operator did not monitor the instructions its service cart operators gave to the contractor's workers in relation to refuelling.

Human and organisational factors

The following performance shaping factors were identified as being significant contributing factors:

- contractor management
- supervision leader expectations
- training sufficiency
- risk management practices
- checking, inspection and monitoring.

Risk control measures

The hierarchy of risk control measures must be considered when managing risks associated with refuelling mobile plant. This is particularly crucial at the following stages:

- before engaging a new contractor
- before the introduction of mobile plant to site
- before undertaking changes
- at pre-start and shift changeovers.

The following control measures are available to reduce the risk of fire when refuelling mobile plant:

- Use low flow fuelling systems to refuel vehicles that do not have quick connect couplings.
- Install clear signs to label equipment and warn of risks.
- Install electronic access controls at refuelling facilities. For example, swipe card access provided to workers authorised to access the system.
- Provide direct supervision at refuelling locations.
- Ensure all workers authorised to fuel mobile plant are adequately trained in the safe use of refuelling systems.

Recommendations

It is recommended that mine operators and contractors:

- review their fuel delivery systems to ensure that only competent and authorised workers have access to refuelling facilities
- conduct an audit of refuelling facilities and service equipment to ensure that all refuelling equipment is fit for purpose
- review safety management systems (including contractor management systems) to ensure that adequate risk assessments are conducted for the full range of work activities
- ensure that adequate supervision is provided to workers undertaking refuelling activities
- train workers about the correct use of refuelling equipment
- prohibit the use of free flow fuel adapters that defeat inbuilt safety functions of refuelling systems.

Contents

1. Purpose of the report

This report describes the mining workplace incident investigation conducted by the NSW Resources Regulator's Major Investigations Unit into the cause and circumstances of the incident.

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

2. Investigation overview

2.1. Major Investigations Unit

The Major Investigations Unit (MIU) investigates the cause and circumstances of major workplace incidents in the NSW mining, petroleum and extractives industries. The unit's role is to carry out a detailed analysis of significant incidents and report its findings to enhance industry safety and to give effect to the NSW Resources Regulator's compliance and enforcement policy.

2.2. Investigation scope

MIU investigators have the authority to investigate this matter as the incident occurred at a mining workplace regulated by the department. In accordance with departmental policy, the incident automatically triggered an investigation by the MIU because it resulted in the serious injury of a worker at a mining workplace. The investigation was conducted under the *Work Health and Safety Act 2011* (WHS Act) and the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* (WHSMPS Act).

2.3. Legislative authority to investigate

MIU investigators are appointed as government officials under the WHSMPS Act and are deemed to be an inspector for the purposes of the 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.

3. The incident

3.1. The mine

Mt Arthur Coal Mine is about 5 km southwest of Muswellbrook, NSW. It is a large open cut mine that uses a strip mining method to remove overburden and coal by shovel and excavators. Haul trucks transport the overburden and coal to onsite processing and transport facilities. The mine is operated 24 hours a day, seven days a week. The mine produces coal for domestic and international energy sector customers.

3.2. The incident location

3.2.1. Mt Arthur Coal's heavy vehicle diesel refuelling facility

The incident occurred at the mine's heavy vehicle diesel refuelling facility that is about 160 metres north-east of its main workshop area. The refuelling facility consists of a bulk storage facility and refuelling station.

Image 3.1 - Overview of relevant areas of Mt Arthur Coal Mine.

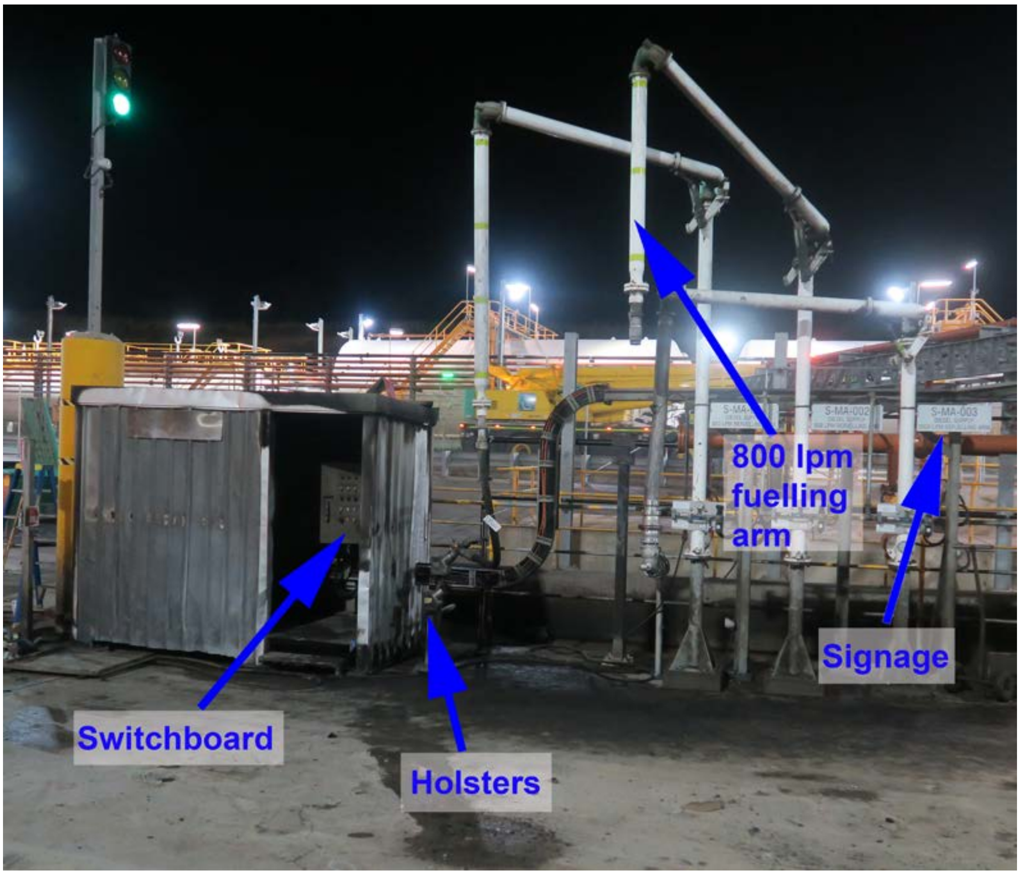
3.2.1.1. Bulk storage facility

The bulk storage facility consists of four diesel storage tanks, each with a capacity of 242,000 litres. The refuelling facility has a series of pumps and pipes that transfer the diesel in the tanks to a diesel refuelling station south of the bulk storage facility.

3.2.1.2. Refuelling station

The fuel dispensing hoses used at the refuelling station are constructed of nitrile rubber and have anti-static properties. The maximum flow rates of the hoses at the refuelling station are 300, 800 and 2000 litres per minute (lpm). The 300 lpm and 800 lpm hoses were both black and had diameters of 50.8 mm and 76.2 mm respectively. Each was fitted with the same size quick connect dry break coupling and stored beside the other in individual holsters. Each holster was fitted with a small placard showing the maximum flow rate of each hose. The hoses were attached to fuel dispensing arms that also had signs on them indicating their maximum flow rate.

Image 3.2 - Mt Arthur Coal's refuelling station.



3.3. The parties involved

3.3.1. The mine operator

Mt Arthur Coal Pty Ltd is the operator of the mine. It is one of several corporate entities that make up the mine's corporate structure. Mt Arthur Coal Pty Ltd is owned by Hunter Valley Energy Coal Pty Ltd. Mt Arthur Coal Pty Ltd is ultimately owned by BHP Billiton PLC.

