Mines Inspectorate (Coal)

Nature and Cause Investigation Report for Chief Inspector of Coal Mines

Accident at Moranbah North Mine on 20 February 2019, resulting in the death of s.73 Irrelevant information.

Date of report - 31 August 2019

Lead investigator

Stephen Smith	Inspector of Mines

Other investigators

Neville Atkinson	Inspector of Mines
Matthew Kennedy	Inspector of Mines
Michael Scully	Inspector of Mines
Robert Sherwood	Senior Inspector of Mines
Andrew Smith	Principal Investigation Officer
Paul Sullivan	Inspector of Mines

Report approval

Lead Investigator	Chief Inspector of Coal Mines
Stephen Smith	Peter Newman
s.73 Irrelevant informati	s.73 Irrelevant information
31 August 2019	3 February 2020

1. Executive Summary

At approximately 3:35pm on Wednesday 20 February 2019, s.73 Irrelevant information, an employee at Moranbah North Mine, (MNM), received fatal injuries. s.73 Irrelevant infor injuries occurred during a grader runaway incident in the People and Equipment Drift, (the drift) at the mine. s.73 Irr s.73 Irrelevan was the only witness to the start of the grader runaway.

Defects were contained in the grader brake systems:

1. Excessive wear of the friction material on the park brake discs, such that when the operator applied the park brake, the discs could not prevent rotation of the grader's wheels.
2. The dual circuit pneumatic system that operated the service brakes had a modification in it. The modification had joined the two circuits into a single circuit. Instead of a fault in each circuit being required to make the service brakes ineffective, only one fault was now sufficient.
3. The pneumatic system for the service brakes contained a defective non-return valve. The valve's design purpose was to allow air to travel through the circuit in only one direction. That direction was from the main pneumatic circuit into the service brake circuit. The defective non-return valve allowed air to escape from the service brake circuit into the circuit used for starting the engine.

The park brake is a failsafe design. It is spring applied and air released. If the brake pneumatic circuit develop defects that release the air, the spring applies the brake.

The grader's service brakes are not a failsafe design. They are air applied and spring released. If the brake pneumatic circuit develops defects that release the air, the springs release the brakes.

A design feature of this grader, is that when the operator sets the park brake, the pneumatic system sends air to the service brakes and sets them as well.

The supplier had provided MNM technical information that accurately described the design and operation of the grader braking systems. That information included a testing procedure for the park brake system.

The MNM risk management process did not identify that the park brake testing procedure they had been provided with could fail to identify defects in the park brake system.

As a result, MNM did not effectively test the park brake system. As the park brake system also applied the service brakes, the brake test could not determine the condition of the park brake. This could lead to the grader remaining in service with a worn out park brake.

A worn out park brake, when combined with the modification to the brake pneumatic circuitry and the defective valve in that circuitry, meant the only requirements for an uncontrolled runaway of the grader, was a slope and the loss of pneumatic energy from the service brake circuit.

When the grader engine shut down in the drift on 20 February 2019, the grader was on a slope of 1:8 and the production of pneumatic energy for the service brake circuit ceased. If sufficient air discharged from the brake circuit while the engine was off, the service brakes would release and no longer hold the grader stationary in the drift.

The service brakes did release and the grader rolled away down the drift. s.73 Irrelevant info received fatal injuries in the area of the drift between where the grader started to run away, and the place the first responders found him, near manhole 30. The grader then collided with a Driftrunner transporting coal mine workers, injuring some of them.

Inspection and testing has provided a scenario for how sufficient air could discharge from the brake circuits to release the service brakes.

That scenario is that s.73 Irrelevant in attempted to start the grader's engine.

Testing has shown that one unsuccessful attempt to start the engine may consume sufficient air to allow the service brakes to start to release. A second unsuccessful attempt further reduces air pressure, allowing the springs to almost completely release the service brakes. Any use of the brake foot pedal while the engine is not running, also releases air.

The investigation has identified the available energy sources to cause the injuries to s.73 Irrelevant inf were:

- An impact from the runaway grader,
- A fall from height off the grader,
- Being caught between the drift wall and the grader
- A combination of these.

s.73 Irrelevant inform exact location in the drift when s.7 was injured is not known. They may have occurred during an attempt to access or to exit from the operator's cab. Alternatively, they may have occurred when s.73 Irrelevant in was standing in the drift, due to contact with the grader and the drift surfaces.

Advice from the police service is that s.73 Irrelevant infor injuries did not appear to be due to a grader wheel passing over s.73 Irrelevant inf On s.73 Irrelevant infor clothing and body there was friction damage consistent with being dragged a short distance, indicating that s.73 was moved in contact with the drift floor or wall for a short time.

Investigation Conclusions:

The runaway grader is the only source of energy that was available to cause s.73 Irrelevant infor injuries.

The mines inspectorate investigation identified the following significant contributing factors:

- The park / emergency brake was unserviceable when the grader stopped in the drift.
- A modification made to the service brake pneumatic circuits of the grader defeated a design redundancy installed in the service brakes. The original design had one circuit to supply the brakes on the left hand side drive wheels and another circuit to supply the brakes on the right hand side drive wheels. The modification joined them into a single circuit supplying both left and right hand side service brakes.
- There was a defective "non-return valve" in the service brakes circuit. This defect allowed bi-directional airflow between the service brake circuit and the main pneumatic circuit.

Recommendations:

1. SSEs' should ensure that plant design is considered in every fit for purpose assessment of the plant.
2. SSEs' should ensure their vehicle maintenance personnel are trained in the possible failure modes of each braking system and the actions to take to prevent such failures causing injury.
3. SSEs' should ensure their vehicle operators are trained in the possible failure modes of each braking system and the actions to take to prevent such failures causing injury.
4. SSEs' should ensure that the brake testing procedures used by vehicle operators and maintainers, test the serviceability of each brake system.
5. SSEs' should ensure the risk management processes used by the mine are identifying and controlling all the hazards involved in the operation and maintenance of equipment.
6. SSEs' should ensure that modifications made to equipment are risk assessed, managed, recorded and communicated.
7. SSEs' should ensure SSEs should ensure the instructions in their procedures are suitable for all foreseeable circumstances that operators encounter and are compatible with equipment capabilities.
8. SSEs' should ensure that they have a process to review technical bulletins for plant and apply the findings to any potentially affected plant items at the mine.
9. Equipment suppliers and service providers should ensure they have robust processes in place to communicate to industry all the hazards they have identified.
10. SSEs' should ensure that when there is the possibility of interaction between pedestrians and vehicles in a drift, recessed manholes are installed in the drift.

2. Contents

3. Jurisdiction

s.73 Irrelevant information received fatal injuries[1], in an accident in the People and Equipment drift, (the drift), at Moranbah North Mine, (MNM), a coal mine, as defined by section 9 of the Queensland Coal Mining Safety & Health Act 1999, (CMSHA 1999).

Investigation of serious accidents at a coal mine is a function of Inspectors of Mines, specified in section 128 of the CMSHA 1999.

Section 199 of the CMSHA 1999 requires that as soon as practicable after receiving a report of a serious accident causing death at a coal mine, an inspector must inspect the place of the accident, investigate the accident to determine its nature and cause, and report the findings of the investigation to the chief inspector.

4. Incident Location and time

- Date: 20 February 2019.
- Time: 3:35pm (approximately).
- Location: People and Equipment drift,
- Mine: Moranbah North Mine,
- Mining Lease: ML 70108.

5. Details of the deceased

Name	s.73 Irrelevant information
Date of Birth	
Age	
Residential address	
Occupation	Coal Mine Worker
Employer	Moranbah North Mine
Cause of Death	TBA

1 Autopsy report

6. Persons named in the report

Name	Occupation	Company
s.73 Irrelevant information	Coal Mine Worker (deceased)	MNM
	Mine Technician	MNM
	Mine Technician (injured)	MNM
	Fitter Development (injured)	MNM
	Coal Mine Worker (injured)	MNM
	Mine Technician	MNM
	Electrical Shift Engineer	MNM
	Electrician (injured)	Black Rock Blue
	Owner's Representative	Anglo Coal (MNM)
	Mine Technician (injured)	MNM
	Maintenance and Engineering Manager	MNM
	Mine Technician (injured)	WorkPac
	Paramedic	Verifact Health Security
	Belt Fitter	Mastermyne
	Explosion Risk Zone Controller	MNM
	Mechanical Engineering Manager	MNM
	Site senior executive	MNM
	Mine Technician (injured)	MNM
	Explosion Risk Zone Controller	Mastermyne
	Mine Technician (injured)	MNM
Neville Atkinson	Inspector of Mines - Electrical	DNRME
Keith Brennan	Inspector of Mines - Mining	DNRME
Matthew Kennedy	Inspector of Mines-Mechanical	DNRME
Leslie Marlborough	Regional Inspector of Mines	DNRME
Michael Scully	Inspector of Mines-Mechanical	DNRME
Robert Sherwood	Senior Inspector of Mines - Mining	DNRME
Andrew Smith	Principal Investigations Officer	DMRME
Stephen Smith	Inspector of Mines – Mining	DNRME
Paul Sullivan	Inspector of Mines – Electrical	DNRME