3.3.2. The mine holder

The authority to conduct mining operations at Mt Arthur Coal is obtained under 13 separate mining leases. Mt Arthur Coal Pty Ltd holds five of these titles. The remainder are held by Hunter Valley Energy Coal Pty Ltd. The incident occurred on an area over which Mining Purposes Lease 263 applies. This authorisation is held by Mt Arthur Coal Pty Ltd.

3.3.3. The contractor

Otraco International Pty Ltd is contracted to provide onsite tyre management services at the mine for Mt Arthur Coal's fleet of light and heavy vehicles. The contractor is ultimately owned by Downer EDI Pty Ltd.

The contractor uses a covered tyre bay a short distance from the mine's workshop area. At the time of the incident, it operated two Hyster 25-9 tyre handlers and employed 18 workers at the mine. OT21 was the mine's vehicle identifier for the tyre handler involved in the incident. Hyster 25-9 tyre handlers are essentially large forklifts that have tyre grabs fitted instead of tines.

3.3.4. The injured worker

At the time of the incident, the injured worker had more than eight years' experience as a tyre fitter. He began working for the contractor at various mine locations in January 2013. In March 2016, he began working in his role as a shift supervisor for the contractor at the mine.

Image 3.3 - Hyster 25-9 tyre handler involved in incident.

3.4. The circumstances of the incident

3.4.1. Pre-incident

The contractor's shift change occurred at 6 am on 10 August 2017. The day shift crew consisted of a relieving manager, shift supervisor, pit serviceman, and two operators. The injured worker was relieving in the role of pit serviceman, but ordinarily performed his role as a shift supervisor on another of the contractor's crews.

A documented pre-shift inspection checklist for the tyre handler was not completed at the start of the shift. Another of the contractor's workers operated the tyre handler after the shift change that morning. He stated that he expected that he would have inspected it and found it to be free of defects. He knew that the fuel level in the tyre handler was low but thought that he would have time to obtain fuel later in the morning.

Shortly before 9.30 am, the other worker noticed that the low fuel alarm on the tyre handler was activated. Around this time, he was advised of a tyre maintenance job that would require the use of the tyre handler. Believing that there was some urgency around the need to obtain fuel, he approached the injured worker and asked him to refuel the tyre handler.

3.4.2. Approval to use the refuelling station

The injured worker told the contractor's relieving site manager that he was taking the tyre handler to the refuelling station to obtain fuel. The only training that the worker had previously been given in the use of the refuelling station was several minutes of ad hoc instruction from one of the mine's service cart operators. He had also been assisted to obtain fuel on one occasion by another of the contractor's workers. The worker had used the refuelling station on about five or six previous occasions. The worker was given permission by the relieving site manager to attend the refuelling station.

3.4.3. Attendance at the refuelling station

The worker drove the tyre handler about 260 metres to the refuelling station. His path of travel is shown in Image 3.1 above. Under the operator's transport management plan, the worker was not required to notify the mine operator that he was entering the refuelling facility, as it was not in a hazardous area. Hazardous areas are identified by signs to that effect located at the entrance to the area. Anyone wishing to access a hazardous area must obtain permission from the person designated on the sign.

The worker parked the tyre handler adjacent to the three fuel dispensing arms at the refuelling station. He turned off the tyre handler's ignition. The tyre handler was fitted with a turbo timer, which enables its engine to run down for 60 seconds after the ignition is turned off. The worker believed that he operated the turbo timer override, thereby shutting down the tyre handler's engine immediately.

3.4.4. Cooling properties of engine components

When the engine of the tyre handler was shut down, the temperature of its exhaust manifold and turbocharger would have increased. This is because the tyre handler's cooling system shuts down when it is turned off. Once the temperature of the exhaust manifold peaks at 318°C, gradual cooling occurs at a steady rate. Testing of a similar series of Hyster trucks that had the same cooling performance standards as the tyre handler produced the following results:

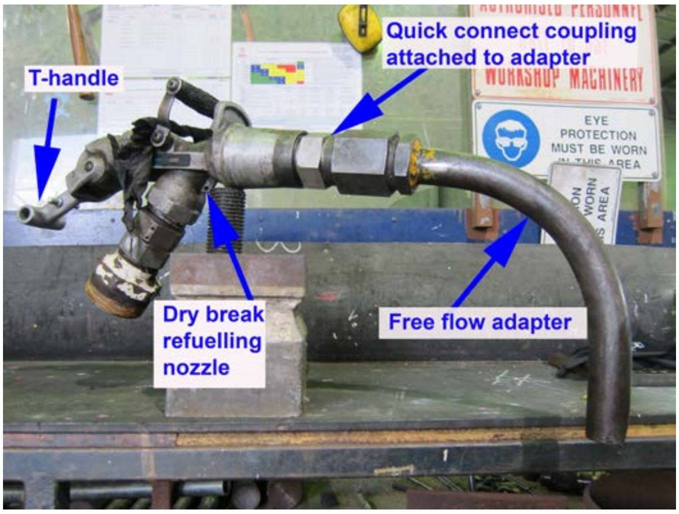
Event	Time period	Temperature
Average operating temperature reached	10-20 minutes	Exhaust manifold - 260°C Turbo clamp - 220°C
Engine shut down	N/A	Exhaust manifold - 249°C
Exhaust manifold - temperature increases	48 seconds after shutting down	Exhaust manifold - 318°C
Exhaust manifold - cooling rate after peak temperature reached	Every 5.83 seconds	Exhaust manifold lowers by 1°C
Ambient temperature reached	Approximately 29 minutes	Exhaust manifold - 25°C

3.4.5. Free flow adapter nozzle

The worker exited the tyre handler and entered a small shed at the refuelling station where he obtained a free flow adapter nozzle connected to a quick connect coupling. The tubular portion of the adapter was 440.0 mm long and had a diameter ranging in size between 40.4 mm and 42.8 mm. The worker had obtained the adapter from the same location on previous occasions and used it to refuel a tyre handler.

The worker returned to the tyre handler and inserted the adapter into the filling neck of the tyre handler.

Image 3.4 - Hose and nozzle assembly with free flow adapter nozzle attached.

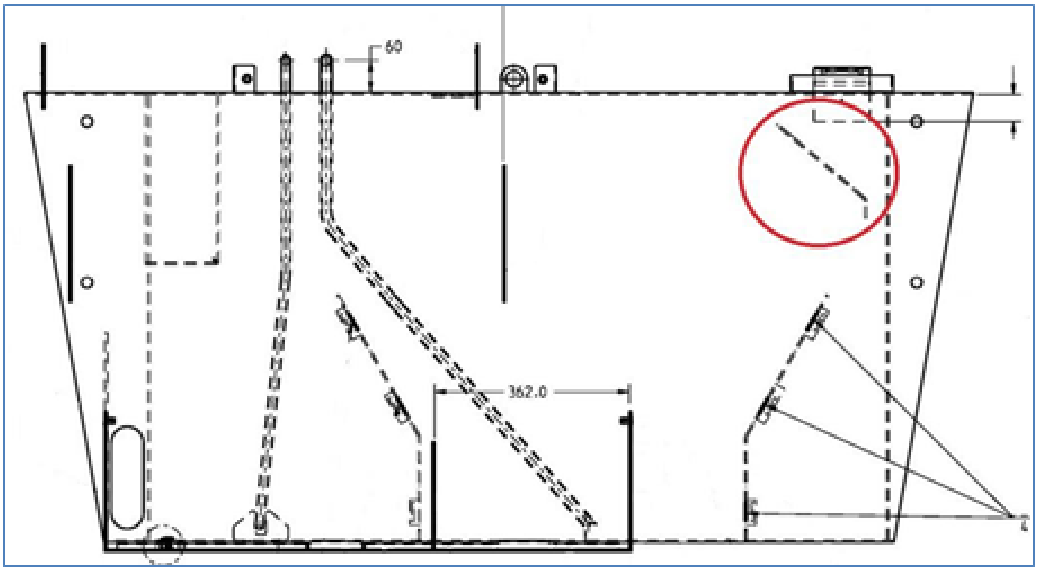


3.4.6. Fuel tank on tyre handler

The tyre handler's fuel tank has a capacity of 305 litres. Its filling neck consists of a short tube that protrudes above and below the surface of the fuel tank. It did not have a quick connect fitting. The interior diameter of the filling neck is 60 mm. The interior of the tank is fitted with a series of baffles as shown below.

Image 3.5 - Filling neck of Hyster 25-9 tyre handler.

Image 3.6 - Internal view of fuel tank of Hyster 25-8 tyre handler.



3.4.7. Use of 800 litres per minute hose

The contractor's workers who used the refuelling station typically used the 300 lpm hose to refuel the tyre handlers. This is because the fuel tanks of the tyre handlers are comparatively small, and the workers felt that it would be too difficult to control the pressure flow of the 800 lpm hose.

The injured worker was aware that each of the hoses at the refuelling station had different flow rates but was unsure what the capacity of each of them was. He selected the 800 lpm hose from its holster, believing that he was selecting the lowest flow hose available. He based this mistaken belief on his perception that he had selected the thinnest of the hoses. He did not read the sign referred to previously.

3.4.8. Connection of hose to adapter and opening of nozzle

The 800 lpm hose was fitted with a quick connect coupling, which could only be joined with other quick connect couplings. When used without an adapter, the quick connect coupling is designed to automatically shut off the flow of diesel when the tank is full. Quick connect couplings are fitted with a dry break mechanism, which detects the back flow of fuel when a fuel tank becomes full, and immediately stops fuel from flowing.

The worker joined the quick connect fitting on the nozzle to the quick connect fitting that was attached to the adapter. The effect of this was that it overrode the automatic shut off function of the coupling. This is because it would prevent the coupling from sensing the presence of any back flow of diesel.

The worker pushed forward the T-handle of the refuelling nozzle to the open position, thereby displacing the poppet inside. The worker was of the belief that diesel would not flow unless the T-handle of the refuelling nozzle was open when the pumps were activated at the switchboard.

When used in this fashion, the only means available to an operator to stop the flow of fuel was to move the T-handle into the off position or shut off on the switchboard. This creates some difficulty for an operator who must closely monitor how full the fuel tank is to be able to stop the flow of diesel before an overflow occurs. The fuel tank of the tyre handler does not have a fuel level window, so the only means of determining whether the tank is full is to listen to the fuel going into the tank or looking into the tank's filling neck. These methods are not reliable nor without risk.

The design of the adapter was such that it did not have the ability to positively connect with the filling neck of the tyre handler's tank. The adapter remained positioned in the fuelling neck solely because of the gravitational force of the weight of the hose and nozzle assembly. This was calculated to be between 144 and 161 newtons (N) ($kg.m/s^2$).

3.4.9. Activation of fuel delivery system

The worker returned to the shed and started the diesel pumps using the buttons on the switchboard inside. As the refuelling nozzle was already in the open position, diesel began flowing through the adapter into the tyre handler's fuel tank. As this was occurring, the worker began walking from the shed towards the tyre handler and the fuel tank.

3.4.10. Ejection of adapter from fuel tank

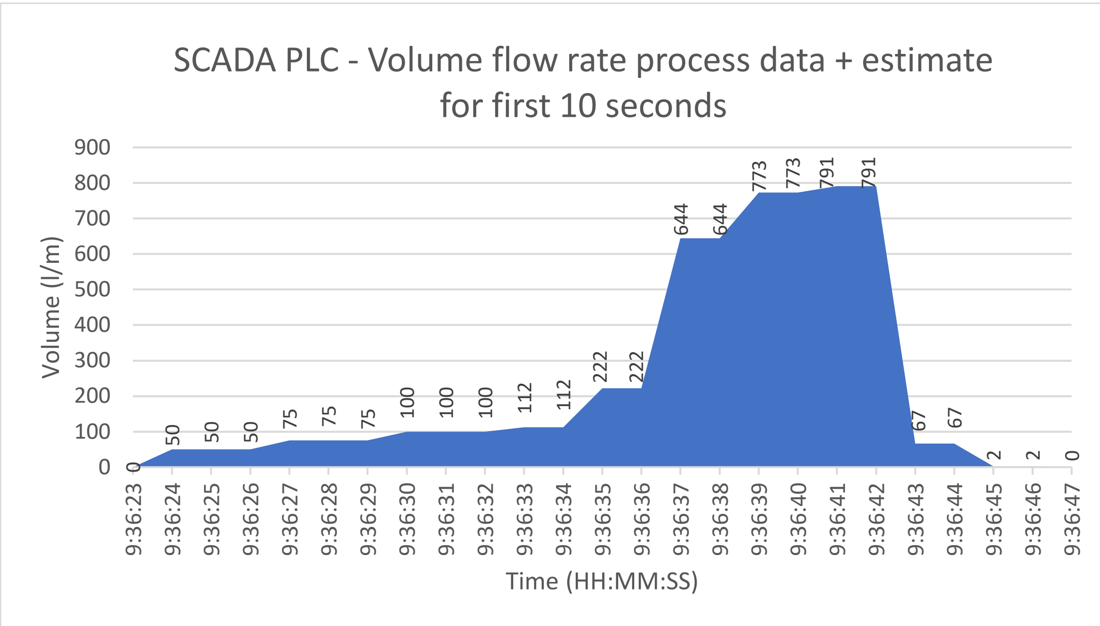
The refuelling system's diesel pumps ramp up gradually during the first 10 seconds of operation. The refuelling facility's logic system does not record the flow rate of the diesel until it reaches the rate of 100 lpm. After the pumps had operated for 10 seconds, there was a significant increase in the flow rate of the diesel into the fuel tank of the tyre handler. This is likely to have coincided with the injured worker returning to the vicinity of the fuel tank. The flow rate increased from 222 lpm after 13 seconds of operation, to 644 lpm after 14 seconds of operation. The assembly was not being held in the tank by the worker during this increase in flow.

When the flow rate of the diesel reached about 400 lpm, the upward force operating on the assembly began to exceed the downward gravitational force described above (at 3.4.8) (the weight of the quick connect coupling). The adapter ejected from the tank at this point and flung around under pressure.

The worker took hold of the assembly. The worker was unsure what distance from the ground it was when he did this. The nozzle moved continuously in various directions. At one point, the injured worker held the assembly above his shoulder and attempted to close the T-handle of the refuelling nozzle from this position. The flow rate of the diesel continued to increase until it peaked at 791 lpm after 18 seconds of operation.

The flow rates described above are shown in the following graph. The data shown for the first 10 seconds has been estimated. The figures for the remainder of the period shown is data taken from the refuelling facility's logic control system.

Image 3.7 - Diesel flow rates at the time of the incident.



3.4.11. Uncontrolled escape of diesel

At one point, while the worker was attempting to control the assembly, the diesel flowed from the adapter in the direction of the tyre handler's left side engine cover. Some of the diesel sprayed back from the engine cover onto the worker and the surrounding ground area. Diesel entered the tyre handler's engine area, through gaps between the engine cover and the body of the tyre handler. (See 4.1 below for further information.)

3.4.12. Ignition of diesel

Applying the engine temperature calculations set out above (at 3.4.4) to the description of the incident given by the injured worker, certain engine surfaces of the tyre handler would have been in the range between 260° C and 318° C at the time that diesel entered the engine area.

The diesel ignited after making contact with one or more of the hot surfaces in the engine area. Diesel can ignite after it comes into contact with a surface with a temperature above 210° C. There is potential for diesel to ignite at 180° C when it is in vapour or mist form.