7. Abbreviations used in this report

Description	Abbreviation
Moranbah North Mine	MNM
People and Equipment Drift	Drift
Mine Grader 002	GR002
Load Haul Dump	Loader
Coal Mine Worker	CMW
Injury Management Officer	IMO
Control Room Operator	CRO
ImPact Communications Appliance	ICA
Radio Frequency Identification	RFID
PPK Mining Equipment Pty Ltd	PPK
KGB Diesels	KGB
Diversified Mining Services	DMS
Anderson Mining Services	AMS
Mining Lease	ML
Queensland Ambulance Service	QAS
Queensland Police Service	QPS
Department of Natural Resources Mines and Energy	DNRME
Inspector of Mines	IOM

8. Mine Details

8.1. Authorities/licences/tenures involved

Tenure Holders[2]	Moranbah North Coal Pty Ltd	88%
	NS Moranbah North Pty Ltd	5%
	Mitsui Moranbah North Investment Pty Ltd	4.75%
	NS Coal (Moranbah North) Pty Ltd	1.25%
	JFEMA Moranbah North Pty Ltd	0.50%
	Shinso Moranbah Coal Pty Ltd	0.50%
Mine Operator	Anglo Coal (Moranbah North Management) Pty Ltd	
Operator's Representative	s.73 Irrelevant information	
Site Senior Executive	s.73 Irrelevant information BoE certificate - SSE s.73 Irrelevant	
Mining Tenures	ML 70108	

8.2. Mine Location

Moranbah North Mine, (MNM) is located 211 kilometres by road southwest of Mackay and 21 km from the town of Moranbah.

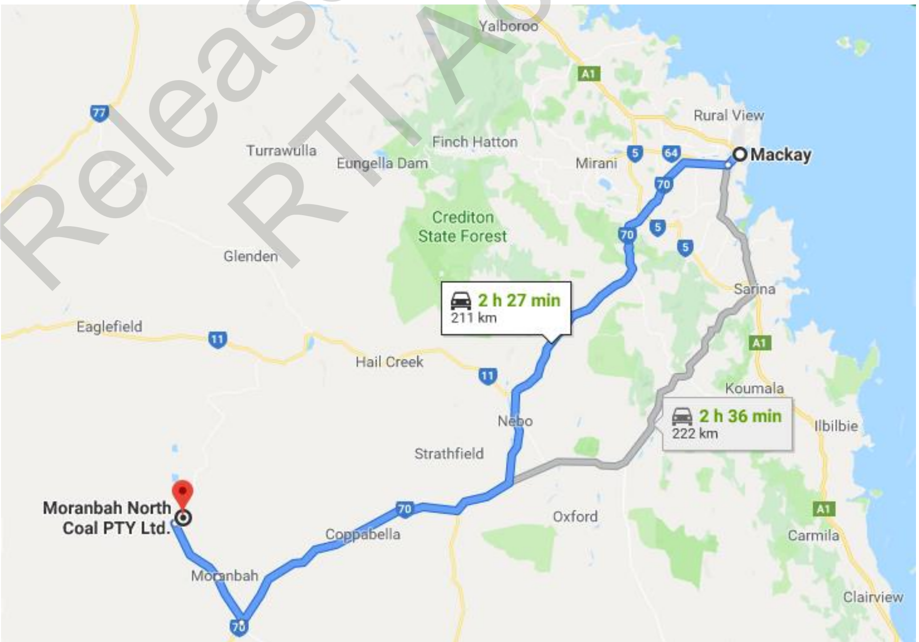

Figure 1. Moranbah North Mine location

2 DNRME Lotus Notes

9. Incidents

9.1. Incident Locations

The drift at MNM is a tunnel that connects the surface to the underground workings. It has an arched profile, see figure 1, and its dimensions are approximately 6.0 metres wide, 4.8 metres high in the centre of the arch and 925 metres in length. The average grade is 1 in 8, (12.5%)[3]. The floor is concrete, to provide a running surface for vehicles.

There are lights at regular intervals in the arch ceiling to improve visibility. When looking downhill from the surface, along the left hand wall of the drift, spaces called manholes, see figure 6, are cut into the tunnel wall, at intervals averaging 18 metres apart. Manholes provide a refuge for pedestrians to stand in and allow vehicles to travel past them without risk of contact. Numbering of manholes is in consecutive order, starting with "1", which is nearest to the surface entry into the drift.

The following photographs provide some context for locations relevant to the accidents described in this report.

Figure 2: Moranbah North Mine Drift Entry

3 MNM Drift Services 19-30CT

Figure 3: View up the drift towards the surface from near manhole 36.

(Services pipes, including air and water, are in the top right quarter.)

Figure 4: View down the drift from manhole 22

(A Driftrunner in the right foreground.)

Figure 5: View to the portal up the drift from manhole 22

(Access to water and air services are next to the sign)

Figure 6: View of manhole 20

(Access to water and air services are next to the sign)

The times used in this report come from an analysis of data captured by MNM's active radio frequency identification, (RFID) tracking system.

The tracking system relies on active RFID Wi-Fi transmitters carried by personnel's ICCL Cap Lamps and attached to underground vehicles and implements. The Wi-Fi Tags continuously transmit signals detected by the Wi-Fi network. The Wi Fi system forwards the signals to the ImPact Communications Appliance, (ICA) for processing. The ICA is the control system for the Wi-Fi network and runs on a computer server, which will typically be physically located in the server room.

A location engine is a computer program used to determine where each tag is on the site in real time. Algorithms in the ICA location engine analyse the signals received by the access points and calculate the location of each tag. That data creates movement logs, displayed on mine plans on monitors in the Control Room.

Location data is input into the MineDash system. MineDash is a browser application, hosted on the ICA, which provides an integrated end user view of tracking, voice communication and vehicle data collection from the ICA system.

In the drift, antennas located near the top and bottom of the drift receive the signals from the RFID's (cap lamps and vehicles.). This information is processed and depending on the signal strength and the location of the antenna receiving the signal, a calculation made as to the location of the RFID.

This calculation can place an RFID at different parts of the drift within seconds. This makes an exact pin pointing of the tag inaccurate and is a guide only. Sometimes the antennas do not pick up a signal at all (as demonstrated by Loader DL15 which was not picked up in the drift but was detected underground and then at the portal).

9.2. Fatal Incident - Runaway Grader

At 3:27pm, s.73 Irrelevant inf driving grader GR002, entered the bottom of the drift, headed for the surface. The grader travelled as far as manhole 22 or 20, see figures, 4, 5 and 6, where it stopped and s.73 Irrelevant inf dismounted. This was about 3:31pm.

At 3:30pm, s.73 Irrelevant informatio operating loader DL15, entered the drift from the mine workings to drive to the surface. As s.7 travelled up the drift, s.73 Irrelevant in saw a vehicle stopped on the left hand side of the drift roadway. No machine lights were visible on the stopped vehicle.

s.73 Irrelevant inf saw a person moving at the rear of that vehicle. The person walked across the drift to where the air and water services taps are located and signalled to s.73 Irrelevant in to drive past. The person stepped into a manhole, clear of the roadway.

When s.7 reached it, s.73 Irrelevant in recognised the machine as the grader and the person to be s.73 Irrelevant inf s.73 recollection of the place in the drift is that it was at or near manhole 22 or 20.

s.73 Irrelevant i stopped and asked s.73 Irrelevant inf if s.73 was okay. s.73 Irrelevant in told him s.73 was. could not hear the grader engine running and saw none of the grader lights operating. s.73 Irrelevant in continued driving up the drift and out of the mine. s.73 saw no other moving or stationary vehicles in the drift. s.73 Irrelevant i reached the surface at 3:37pm[4][5].

After s.73 Irrelevant i had driven past, the grader commenced rolling down the drift. s.73 Irr s.73 Irrelevai was the only witness to the commencement of the grader runaway event.

s.73 Irrelevant inf received fatal injuries during the grader runaway event.

9.3. Secondary Incident – Vehicle Collision

At 3:34pm on 20 February 2019, Driftrunner, unit DR029, driven by s.73 Irrelevant with s.73 Irrelev s.73 Irre in the front passenger seat and nine passengers in the rear compartment, entered the bottom of the drift headed for the surface.[6]

The Driftrunner started overheating so s.73 Irrelev stopped on the right hand side of the drift, (looking up), near manhole 36, to access water to cool the overheating engine. s.73 Irrelev got out of the vehicle to get the water. While s.73 Irreleva was doing this, s.73 Irreleva saw a vehicle parked on the left hand side of the drift, a distance s.73 estimated to be about 100 metres further up the drift towards the surface. No lights were showing on the vehicle.