The specific points of ignition were not determined. The most probable ignition points were the exhaust manifold, turbo clamp and housing. Diesel continued to flow from the hose at a rate of 791 lpm at the time of ignition.

Image 3.8 - View of fire taken from workshop area.

3.4.13. Spread of fire

After the diesel ignited, a flame flashed back towards the worker and other areas that were affected by diesel, as shown in Image 3.9 below. They included the tyre handler's engine area and the ground between the tyre handler and the shed. The worker's hair and the sleeves of his long sleeve work shirt caught fire. The worker dropped the assembly and ran in an easterly direction to escape the fire.

Image 3.9 - Direction of flames.

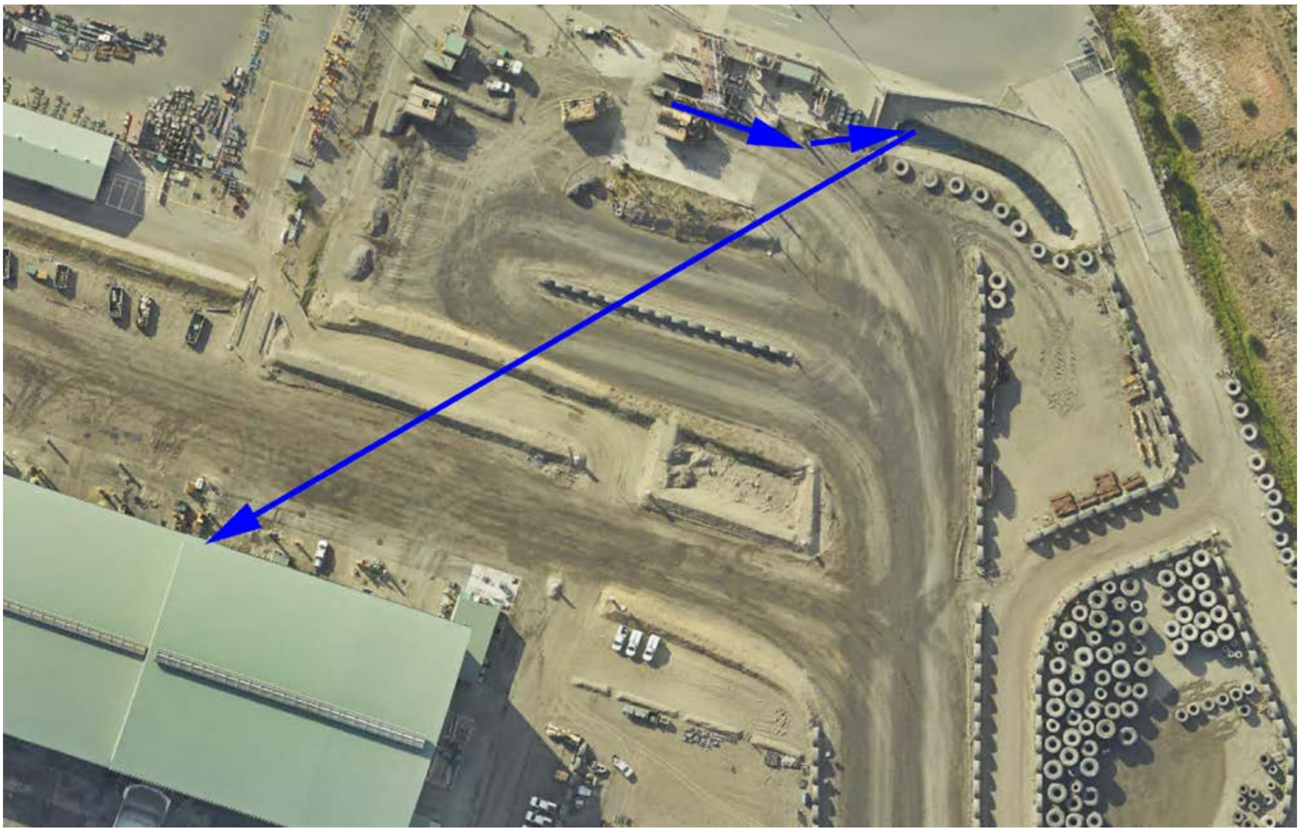
3.4.14. Cessation of diesel flow

Logic control data shows that the T-handle of the refuelling nozzle was closed 19 seconds after the diesel pumps were activated. This caused the diesel to stop flowing. It was not established whether the T-handle closed because of the above attempts by the injured worker (see 3.4.10), or whether it resulted from the assembly being dropped on the ground. It is estimated that between 87 and 98 litres of diesel were released during the incident of which only a small proportion entered the tyre handler's fuel tank.

3.4.15. Actions of injured worker

The injured worker ran in an easterly direction. He knew that the sleeve of his shirt was on fire and took the shirt off as he ran. He knew that there was an emergency shower at the refuelling facility but considered it to be too close to the fire to stop and safely use it. After he took his shirt off, he realised that his hair was on fire. He continued to run to a drain at the eastern end of the refuelling facility. He put his head into mud that was in the drain and extinguished the fire in his hair. He was assisted by another worker who escorted him to an emergency shower in Bay 18 of the mine's workshop.

Image 3.10 - Path travelled by the injured worker following incident.



3.4.16. Extent of fire

The fire burning in the engine area and on the ground became well established. The flames spread to cabling outside the shed, and through that cabling into the shed. Damage was occasioned to the following areas:

- engine area of the tyre handler
- interior of the shed, including the switchboard
- cabling connected to the switchboard; both outside and inside the area.

Image 3.11 Damage inside switchboard shed.

Image 3.12 - Damage to wiring leading into switchboard shed.

Image 3.13 - Damage inside left-hand engine bay of tyre handler.

3.4.17. Extinguishing the fire

Two of the mine's water carts provided the initial response to the fire. They applied large amounts of water in the direction of the flames. A short time later, the mine's emergency response vehicle responded and extinguished the remainder of the flames.

3.4.18. Treatment of injured worker

The injured worker was assisted by other workers, and then paramedics in the workshop area. NSW Ambulance officers attended. The injured worker was flown by rescue helicopter to Royal North Shore Hospital's Burns Unit.

The injured worker sustained 8% total body surface area burns.

These injuries required extensive treatment, including skin grafts.

3.5. Chronology

Date	Activity
7 March 2013	Operational risk assessment for the refuelling facility completed.
2 August 2013	The mine's refuelling facility began operation on 2 August 2013.
17 October 2013	The contractor, Otraco, tenders for the contract for the operator's on-site tyre management services.
12 June 2014	Contract for the provision of tyre management services at the mine by the contractor was executed.
Prior to 1 July 2014	Tyre management services at the mine were performed by another contractor.
1 July 2014	The contractor begins performing tyre-management services for the operator. Six former employees of the previous tyre contractor transfer to the employ of the contractor.
1 October 2014	The Hyster 25-9 that was involved in the incident (OT21) introduced to the mine by the contractor and examined by the operator.
16 October 2014	The operator undertakes a fire risk assessment of forklifts and telehandlers used at the mine.
22 October 2014	Second Hyster 25-9 tyre handler (OT22) introduced to the mine by the contractor and inspected by the operator.
9 September 2015	Annual re-inspection of OT21 by the operator.
22 March 2016	The injured worker commences as a shift supervisor for Otraco at Mt Arthur Coal.
26 September 2016	The contractor adopts Mt Arthur Coal's safety management system for work conducted at the mine.
1 December 2016	Annual re-inspection of OT21 by the operator.
Events of 10 August 2017	
Between 5.30 am and 6.00 am	The injured worker arrived at work.
Approx. 6.15 am to 9.15 am	The worker performs services in the pit in a light vehicle.
6.30 am to 9.30 am	Another worker operates tyre handler OT21

Date	Activity
Approx. 9.15 am	Low fuel alarm on OT21 activated.
Approx. 9.15 am	Operator of OT21 learns of an unexpected job that will require OT21 to be used.
Approx. 9.30 am	OT21 operator requests the injured worker to refuel tyre handler.
Approx. 9.30 am	The worker approaches the contractor's site manager and advises him that he was refuelling the tyre handler at the refuelling facility.
Approx. 9.32 am	The worker drives tyre handler to refuel facility.
Approx. 9.36 am	The worker begins refuelling tyre handler.
9.37.01 am	First emergency call made notifying of incident.

4. Design and examination of tyre handler

4.1. Engine cover seals

The Hyster 25-9 tyre handler is designed to have rubber seals fitted along the inside bottom edge of its engine covers, and on each side of the frame of the engine bay where the engine cover closes on it. Examinations showed that the rubber seal was missing from the inside edge of the left side engine cover of OT21 at the time of the incident. They also showed that the seals at each side of the left-hand engine bay did not make full contact with the engine cover frame. These seals are only designed to reduce noise and protect paint, and not to prevent liquids entering the tyre handler's engine bay. However, it is likely that if the engine cover had been better sealed, the amount of diesel that entered the engine bay during the incident would have been reduced.

Image 4.1 - Gap between the engine cover and the engine bay frame of OT21.

4.2. Proximity of fuel tank to engine

The proximity of the tyre handler's filling neck to its engine bay was examined during the investigation. Its design was found to meet the requirements of AS2359.6-2013 for 'Self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden carrier trucks'. Part 4.5.2.1. provides that

> *If a fuel tank is within or adjacent to the engine compartment and excessively high temperatures can occur, the tank and/or filling arrangement shall be isolated from the electrical and exhaust systems by suitable protection, e.g. a separate enclosure or baffles. The tank location and facilities for filling shall be such that spillage or leakage will not drain into the engine or operator's compartment or onto electrical or exhaust system parts.*

It is highly unlikely that the above requirements in relation to the drainage of 'spillage or leakage' would extend to preventing high volume flows close to 800 litres per minute. With effective engine cover seals in place, it would be reasonable to expect that the raised lips beneath the engine cover and around the filling neck would be sufficient to prevent the ingress of spillage or leakage into the engine bay of the tyre handler.

Image 4.2 - Proximity of filling neck to left side of engine cover of OT21.

5. Intended refuelling procedure for tyre handlers

5.1. The operator's fleet of service carts

Mt Arthur Coal operates a fleet of service carts that are equipped with hoses to supply various hydrocarbons, including diesel, to a range of plant across the mine. The service carts are equipped with a low flow hose and nozzle that operate in a similar manner to those used on bowsers at light vehicle service stations. These nozzles are designed to automatically shut off when the tank being filled is full.

5.2. The operator's understanding and expectation

The mine operator's understanding and expectation was that the practice for refuelling the contractor's tyre handlers would be as follows:

- The contractor requests that a service cart attends the tyre handler's location.
- The service cart attends the tyre handler's location and refuels it using its low flow hose.

5.3. The contractor's understanding and expectations

Two of the contractor's managers were involved to varying degrees in the tender, contracting and mobilisation of resources associated with the provision of services at the mine by the contractor. They understood that the operator was responsible for the supply of diesel to its tyre handlers. However, neither considered how the tyre handlers would be refuelled at any time before the incident. This remained the situation from the time that the contractor arrived on site, until the time of the incident.

The contractor's site manager had worked at the mine since July 2016. His understanding was that the preferred method for refuelling the tyre handlers was using the mine's service carts. However, he knew that there were often delays with the attendance of the service carts, and on occasions some of the employees would refuel at the refuelling station.

6. Development of ad hoc practice for refuelling tyre handlers

The actions of the injured worker in attending the refuelling station to refuel the tyre handler had become common practice among some of the contractor's workers. The practice began almost immediately after the contractor began providing services at the mine in July 2014. However, not all workers nor all of the contractor's teams undertook the practice.

6.1. Instructions given by service cart operators

Each of the contractor's workers who were involved in refuelling the tyre handlers at the refuelling station provided a consistent version as to how the practice developed. Each described initially calling up on the mine's two-way radio system for a service cart to attend their location to refuel a tyre handler. They described receiving one of the following responses from the service cart operators:

- → The service cart operator will attend as soon as they were able.
- → The service cart operator will attend but there will be significant delays. There is an adapter at the refuelling station, it will be quicker to refuel it yourself.
- → There is an adapter at the refuelling station. Go over and refuel it yourself.

The contractor's workers had varying experiences about how often they were instructed to go to the refuelling station. Some said they were given the instruction on about 90% of the occasions that they requested the attendance of the service carts.

Each of the mine's service cart operators denied issuing instructions to the contractor's workers to attend the refuelling station. All but one of the service cart operators advised that they had never heard a mine worker tell a contractor that they should attend the refuelling station. One operator had heard instructions to this effect given by unknown colleagues on a couple of occasions, but that it happened a long time ago and they could not recall when it was.

6.2. Failing to request the attendance of service carts

Some of the contractor's workers reported that it was common for them to receive instructions from the mine's service cart operators to use the refuelling station when making requests for a service cart to attend the tyre handling bay.

The contractor's workers generally felt that it was a waste of time to request the attendance of the mine's service carts. Newer workers were advised by their colleagues that any request for fuel cart service would be met by significant delays, or an instruction to attend the refuelling station.

6.3. Instruction in the use of refuelling station

Most of the contractor's workers who used the refuelling station, were initially shown how to use it by unidentified mine employees. The instruction was generally provided after a request was made by the contractor's worker directly to the mine employee. Several of the contractor's workers provided instruction to their colleagues about how to use the refuelling station, after they had been shown how to use it by a mine employee.

In all cases, the instruction given involved refuelling the tyre handler using the adapter. It generally consisted of a single refuelling demonstration of the following:

- → connecting the adapter to the 300 lpm hose
- → which buttons to press on the switchboard to commence the flow of fuel.

The instruction did not extend to the safety features of the refuelling facility such as using emergency stops and showers, and how to isolate energy sources.

6.4. Frequency in the use of the refuelling station by the contractor's workers

The use of the refuelling station by some of the contractor's workers became common practice. One worker stated that he only used service carts to refuel tyre handlers on less than 10% of occasions that the tyre handlers needed fuel. He would take the tyre handler to the refuelling station on the balance of those occasions. Most of the contractor's workers who used the refuelling station, had done so on at least five or six occasions.

6.5. Normalisation of refuelling practice

6.5.1. The contractor's workers

The contractor's workers who used the refuelling facility believed they were authorised to use the refuelling facility. These beliefs were based on a range of factors, including that the contractor's supervisors and managers approved the practice, the frequency with which the practice occurred and that the practice was believed to have been carried over from the previous contractor.

6.5.2. The operator's workers

Over half of the mine's service cart operators had observed the contractor's tyre handler's being refuelled at the refuelling facility by the contractor's workers. Most had observed this occur on more than one occasion. Each assumed that the contractor's workers must have been authorised to use the refuelling facility and did not report the practice to their supervisor. Most made their assumption based on the mine's rule that workers need to be trained and passed out on any equipment that they use. However, one service cart operator made this assumption on the basis that he was never told that he was required to refuel the tyre handlers.

7. Investigation findings

Five key failures were identified as contributing to the employment of unsafe fuelling practices by the operator and contractor. They were failing to:

- → identify and assess risks
- → implement safe systems of work
- → provide adequate information and training
- → properly supervise workers
- → use fit-for-purpose equipment.

Each of these failures are described below.