Shortly after, and from that same direction, s.73 Irreleva saw sparks and a cloud of dust, heard a loud noise and saw what appeared to be a wheel coming down the drift towards him. s.73 Ir s.73 Irre told s.73 Irreleva to get out of the drift roadway and into the manhole. s.73 Irrelevan did so and s.73 Irrelevan told the passengers in the back to brace themselves for a collision.

s.73 Irreleva saw the loose wheel approaching and the grader following it. The grader collided with the Driftrunner and the two machines slid down the drift, see figure 7, stopping near to manhole 37.[7] [8]

When the machines had stopped moving, s.73 Irreleva climbed out the passenger window of the Driftrunner and checked on the passengers in the rear compartment. s.73 I saw an injury to one passenger and other passengers holding their necks. s.73 instructed the uninjured passengers to secure both vehicles with wheel chocks and to attend to the injured passengers. s.73 Irreleva removed wheel chocks from the grader and the Driftrunner to secure the two vehicles.

No operator got off the grader after the collision. The grader engine was not running, nor were its lights operating.[8]

4 Data Analysis spreadsheet - rows 112, 129, 117, 3

5 ROI s.73 Irrelevant - pgs 5, 6

6 Data Analysis spreadsheet - rows 7, 70.

7 ROI s.73 Ir - pgs 5-7

8 ROI - pgs 5-7

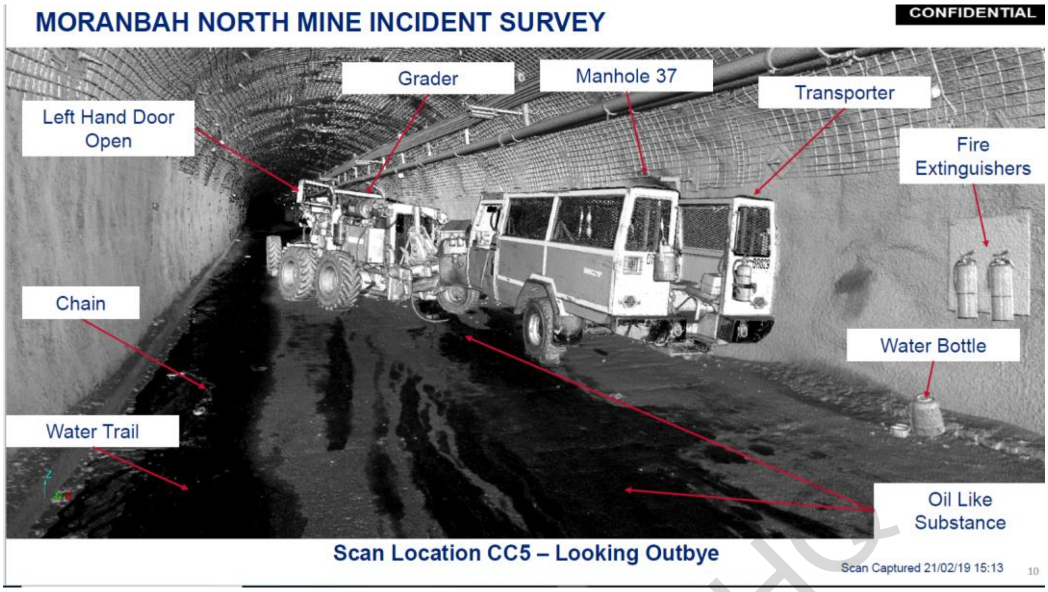

Figure 7: Showing final position of GR002 and DR029 at 37 manhole

(Provided by MNM)

s.73 Irrelevan looked up the drift and saw a light and a shape on the floor of the drift, a distance s.73 estimate s.73 be approximately 100 metres uphill. With some of the Driftrunner's passengers, s.73 went to investigate. As they walked uphill, s.73 Irreleva8 used s.73 mobile telephone to contact the mine Control Room Operator, informed s.73 I of the emergency and asked for the site ambulance to attend.

They found s.73 Irrelevant inf lying on the ground on the left hand side of the drift, near to the manhole 30 location[9]. s.73 Irrelevant inf was lying with s.73 head downhill and was unresponsive.

s.73 Irrelevar gave s.73 phone to a coal mine worker and instructed s.73 I to continue relaying information to the Control Room Operator. s.73 assessed s.73 Irrelevant inf while s.73 Irrelev s.73 Irrelevant info took notes of the assessment observations.

s.73 Irrelevan assessment found s.73 Irrelevant inf to be unresponsive, to have a swollen tongue, no pulse or respirations. s.73 Irreleva and others turned s.73 Irrelevant in to position s.73 head higher up the drift than s.73 feet and s.73 Irrelev used a pen to clear s.73 Irrelevant infor airway. s.73 Irreleva commenced Cardio Pulmonary Resuscitation, (CPR). When s.73 ommenced CPR, s.73 Irrelevar noticed internal injuries were already present in s.73 Irrelevant infor chest.

The mine ambulance arrived at the scene with s.73 Irrelevant in, s.73 Irrelevant informatio and s.73 Irrel s.73 Irreleva who assisted with the first aid for s.73 Irrelevant in. Not long after, s.73 Irrelevant informa, the Injury Management Officer, (IMO), arrived at the incident scene in another vehicle. After assessing s.73 Irrelevant infor condition, s.73 Irrelevant arranged to transport him to the surface in the ambulance.

9 ROI s.73 Irreleva pgs 8-9

10. Emergency Response

3:38pm: The Control Room Operator[10] received an emergency call informing of an accident involving a Driftrunner and a Grader in the drift. s.73 Irrelevant inf was receiving CPR from s.73 s.73 Irrele

3:44pm to 3:45pm: The Control Room Operator instructed s.73 Irrelevar to take the Mine Ambulance underground. The ambulance, driven by s.73 Irrelevan carrying s.73 Irrele and s.73 s.73 Irrelev as passengers, left the surface and went to the accident scene.

s.73 Irrelevant ir, the IMO, after hearing the emergency call over the intercom went to the mine Control Room. The Control Room Operator was busy on the telephone and s.73 Irrelevant i overheard there had been an emergency involving a vehicle.

s.73 Irrelevant returned to the first aid room and commenced preparing to go underground. When s.73 went to the go line, s.73 I found the ambulance was not there.

3:45pm to 3:58pm: s.73 Irrelevant i went to the workshop and got a lift in a Driftrunner down the drift to the incident scene.

On s.73 arrival, s.73 Irrelevant i observed s.73 Irrelevant ir lying on the floor and CPR underway and went to assist. s.73 Irrelevant i observed s.73 Irrelevant inf was unconscious and not breathing.

s.73 Irrelevant i asked if there were any signs of life and was told "no". During the CPR s.73 Ir s.73 Irrele noted s.73 Irrelevant inf was not getting effective ventilation, due to an obstructed airway and what appeared to be "flail chest".

s.73 Irrelevant i arranged to move s.73 Irrelevant inf into the ambulance, placed the defibrillator pads onto s.73 Irrelevant inf checked for a pulse and found none. CPR continued on s.73 Irrelevant infor while the ambulance reversed out of the drift and went to the first aid room.[11]

3:58pm: Queensland Ambulance Services, (QAS), arrived at the first aid room and took over the care of s.73 Irrelevant info continuing with CPR.

4:20pm: QAS Paramedic[12] declared s.73 Irrelevant inf deceased.

10.1. Other injured Coal Mine Workers

Several of the passengers travelling in the Driftrunner received a first aid assessment from the QAS personnel at the mine, some were transported to hospital for further assessment or treatment. They were:

- s.73 Irrelevant inform
-
-

10 MNM Control Room Log

11 ROI s.73 Irre - pgs 7-13

12 Queensland Ambulance Service- electronic Ambulance Report Form

- s.73 Irrelevant inform

Other passengers have since reported mental health injuries, following the accidents:

- s.73 Irrelevant information
-
-
-

11. Notification of the Incidents

s.73 Irrelevant informatio Senior Site Executive for Moranbah North Mine contacted Leslie Marlborough, Regional Inspector of Mines by telephone.

s.73 Irrelevant in reported that:

> *"At approximately 16:00 pm on 20 February 2019, a Driftrunner (man transporter) with 10 passengers was driving up the drift on the way out of the mine. A Grader was travelling down the drift in the opposite direction. A collision occurred between the two vehicles. Three people in the Driftrunner have injuries, not believed to be serious at this time. It is believed the grader operator had suffered a heart attack. The Grader operator was taken to the surface where* s.73 *eceived treatment from the paramedic and had subsequently passed away*[13]*."*

12. Notification of next of kin

Officers from the Queensland Police Service informed s.73 Irrelevant infor next of kin.

13 Death of Coal Mine Worker at Moranbah North Mine

13. Equipment Involved

13.1. Mine Grader

Figure 8: Anderson Wright Mine Grader GR002

Photo taken at Torque Enterprises

The Anderson Wright Mine Grader is a modified version of a Caterpillar 120G Grader for use in underground coal mines to maintain the roadways.

Figure 9: Side view of GR002

Taken during 2015 PPK rebuild

13.2. Driftrunner

Figure 10: Example of an SMV Driftrunner

The model shown is a personnel transport, of a design similar to the one involved in the collision with the runaway grader. That Driftrunner had seating capacity for nine passengers in the rear compartment, plus the driver and a passenger in the front compartment.

14. Investigation

14.1. Investigation Activities

The following is a list of investigative activities carried out by the mines inspectorate to date:

- Inspections of the incident scene
- Photography of the incident scene
- Collection and review of the mine's SHMS documentation, this included:
    - Training records
    - Supervision appointments
    - Work procedures / instructions
    - Maintenance records
- Interviewed witnesses and other relevant people
- Examination and testing of grader GR002

14.2. Accident Timelines

Time	Activity
5:00am	Shift pre-start meeting conducted and attended by s.73 Irrelevant info
6:30am	s.73 Irrelevant info completed pre-start on GR002
6:49am	GR002 departs workshop go-line
7:00am	GR002 enters portal of drift
7:08am	GR002 arrives D Hdg Mains
7:54am	GR002 arrives MG604
10:08am	GR002 departs MG604
10:50am	GR002 arrives Mains 3
1:14am	GR002 departs Mains 3
1:20pm	GR002 mains 1 and 2 roadworks
3:25pm	GR002 D Hdg 2-4 c/t
3:27pm	GR002 enters drift
3:31pm	GR002 stops at 22 manhole
3:33pm	DL15 operated by s.73 Irrelevant in passes GR002 at 22 or 20 manhole and confirms s.73 Irrelevant i is "ok"
3:34pm	Driftrunner DR029 enters drift
3:35pm	s.73 Irreleva stopped Driftrunner DR029 at 36 manhole to cool the radiator down and noticed a vehicle outbye in drift.
3:34-3:36pm	GR002 begins to roll down drift
3:36pm	s.73 Irrelevan observes sparks and dust immediately followed by a tyre and the grader. s.73 Irreleva instructs s.73 Irreleva to move into manhole and personnel in the Driftrunner to brace for impact.
3:36pm	Grader contacts front of Driftrunner pushing it backwards from MH36 to MH37
3:37pm	DL15 operated by s.73 Irrelev leaves the drift
3:38pm	s.73 Irreleva and CMW's leave the Driftrunner and check on injured CMW's.
3:38pm	s.73 Irreleva calls an emergency on the mine two way radio to Control
3:41pm	Mine ambulance enters drift
3:46pm	Driftrunner enters drift with IMO on-board
3:48pm	IMO s.73 Irrelevant i assesses s.73 Irrelevant inf and instructs CMWs to transport s.73 Irrelevant inf to the surface
3:55pm	Ambulance exits drift and transports s.73 Irrelevant in to medical treatment room
4:01pm	QAS arrives onsite and takes over treatment of s.73 Irrelevant inf
4:20pm	QAS Paramedic declared s.73 Irrelevant in deceased
4:35pm	QPS notified of incident
5:30pm	QPS arrive and take control at the incident scene
10:30pm	QPS release the scene to Inspector of Mines Keith Brennan

14.3. Pre runaway

The prestart inspection card for GR002[14] completed by s.73 Irrelevant inf and the log kept by the CRO has s.73 Irrelevant in reporting that s.73 completed the prestart inspection at 6:30am. There is no record in the log of s.73 Irrelevant inf reporting any defect on GR002 at that time. The sections for brake checks on the prestart card are not marked in a manner that might indicate a defect existed.

s.73 Irrelevant inf serviced the grader at the surface fuel bay and departed underground.

During the course of s.73 shift, s.73 Irrelevant in operated the grader in the following areas of the mine:

- 604 MG
- B Hdg to 81 C/T
- D Hdg to 59 C/T
- East Mains.

s.73 Irrelevant info entered the drift on the grader at 3:27pm and headed towards the surface. The grader stopped near manhole 22 or 20 and s.73 Irrelevant inf dismounted. s.73 Irrelevant i spoke with s.73 Irrelevant inf near the stopped grader. At that time, s.73 Irrelevant info had no injuries and did not request assistance.

14.4. Grader runaway

An estimate for the time the runaway of GR002 commenced is between 3:34pm and 3:36pm. The RFID system has s.73 Irrelevant ir entering the drift at 3:30pm. The estimated time for the loader to travel to manhole 20 or 22 is 4 minutes. The grader's collision with the Driftrunner was at 3:36pm. Two minutes is sufficient time for GR002 to move under gravity between manhole 20 or 22 to manhole 36.

14.5. Post collision

After the collision, the Driftrunner's passengers did not see s.73 Irrelevant inf dismount from the grader. They found him near manhole 30, uphill about 140 metres from the collision point. It is a location unlikely to have been the result of the forces involved in the collision with the Driftrunner.

s.73 Irrelevant inf was about 130 metres downhill from manhole 22. When found, s.73 Irrelevant info was not breathing, had no pulse, was unresponsive and appeared to have chest injuries.

After s.73 Irrelevant i went past GR002 in the loader, the grader was the only vehicle that moved through the part of the drift where the mine personnel found s.73 Irrelevant infor

Examination of the grader at the incident scene found:

1. The operator's cab canopy door open, see figure 11

14 Prestart Grader 002

2. Rope around the handle, see figure 11
3. The park brake button in the engaged position, see figure 12
4. The run/stop toggle switch in the run position, see figure 13
5. The transmission lever in the neutral position, see figure 14
6. The implements in the travel position,
7. The seat belt joined, see figure 15
8. A length of hose attached to the air fill point with the valve in the receiver charging position, see figure 16. There was no coupling fitted to the free end of the hose.