7.1. Failing to identify and assess the risks

The operator and contractor undertook extensive risk assessment activities regarding the vast majority of the work each performed at the mine. There was however, a failure by both to identify all risks associated with the operation of two key ancillary assets at the mine; the refuelling facility and the contractor's tyre handlers. The reason for this failure was that the risk assessments that were undertaken were largely focused on the core business activities of the operator and contractor. By not considering all vulnerabilities associated with these ancillary assets, the operator and contractor failed to identify risks associated with:

- → workers accessing the refuelling facility without authorisation and/or training
- → the introduction and use of non-fit for purpose equipment at the refuelling facility.

These failures are discussed in further detail overleaf.

7.1.1. Refuelling facility

7.1.1.1. Operator

The mine operator undertook a range of risk assessment processes during the planning, commissioning and operation of its refuelling facility. The risks identified by the operator were primarily associated with the functional safety of the refuelling facility. The following sample of assessments, audits and inspections is given as a broad overview of the types of matters that were risk assessed.

Date	Name	Scope
22 July 2011	Risk assessment hydrocarbons	Hazards relating to infrastructure at refuelling facility
20 October 2011	Risk assessment for hydrocarbons	Design and functional safety risk assessment
7 March 2013	Operational risk assessment hydrocarbon facility	Hazards relating to inspection, cleaning, operating and maintaining the facility
7 June 2013	AS1940 audit	Hazards relating to infrastructure.
14 September 2016	BP asset management: customer facility review	Assess compliance with legislation, codes and standards in relation to the storage of diesel

The operational risk assessment undertaken by the operator on 7 March 2013 (see above chronology), did identify some risks associated with workers accessing the refuelling facility. However, these risks primarily related to interactions between mobile plant. The only consideration that was given in the operational risk assessment to unauthorised access to the refuelling facility, concerned the risk of a crush injury occurring while maintenance was being performed.

No risk assessment was undertaken by the mine operator that would have enabled it to identify the potential use of non-fit for purpose adapters at the refuelling facility.

Having regard to the size of the workforce at the mine and the large volumes of hydrocarbons stored and used at the refuelling facility, an effective broad-brush risk assessment could have identified all risks associated with the facility’s operation.

7.1.1.2. Contractor

The contractor did not undertake any risk assessment activity in relation to the use of the refuelling facility by its workers, despite being aware that its workers were using it. The contractor stated that the reason for this was that the refuelling facility was under the management and control of the operator. The failure by the contractor to conduct a risk assessment at the refuelling facility resulted in it being unaware that the adapter was being used by its workers in the refuelling process.

7.1.2. Contractor's tyre handlers

7.1.2.1. Operator

The operator undertook various risk assessment activities in relation to the contractor's activities at the mine, including the operation of its tyre handlers. However, the focus of these activities was upon the contractor's tyre management activities. The processes described below are provided as examples of the types of risk assessments undertaken by the operator in relation to tyre handlers and similar mobile plant.

- → **Formal risk assessment:** On 16 October 2014, the mine operator undertook a formal risk assessment to identify key fire risks associated with the operation and use of forklifts and telehandlers at the mine. The contractor was not involved in this risk assessment, even though the first of its tyre handlers was introduced to the mine only 15 days earlier. The risk assessment identified that there was a risk of fire if diesel sprayed onto an exhaust system or other hot surface. However, the consideration of factors that would cause diesel to spray in this manner were restricted to mechanical rather than human factors. The results of the fire risk assessment were not provided to the contractor.
- → **Desktop analysis:** A desktop risk analysis that was undertaken by the operator on 23 September 2016, identified that the contractor operated its own vehicles at the mine. The analysis did not assess how the contractor's vehicles were refuelled. The primary risk identified in relation to the operation of the contractor's vehicles was their potential for interaction with other mine vehicles. More generally, refuelling of the contractor's vehicles was assessed as part of the operator's site-wide refuelling activities.
- → **Inspection programs:** The operator conducted annual inspections of the contractor's tyre handlers. These annual inspections resulted in action being taken to reduce the likelihood of fires occurring in the engine area of the tyre handlers. For example, when OT21 was introduced to the mine site, the operator required the turbo oil supply line to be sheathed and sealed.

None of the programs employed by the operator were broad enough to identify the risks associated with the matters outlined at 7.1. above.

7.1.2.2. Contractor

The contractor did not undertake any risk assessments in relation to the refuelling of its tyre handlers at the mine. The contractor's risk assessment processes, which included broadbrush risk assessments, were entirely focused on its tyre management activities. Failing to identify hazards associated with all of its ancillary activities at the mine resulted in the risks associated with the refuelling of its tyre handlers being overlooked.

7.2. Failure to implement safe systems of work

The mine operator and contractor each failed to establish safe systems of work for refuelling the contractor's tyre handlers at the mine. They both developed a broad range of operational procedures outlining the way that their work was to be performed. However, neither party had developed a documented procedure specifically for refuelling the contractor's tyre handlers. This was a consequence of the above failures to identify and assess risk.

7.2.1. Systems of work before the engagement of the contractor

The mine's previous onsite tyre management contractor operated a similar fleet of tyre handlers to that used by Otraco. Its tyre handlers had the same type of filling neck as Otraco's. The operator also supplied diesel to that contractor under their service agreement. There were no documented procedures established for refuelling the previous contractor's tyre handlers.

The practice that was employed by the previous contractor for refuelling its tyre handlers was that it would contact the mine's service carts. A service cart operator would then refuel the tyre handlers using the service cart's low flow hose. Otraco stated that several of its employees, who worked for the previous contractor, had advised that they used the refuelling station while working for that previous contractor. Conflicting evidence was obtained during the investigation as to whether that was the case.

7.2.2. Agreement for the provision of fuel by the operator

The original agreement for the provision of tyre management services by the mine operator stated that the cost of fuel for the contractor's tyre handlers was to be borne by the contractor. Notwithstanding this, the understanding of both parties was that the mine operator was responsible for supplying the fuel. This is a common arrangement in relation to refuelling mobile plant operated by a contractor, that does not leave the mine site. This arrangement between the mine and contractor did not specify the way that the fuel was to be provided.

On 4 May 2016, a variation to the agreement was made. The variation inserted a provision that specified that the mine operator was responsible for the supply of diesel used by the contractor's tyre handlers. The variation did not specify the way the fuel was to be provided.

7.2.3. Safety management systems

7.2.3.1. The mine operator

In April 2014, the mine operator implemented its safety management system (SMS) pursuant to clause 13 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014.

Within the mine operator's SMS is its contractor management system (CMS). A requirement of the CMS was that contractors must comply with the operator's SMS as a minimum standard. This requirement was acknowledged in writing by the contractor on 26 September 2016.

The operator's CMS sets out various responsibilities regarding the management of the contractor's activities onsite. It requires a contract owner to be allocated in relation to each contractor operating at the mine. The contract owner is a Mt Arthur Coal representative, who has overall accountability for the execution of the contract and is accountable for the contractor's work health and safety performance on site.

The CMS contains a mobilisation checklist that requires a risk assessment to be undertaken by the contract owner regarding the contractor's on-site activities. It also sets out a series of actions that must be taken by the contract owner regarding the supervision and management of the contractor's safety performance.

7.2.3.2. The contractor

The contractor published its health and safety plan on 30 June 2014. One of the objectives of the plan is to 'provide a framework for monitoring, reporting and continually improving safety performance.' Under the plan sits a series of risk management and work practice standards, aimed at managing risk and developing consistent work practices.

7.2.4. Failure to communicate expectations

The mine operator was unable to provide any evidence that it had communicated its expectations to the contractor about refuelling the tyre handlers. Neither party established documented procedures to clarify what their expectations were. The mine operator's contract owner had seen the mine's service carts refuelling the contractor's tyre handlers during several of his earlier interactions with the it. The contract owner believed that this was the practice that was used on each occasion that the tyre handlers were refuelled.