Figure 11: Open canopy door

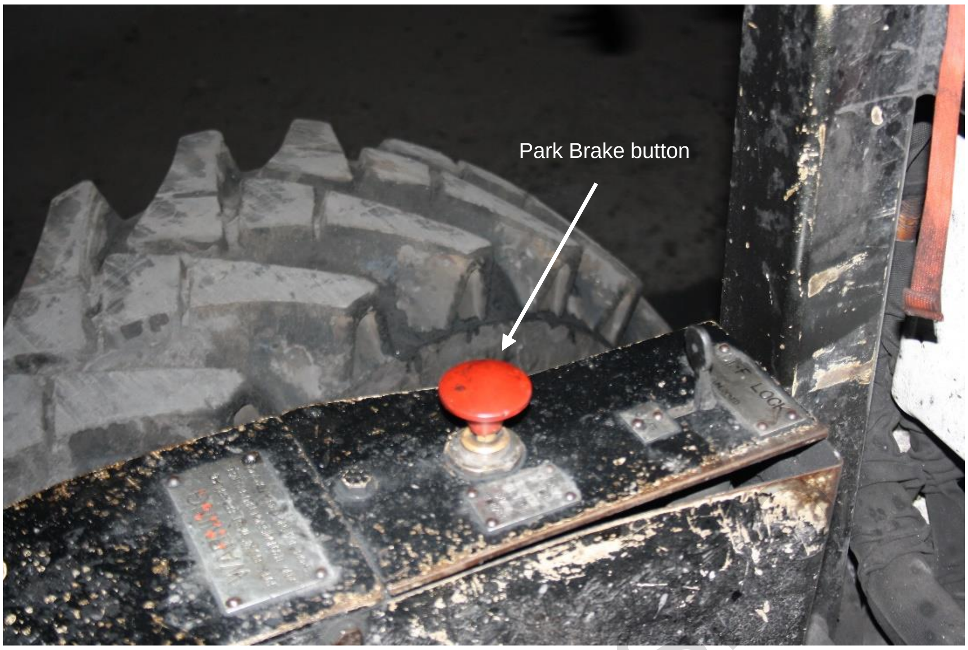

Figure 12: Park Brake Button engaged

Figure 13: Run stop switch in the run position

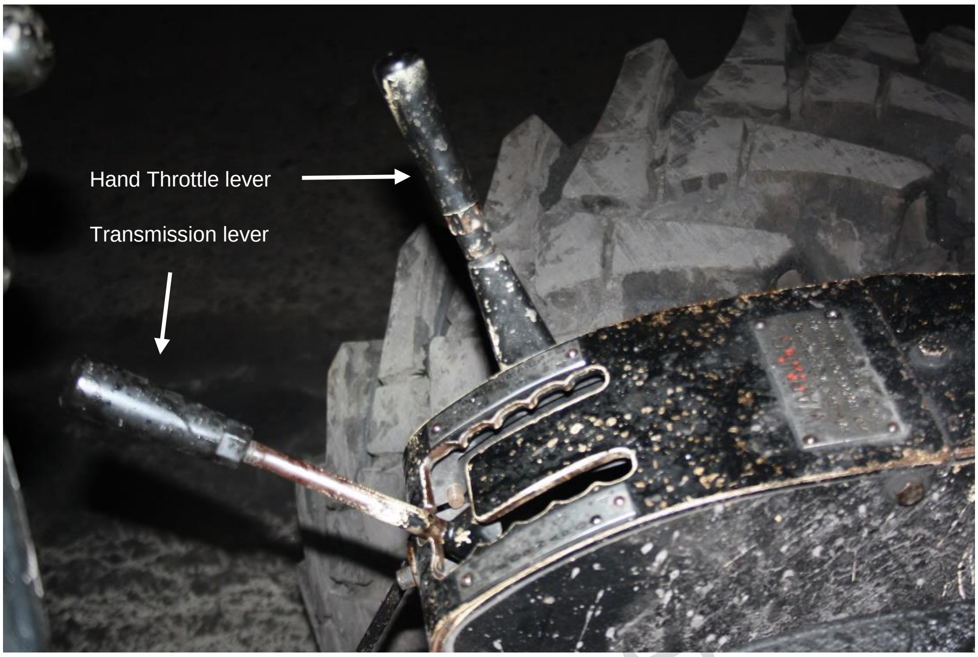

Figure 14: Transmission lever in the neutral position

Note: The other lever is a hand throttle

Figure 15: Seat belt fastened

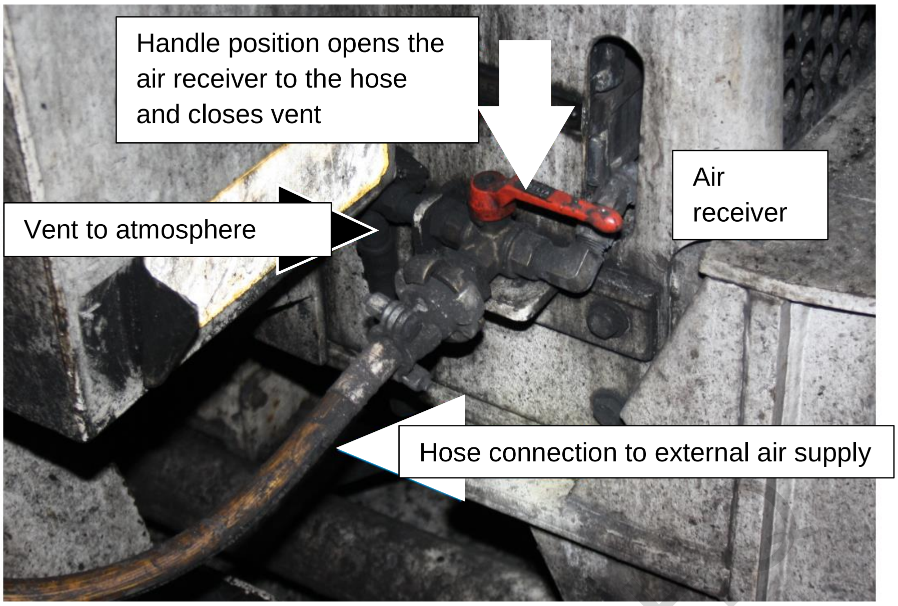

Figure 16: Hose attached to air fill point with valve open to the receiver

14.6. Movement of the Grader

For some or all of the distance it travelled during the runaway, s.73 Irrelevant inf was not at the grader controls and the grader engine was not running.

It is certain that the grader was a driverless, runaway machine from near manhole 30 to the collision point with the Driftrunner.

No witnesses saw the grader's lights operating immediately before, during or after the runaway. The engine must be running for the grader lights to operate. It is essentially impossible for the operator to release the park brake without the engine running. No hydraulic functions operate without the engine running.

The conclusion is that the engine was not the energy source responsible for the grader's movement down the drift.

Gravity is the only energy source left to move the grader down the drift. There are limited possibilities to explain the runaway movement of the grader due to gravity.

1. A loss of friction between the grader tyres and the drift surface, allowing gravity to move the grader down the drift.
    a. There was no evidence in the drift that supported this scenario.
2. The presence of defects in the grader braking systems allowing gravity to move the grader down the drift.
    a. The results of the examination and testing of the grader following the runaway support this scenario.

When the engine is not running, for the grader to move under the influence of gravity, the following conditions must be satisfied:

1. The park brake must be unserviceable, and
2. The service brakes must be:
    a. unserviceable, or,
    b. have insufficient air pressure available to keep them applied.

15. GR002 Braking System

A fault, or faults in the braking system is the only feasible cause of the runaway of the grader. Consequently, the scope for the examination of the grader has focused on the braking systems.

15.1. Service Brakes (foot brake)

Each of the four drive wheels has a brake unit fitted to it. They are end mounted and made up of multiple disc plates that are oil immersed for cooling during use. The operator applies the brakes using air pressure. The pneumatic circuits are operated using a foot pedal that controls a dual section, forward modulating, treadle valve.

The treadle valve is supplied from an air receiver that is split into two (x2) sections (dual). Each side of the air receiver supplies compressed air to one section of the brake treadle valve, which then supplies compressed air to the two (x2) brake units attached to the two drive wheels on that side of the machine.

Pressing the foot pedal delivers air pressure to the brake units and applies the brakes. When the operator releases the foot pedal, a spring automatically releases the brakes from each drive wheel. This design is not fail to safe. Faults in the pneumatic circuit may prevent the foot pedal applying the brakes, see figure 17.

A feature of the brake system design is one pneumatic circuit operates the left hand side, service brake units and a second pneumatic circuit operates the right hand side, service brake units. This is to prevent a fault in one circuit causing a total loss of service brake operation.

Figure 17: Cab side view showing the foot pedals – accelerator and brake

15.2. Park/Emergency Brake

The park / emergency brake is fitted in the transmission housing, see figure 22. It is a multi-disc, oil immersed, failsafe brake system. A spring applied, air release actuator, externally mounted to the final drive is used to engage the internal brake system. A connecting rod and two clevis pins attach the actuator to the internal multidisc brake. The spring applied function fulfils the failsafe criteria.

In normal operation, there are gaps present between the brake friction discs; these allow the transmission to rotate the drive wheels unimpeded by the brake. When engaged, the brake friction discs clamp together to prevent the rotation of the transmission and the drive wheels.

The park brake design has sufficient capacity to hold the grader stationary in the drift for an indefinite period.

The location in the transmission prevents a physical condition inspection of the park brake or measurement of the clearances between brake discs. There is no access to the park brake components in the transmission without the removal of the engine and transmission from the grader.

The operation of the park brake is by:

- A push / pull button in the grader operator controls, see figures 18, 19
- An interlock in the driver's door
- Conditions that activate the engine safety circuit system to protect the engine
- Engine shutdown by the operator

Figure 18: Side view - operator's seat and red park brake button

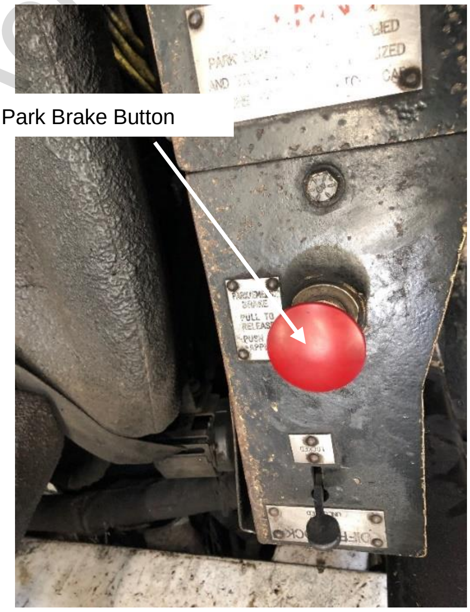

Figure 19: Park brake button

The engine must be running and supplying compressed air before the operator can release the park brake.

15.3. Secondary Emergency Braking System

A secondary feature of the park / emergency brake system design is that when the park brake is applied, the service brake dual air receiver sends air to the four service brake units. This means that activating the park brake automatically activates the service brakes as well.

The service brakes will stay activated as long as there is sufficient air pressure in the brake air receiver. If the receiver's air pressure decays for any reason, the springs will eventually release the service brakes.