7.2.5. Delays in the supply of diesel to the contractor's tyre handlers

Each of the contractor's workers at the mine who were interviewed described experiencing significant waiting times for the arrival of the mine's service carts, after a request for their attendance was made. The reason for these delays were canvassed with the mine's service cart operators. Most of the service cart operators and their supervisors were unclear what was their obligation to refuel the tyre handlers. This lack of clarity was primarily a result of the failure to implement and enforce robust procedures in relation to the refuelling of the tyre handlers.

7.2.5.1. Lack of awareness of obligation of service cart operators to provide fuel

A service cart operator who had two years' experience in the role, told investigators that he had never refuelled the contractor's tyre handlers, nor had he ever heard of one of his colleagues doing so. His understanding was that the tyre handlers were refuelled at the mine's light vehicle fuel station. This was incorrect, as the tyre handlers are too tall to fit into the mine's light vehicle refuel station.

The production 2 supervisors who supervised the service cart operators, did not understand the intended procedures for refuelling the contractor's tyre handlers. Several told investigators that they did not know how the tyre handlers were refuelled before the incident, and that they did not know whether the service cart operators were involved in this process.

7.2.5.2. Low priority given to contractor's requests for fuel

The mine's service cart operators assigned a very low priority to requests made by the contractor to refuel its tyre handlers. Their practice was to prioritise refuelling the mine's equipment in production areas. As the area where the tyre handlers primarily worked was located between the refuelling facility and the pit area, the service carts would only refuel the tyre handlers when they were on their way to or from the pit. The lack of priority given to refuelling the tyre handlers may be partly attributable to the fact that there were two tyre handlers onsite, the thinking being that the second machine could be used if the first ran out of fuel.

Opinions varied among the workers interviewed about what the maximum wait time was for the service carts to refuel the tyre handlers. The consensus was that it was about two hours. However, some indicated that the delay could be as much as five or six hours.

7.3. Failing to properly supervise

7.3.1. Supervision of the refuelling facility

The mine operator stated that it used three controls to prevent unauthorised access to the refuelling facility. None of the controls were effective for the following reasons:

Control	Reason control not effective
Site induction processes (e.g. workers are only permitted to use equipment on which they have been assessed and are competent)	The refuelling facility was not supervised to ensure compliance with site induction processes (see below).
External boundary fences	The contractor worked within the external boundary fences
The provision of light vehicle and forklift bowsers	The masts of the contractor's tyre handlers were too tall to fit under the roof of the mine's light vehicle refuelling facility. The forklift bowsers referred to were pods with a capacity of approximately 1000 litres fitted with low flow pumps. They were at various locations throughout the mine. The contractor was not given any instructions in relation to using these bowsers.

The operator did not use CCTV to monitor activity at the refuelling facility. The refuelling facility was not fitted with a key or swipe card system that would only permit authorised users to obtain fuel. It had however, previously identified that there was a risk of unauthorised access to its light vehicle refuel station and implemented electronic controls to mitigate that risk.

The operator did not specifically task any person to actively supervise the refuelling facility.

The operator's production 2 supervisors were responsible for supervising the service cart operators who used the refuelling facility. The operator advised that the production 2 supervisor would 'catch up' with the service cart operators at least once each shift. The operator asserted that it supervised activity at the refuelling facility through these catch ups.

The production 2 supervisors were not required by their manager to specifically monitor activity at the refuelling facility. Most of the interactions between service cart operators and their supervisors occurred in the workshop areas or out in the pit. The supervisors generally attended the refuelling facility to catch up with their workers about once a month. The production 2 supervisors did not otherwise monitor activity at the refuelling facility.

7.3.2. Supervision of the contractor's workers

7.3.2.1. The mine operator

The agreement for services between the mine operator and contractor provided that there was a general requirement for the contractor to provide adequate supervision of its own workers. In any event, the operator did not supervise the contractor's workers in the use of the refuelling facility as it did not know that they were using the refuelling facility.

7.3.2.2. The contractor

The contractor did not supervise its workers when they used the refuelling facility as it did not regard the use of the refuelling facility to be a 'material risk'. Its onsite manager had never been to the refuelling facility to observe the way the tyre handlers were being refuelled by its workers.

7.4. Failing to provide information and training

7.4.1. The mine operator's workers

A consequence of the failure by the operator and contractor to establish procedures for the refuelling of the contractor's tyre handlers (see 6.7 above) was that service cart operators and their supervisors were not given specific training in relation to their obligation to refuel them. This led to the confusion about their obligations to supply fuel (see 7.2.5.1 above) and may have contributed to the belief by a number of service cart operators that the contractor's workers were authorised to use the refuelling facility (see 6.5.2 above).

7.4.2. The contractor's workers

7.4.2.1. Training provided by the operator

The operator provided site specific theoretical and practical inductions and training to the contractor's workers. An important component of the information given to all workers is that workers are only authorised to undertake tasks for which they are "trained, competent and authorised".

The operator did not provide any formal training to the contractor's workers in relation to the use of the refuelling facility. This was because it did not know that the contractor's workers were using the refuelling facility, and it did not intend for them to use the facility.

As outlined above (at 6.3), the ad hoc instruction that was provided to the contractor's workers by a number of the operator's service cart operators was incomplete. In addition to the deficiencies detailed above (at 6.3), the level of instruction given to the injured worker directly contributed to the incident in the following ways:

- **Confusion about the order of actions when fuelling:** Due to the quality of the training provided to the injured worker, he was confused about the operation of the refuelling facility's logic control system. The system causes the fuel pumps to stop if a certain volume of diesel has not been dispensed within 10 seconds of activation. The worker was under the misapprehension that the pumps would not start unless the T-handle was pushed forward when the switchboard was activated. This led him to open the T-handle before starting the flow of fuel via the switch board. As a result, he was not able to hold the nozzle in the tank as he was in the switch shed when the flow of diesel began. The practice of other workers was not to open the T-handle of the nozzle until after they had activated the flow of diesel on the switchboard. As a result, they could hold the T-handle when the flow of diesel started.
- **Inability to identify risk:** The training provided to the workers was not comprehensive enough to identify the risks associated with the method of refuelling that they were undertaking.

7.4.2.2. Training provided by the contractor

The contractor provided general and site-specific training to its workers in relation to the operation of its tyre handlers. The training did not include any instruction in relation to how the contractor's tyre handlers were to be refuelled. New workers were provided with information about refuelling the tyre handlers by their colleagues, several of whom were already using the refuelling facility. This permitted the unauthorised practice of using the refuelling facility to continue.

The contractor did not provide any training to its workers at the mine in relation to the use of the refuelling facility. It was aware that its workers were given 'basic' training in the use of the refuelling facility by the operator's service cart operators and/or other employees of the contractor. It chose not to provide training to its workers as it did not consider the use of the refuelling facility to be a 'material risk'.

7.5. Provision of equipment that was not fit for purpose

As detailed above, (at 3.4.6 and 3.4.8) the adapter was not fit for purpose for refuelling the contractor's tyre handlers.

7.5.1. Introduction of adapter to site

It has not been precisely determined who introduced the adapter to the mine site. The operator stated that it did not know the adapter was used at the mine. It was unable to supply any records in relation to the acquisition, maintenance or use of the adapter.

Although similar adapters are commercially available, having regard to the crude design of the adapter it is likely that it was not purchased from a manufacturer.

The adapter has been in use at the mine since at least 1995. It was previously used to refuel lighting plants at various locations at the mine. This practice stopped around 2005, when all the mine's service carts were fitted with low flow hoses and nozzles. Since that time, the adapter was primarily kept in the switch room shed, the location from which the injured worker retrieved it on 10 August 2017. Most of the operator's service cart operators and the contractor's workers were aware that the adapter was kept in the switch room shed.