16. Examination of Grader GR002

Inspectors of Mines Michael Scully and Matthew Kennedy directed the testing and inspection of Grader GR002, conducted at Torque Enterprises in Mackay. Torque Enterprises full report is attached[15].

Initial inspection of the grader found the following:

- Fluid levels were within operating limits, (oil, coolant, exhaust scrubber water),
- Fuel level was within operating limits,
- The service brakes in the released position,
- The park brake in the applied position,
- Zero air pressure in the pneumatic circuits.

Initial testing of the grader found:

- The lights on the grader were operational when the engine was running.
- The service brakes could hold the grader stationary on a grade of 1:8, equivalent to the MNM drift grade.
- The park brake could not hold the grader stationary on a grade of 1:8, equivalent to the MNM drift grade.

The results of further examination and testing were as follows.

15 Torque Report

16.1. Grader Drive Wheels

A drive wheel on the right hand side was detached from the grader during the runaway, see figures 20 and 21. It finished movement on the uphill side of the two vehicles after the collision. Witness marks of an impact were found on the wall of the drift near manhole 33. It is likely that the wheel detachment occurred there. The loss of the wheel unit opened the pneumatic circuit supplying the service brake units to atmosphere.

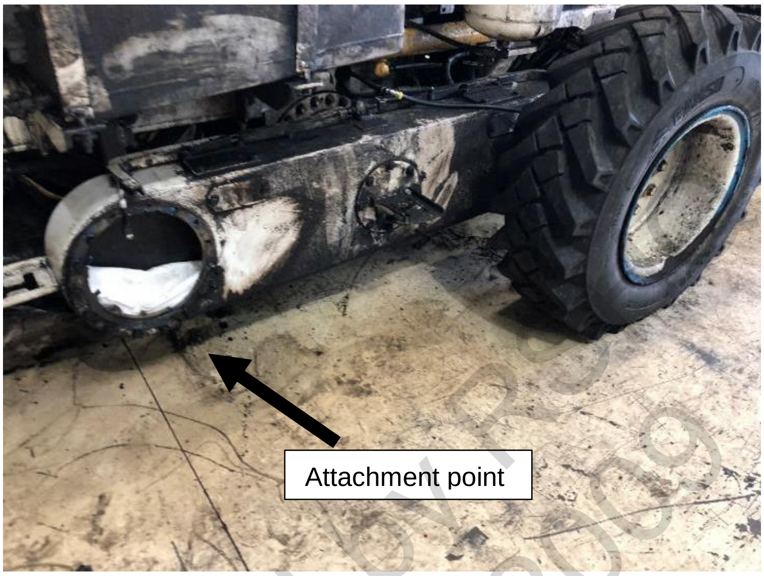

Figure 20: Drive wheel attachment point

Figure 21: Drive wheel found after collision

16.2. Transmission mounted park/emergency brake

During initial testing, the park / emergency brake had no retarding effect on the movement of the grader drive wheels.

When removed from the transmission housing, a physical inspection found sufficient wear on the brake components to explain the lack of any retardation capacity.

The wear on the brake's friction discs is such that when the park brake actuator is at maximum travel, there was still clearance between some of the friction discs and the brake plates. This rendered the park brake unserviceable.

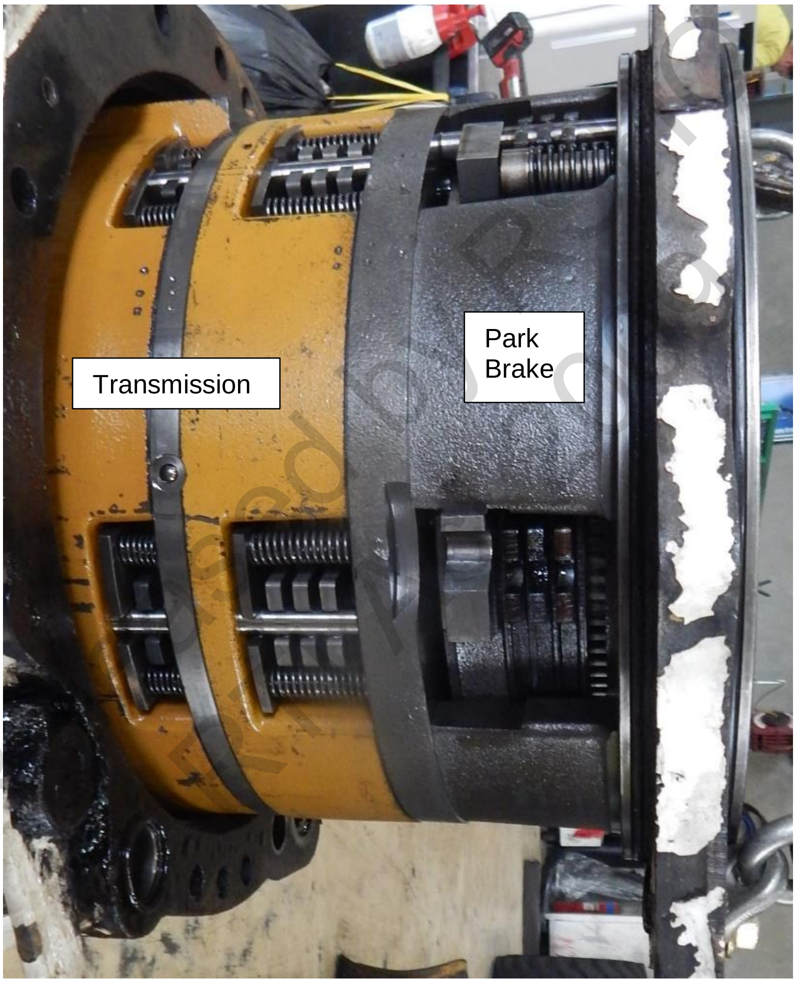

Figure 22: Transmission mounted Park / Emergency brake

16.3. Left Hand Side Brake Dryer/Lubricator

This component removes moisture from the left hand side service brakes pneumatic circuit and adds lubricating oil. Prior to the accident, it was disconnected from the pneumatic circuit and a bypass connection installed, see figure 23.

The method used to bypass it has joined the separate left hand side and right hand side service brake circuits into one circuit. All the service brakes were being supplied from the right hand side dryer/lubricator.

The arrows on the image point to the open fittings of the left hand dryer/lubricator. The hoses can be seen to the left side of the photo, joined together, where they are then connected to the right hand dryer/lubricator.

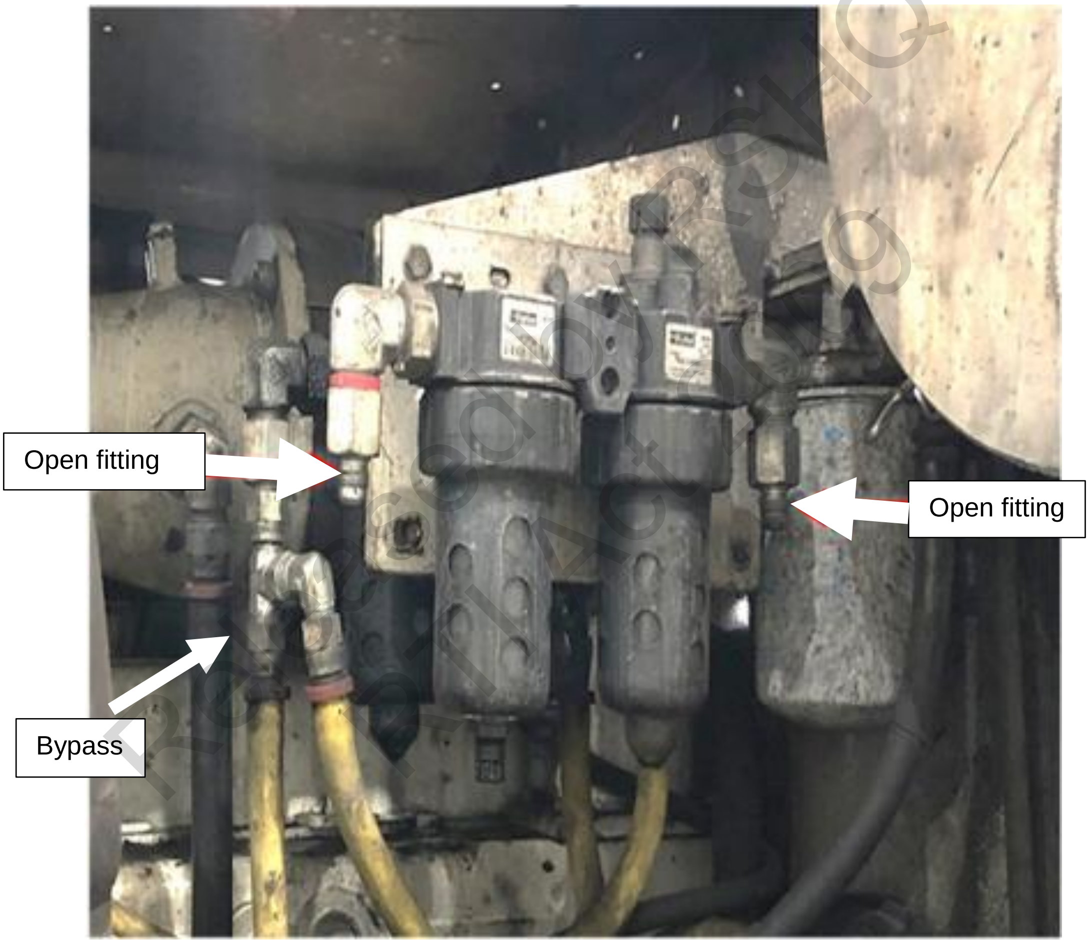

Figure 23: Modification to service brake pneumatic circuits.

All attempts to identify who made the modification and when it occurred have been unsuccessful.

The modification removed a redundancy in the service brake system, installed to reduce the probability of total loss of service brakes. With the air supply to the service brakes on each side of the grader provided by a separate pneumatic circuit, a fault in one circuit could not disable the service brakes supplied by the other circuit. This modification defeated that design intent.

The schematics below illustrate the relevant sections of the pneumatic circuits “as designed” and “as found”.

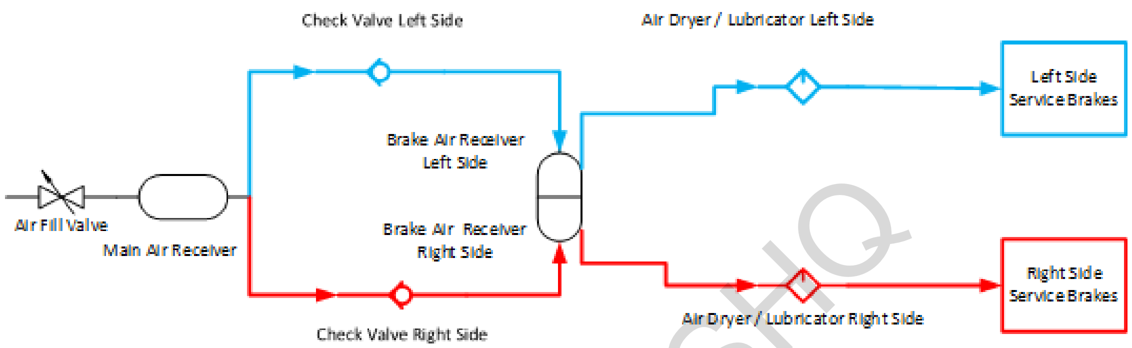

Figure 24: Pneumatic circuit as designed

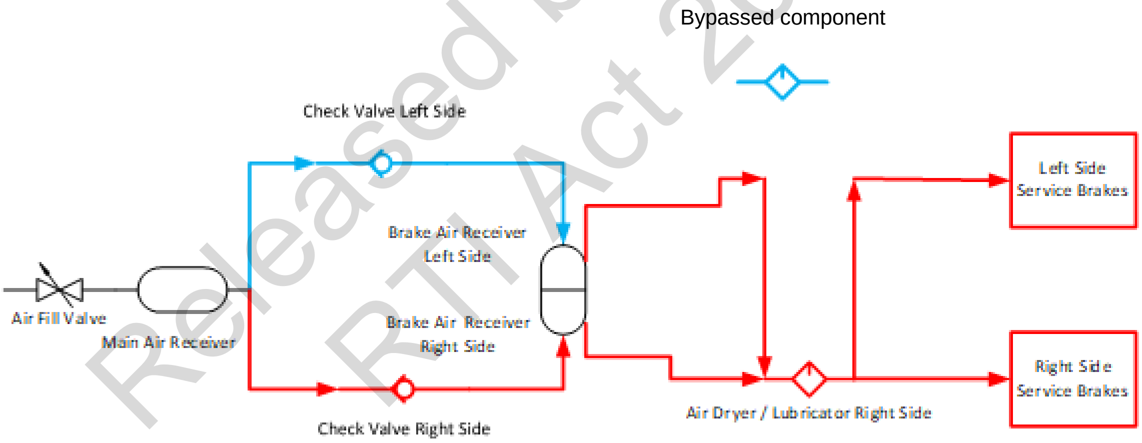

Figure 25: Air Dryer/Lubricator left side bypassed by modification. No evidence modification is authorised. Converts dual circuit into a single circuit.

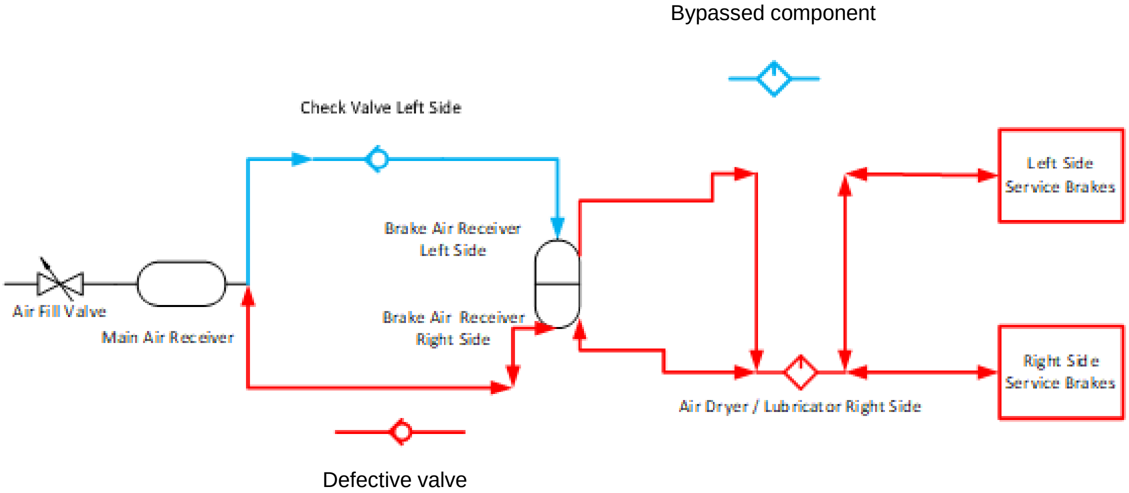

Figure 26: Right side check valve failed in service. Allows air to flow in both directions. Any reduction in main circuit air pressure reduces air pressure in service brakes allowing springs to release brakes.

16.4. Defective check valve

The pneumatic circuit for the right hand side service brakes had a defective one-way check valve in it, between the main air supply and the brake air receiver, see figure 26. The function of the check valve is to allow air from the main air supply to enter the service brake circuit, but prevent air from leaving the brake circuit to enter the main pneumatic circuit. The fault in the valve identified in the testing made the one-way valve into a two-way valve.

The result is the main pneumatic circuit and the right hand side, service brake circuit, are directly connected. If an unsuccessful attempt to start the engine occurred, the air pressure in both the main circuit and the right hand side, service brake pneumatic circuit would fall. Enough reduction in air pressure in the service brake circuit would allow the springs to release the service brakes.

The modification described in 16.3 that joined the two service brake circuits together, meant that an unsuccessful attempt to start the engine reduced the air pressure to the service brakes on both sides of the grader.

16.5. Other reported and observed faults

Witness marks found on the flywheel and ring gear indicate a failure of the gears to mesh correctly during some engine starting attempts. Each start attempt consumes air from the main air receiver. If the gears fail to mesh, attempted engine starts can completely deplete the air receiver.

The faulty check valve described in 16.4, allowed air to leak to atmosphere from the circuit when the engine is off and the run/stop switch is in the “run” position. Over time, this loss of air pressure would allow the springs to release the service brakes without further human intervention. Testing found this took some 30 minutes to occur, depending upon the initial system pressure.

A second bypass found in the main pneumatic circuitry, has removed the main air receiver's dryer/lubricator unit from the circuit. This allows moisture to circulate with the air, which may adversely affect the functioning of circuit components such as check valves. Maintenance records indicate that check valves have required maintenance possibly due to excessive moisture in the circuit.

17. Grader History

17.1. Supplier History

The Wright 120 grader is a modification of a design by Caterpillar, a global equipment manufacturer and supplier. During the investigation, several companies with knowledge of the machine type have provided relevant information. These include:

- Hastings Deering, (Queensland distributer for caterpillar equipment and parts).
- Anderson Industries Pty. Ltd, (AMS), a mining services provider.
- Diversified Mining Services, (DMS), a mining services provider.
- PPK Group, (PPK), a mining services provider.
- KGB Diesels, (KGB), a mining services provider.