7.5.2. Failure to locate adapter

7.5.2.1. Mine operator

The mine operator acknowledged that the adapter was not fit for purpose for refuelling plant and equipment. The fact that the adapter was kept at the mine for such a long time demonstrates that there was a deficiency in the operator's inspection regime for the refuelling facility. Inspections of the refuelling facility were undertaken by the operator's infrastructure department. It should have been evident to any person with a mechanical background that the adapter was not fit for purpose.

7.5.2.2. Contractor

As detailed above (at 6.1.1.2) the contractor did not know that the adapter was being used. This was a result of its failure to undertake risk assessments and supervise its workers, in relation to the use of the refuelling facility.

8. Human and organisational factors

Human and organisational factors

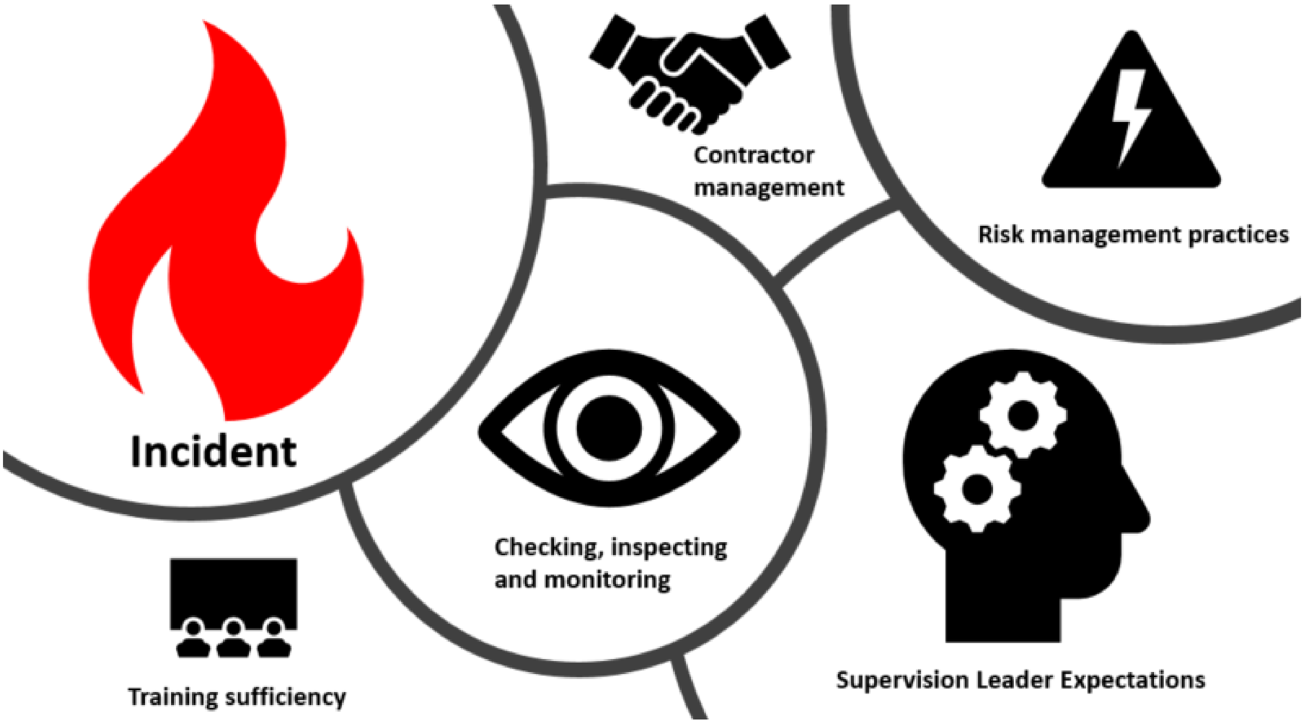
Human and organisational factors are the attributes that influence our behaviour at work and include three interrelated aspects of the job, the individual and the organisation. Each aspect consists of characteristics known as performance shaping factors.

Performance shaping factors are the characteristics of the task, the individual and the organisational elements that influence human performance. They operate at different levels within the organisation and are used to identify the key factors that contribute to the likelihood of error.

The following performance shaping (organisational) factors were identified as being significant contributing factors:

- **Contractor management** - The mine operator's contractor management system failed to identify that the contractor's workers were undertaking risky refuelling practices.
- **Supervision leader expectations** - The mine operator and contractor failed to communicate with each other about the difficulties that the contractor was experiencing with respect to refuelling.
- **Training sufficiency** - The mine operator and contractor each failed to provide workers with enough training to competently identify the risks associated with refuelling.
- **Risk management practices** - Effective risk management practices were not applied by the contractor, nor enforced by the mine operator, in relation to the fuelling of the contractor's mobile plant.
- **Checking, inspection and monitoring -** The mine operator did not supervise activity at its refuelling facility to a sufficient standard to enable it to identify that unauthorised use was occurring.

Image 8.1 - Human and organisational factors contributing to incident.



9. Remedial action

9.1. Response by mine operator

The key responses taken by the mine operator were to:

- → address the contractor's workers and reinforce its expectation that the only method for refuelling the tyre handlers was using the service carts
- → advise the contractor that it should contact a production 2 supervisor if it is experiencing delays with the attendance of service cart
- → reinforce with service cart operators their responsibilities with respect to refuelling the contractor's tyre handlers
- → ensure that no other adapters were in use across all BHP mine sites in Australia
- → check that there were no similar adapters at the mine
- → communicate the risks associated with the use of free flow adapter nozzles
- → require modifications to the engine cover seals on the contractor's tyre handlers.

9.2. Response by contractor

The key responses taken by the contractor were to:

- → prohibit the use of adapters attached to quick flow nozzles
- → issue an information bulletin detailing this prohibition and the risks associated with using adapters attached to quick flow nozzles
- → conduct an audit across all its operations and confirmed that there were no other sites using the adaptor involved in this incident
- → advise its clients of the risks associated with the use of adapters attached to quick flow nozzles
- → install a 1000 litre fuel pod fitted with a low flow nozzle at the tyre bay used by the contractor for the refuelling of its tyre handlers.

Image 9.1 Low flow refuelling pod installed by the contractor at its tyre bay to refuel tyre handlers.

10. Recommendations

It is recommended that mine operators and contractors:

- review their fuel delivery systems to ensure that only competent and authorised workers have access to refuelling facilities
- conduct an audit of refuelling facilities and service equipment to ensure that all refuelling equipment is fit for purpose
- review safety management systems (including contractor management systems) to ensure that adequate risk assessments are conducted for the full range of work activities
- ensure that adequate supervision is provided to workers undertaking refuelling activities
- train workers about the correct use of refuelling equipment
- prohibit the use of free flow fuel adapters that defeat inbuilt safety functions of refuelling systems.

11. Resources

Further information about the frequency of fires with which fires occur on mobile plant, and measures to eliminate or mitigate the risk of fire is detailed below:

- MDG 1032 Guideline for the prevention, early detection and suppression of fires in coal mines (January 2010) - Recommended industry practice for mitigating the risks associated with the fires in coal mines.
- SB15-03 - Safety Bulletin: Fires ignite while refuelling mobile plant with quick fill systems (May 2010) - Recommendations to industry regarding the use of quick fill refuelling systems.
- Investigation Information Release IIR17-10: Mt Arthur serious injury fire (August 2017) - Recommendations made by the regulator shortly after the incident.
- MDG 15 Mobile and transportable plant for use on mines and petroleum sites - Intended to assist in the elimination or minimisation of lifecycle risks associated with mobile and transportable plant intended for use at mines and petroleum sites.
- Discussion Paper - Preventing fires on mobile plant (August 2018) - Provides an overview of fires on mobile plant in NSW mines and considers strategies to reduce such incidents.