Former employees of AMS interviewed, have recalled performing work on these machine types. Recollections included an incident at an AMS workshop, when a Wright 120 grader with the park brake applied, moved uncontrolled in the workshop.

In 2009, privately held company, DMS, merged with AMS's Queensland and NSW based business. A Risk Assessment/FMEA on the Wright 120 grader type dated 2011, by DMS personnel, identified that the brake testing process did not test the park brake in isolation from the service brakes. The hazard identified was the park brake could be faulty and the test would not identify it. The control identified was to install a valve to provide a simple means to test the park brake without the service brakes interfering.

The results of the FMEA was not communicated to MNM. Neither of MNM's graders, GR001 or GR002 are fitted with this test valve. Graders operated by other mines in Queensland are fitted with the test valve, including Grasstree Mine, operated by Anglo Coal (Capcoal Management) Pty Ltd.

In 2012, DMS conducted another Risk Assessment/FMEA on the Wright 120 grader type. This identified that the braking system did not meet the NSW MDG39 Guideline for braking system registration. Draft brake circuit drawings to address this were prepared. Document development ceased at the draft stage. No grader of this type is known to be in operation in NSW. The results of this FMEA was not communicated to MNM.

Publicly listed companies Mastermyne and PPK acquired separate parts of DMS in 2014.

PPK have performed work on both of MNM's graders since 2014, which included a transmission replacement that required work on the park brake.

KGB Diesels have performed work on the park brake system of GR002 at various times since 2012 after MNM purchased it.

17.2. Grader GR002 History

AMS offered grader GR002 for sale to MNM in 2011. MNM purchased the grader directly from Solid Energy in 2012. Prior to it commencing service, MNM sent the grader for a Code D as per AS3584 to KGB.

The grader commenced service at MNM in March 2013. In April 2014, the grader went to KGB for transmission replacement.

In August 2015, MNM sent the grader to PPK, a mining services company, for a complete overhaul and upgrade. This included a request that known safety related upgrades be installed. PPK conducted this work at Tomago, NSW.

In November 2016, MNM again sent GR002 to PPK in Tomago for work that included a transmission rebuild. Westrac rebuilt the transmission and PPK refitted it to the machine.

This is the last recorded time any direct inspection of the internal park brake components occurred.

In May 2018, the grader went to KGB for repairs to park brake components, external to the transmission housing. After completing the work, KGB tested the park brake in isolation from the service brakes. KGB conducted the test by placing the grader on machine stands, isolating the service brakes, applying the park brake and ensuring the drive wheels stopped rotating.[16]

This was the last recorded occasion that physical verification of the park brake operation in isolation from the service brakes occurred.

Maintenance and training documentation held by MNM for the grader includes documents provided by KGB and PPK.

16 s.73 Irr Interview documents

18. Brake systems statutory testing

18.1. Obligations

The MNM safety and health management system must provide for the continued effectiveness of the braking systems on mobile plant at the mine. It must provide for the dynamic testing of service brakes and appropriate testing of parking brakes and emergency brakes.

The MNM maintenance management system schedules weekly testing of the grader brakes.

The design of the braking system permits electronic dynamic testing of the service brakes. A device is fitted to the grader that measures deceleration force. The grader is driven in a specific gear, to a specific speed, the service brakes are applied and the deceleration force is recorded.

The test records for the scheduled dynamic testing performed by MNM on 15 February 2019 prior to the accident show that the service brakes passed the dynamic test[17].

The MNM maintenance management system does not require weekly electronic testing of the park brake. The description in the work order for the brake test requires the tester to apply the park brake and attempt to drive through the brake using 2nd gear. The vehicle should not move. An additional test checks that opening the operator's door engages the park brake button in the cab within 1 – 2 seconds.

The record of the park brake tests performed on 15 February 2019 by MNM show the park brake as passing the tests.

In addition to the scheduled weekly tests, a further opportunity to test the braking system on the grader occurs each time the grader returns to site following off-site maintenance work. All machines returning to the mine from off-site maintenance are taken through what is called the "introduction to site" process.

The records examined for several GR002 introduction to site process performed by MNM show the park brake as passing the tests.

The MNM safety and health management systems requires operators to perform a brake functionality test as part of the pre-operation inspection of the vehicle. The pre-start inspection conducted by s.73 Irrelevant infor on 20 February 2019 has check marks against those items indicating successful completion.

18.2. Testing deficiencies

The testing procedure used by MNM cannot verify the condition of the park brake, unless the service brakes are faulty.

17 GR002 7 Days Mech Inspec offline 20190215

When the park brake is applied, the service brakes automatically engage as well. The service person cannot know if their attempt to drive through the brakes using 2nd gear is prevented by the park brake, the service brakes, or both brakes.

The design of the grader braking system only permits a reliable test of the park / emergency brake components in the transmission housing, when there is a procedure to isolate it from the service brake system.

MNM did not use such a procedure when testing the park brake.

All the MNM test procedure could verify was that the external components of the park brake system activated, such as the door interlock activating the park brake button or the spring actuator for the park brake engaging, provided the tester checked these visually.

A procedure describing how to isolate the park / emergency brake from the service brakes is available in documents supplied to MNM by PPK after the 2015 overhaul. There is no record of the use of this procedure by MNM personnel.

A further deficiency in the testing regime is that there is that no test procedure is in place to verify the performance of the service brakes dual pneumatic circuit system. Such a test is not included in the documentation provided by the suppliers, nor is it mentioned in the MNM risk management documentation.

18.3. Grader braking system maintenance timeline

A timeline of mechanical inspection and testing which included inspection and testing of the braking systems, conducted at the mine is included[18].

18 Mechanical inspection and testing timeline

19. Employment and Training History for s.73 Irrelevant information

19.1. Employment History

s.73 Irrelevant info worked at MNM for a number of years for a labour provider before MNM employed him directly s.73 Irrelev

Date	Activity
14/05/2007	Employed as a s.73 Irrelevant information
15/12/2007	Resigned from s.73 position at the s.73 Irrelevant in
01/11/2008	Employed as a s.73 Irrelevant information
01/04/2009	Employed as a

19.2. Training History

s.73 Irrelevant info received training to operate a grader at MNM several years before GR002 commenced service at MNM in s.73 Irre

Date	Activity
12 May 2006	s.73 Irrelevant inf authorised to operate a grader at MNM
5 January 2012	s.73 Irrelevant inf completed RIIMP0307A Conduct Wheel Operations in U/G Mines- Additional Underground Wheel Grader for MNM
16 February 2017	s.73 Irrelevant inf approved to operate the grader

19.3. Roster / Shifts

On the day of the incident, s.73 Irrelevant in had commenced s.7 third 12-hour shift. [19] There is no evidence that fatigue played any part in the incident.

19 Roster s.73 Irrelev

20. Analysis / ICAM

A systematic safety investigation analysis method called Incident, Cause, Analysis, Method (ICAM) facilitated by Inspector Paul Sullivan, was undertaken by Inspectors Smith, Scully, and Kennedy, to identify local factors and failures within the broader organisation and productive system (e.g. communication, training, operating procedures, incompatible goals, organisational culture, equipment, etc.) which contributed to the accident.

Through the analysis of this information, ICAM provides the ability to identify errors, which have occurred, and to prevent recurrence. This method is used to present the accident findings in terms of:

20.1. Absent / failed defences

These failures result from inadequate or absent defences that failed to detect and protect the system against technical and human failures. These are the last minute measures, which did not prevent the outcome or mitigate the consequences of an individual or team action that resulted in an incident or near miss.

- The park brake system on the grader failed resulting in an unplanned movement of the grader
- The park brake disc pads were worn
- The dual pneumatic service brake system had a modification made to it
- The pneumatic system for the service brakes contained a defective check valve
- Loss of air pressure on the grader to below 70psi would allow the service brakes to release
- The operator's pre-start inspection procedure is unable to determine the condition of the park brake, or identify the presence of modifications by physical test or inspection.
- Brake test procedures used weekly by MNM maintenance personnel did not identify if the park brake was serviceable or not.
- The grader did not have a valve fitted to allow testing of the park brake.
- Wheel chocks were not in place to prevent a run-away.
- The grader blade could not be lowered to the ground unless the grader engine is running
- The grader design requires the engine to be running for steering operation

20.2. Individual / team actions

These are the errors or violations that led to the incident. They are typically associated with personnel having direct contact with the equipment, such as operators and maintenance personnel. They are always committed 'actively' (someone did or did not do something) and have a direct relation with the incident. Human error types are slips, lapses, mistakes and violations.

- Weekly brake tests – The methodology used by MNM does not allow the maintenance person to identify if the park brake is serviceable.
- Brake circuit modification – A person modified the service brake circuit in a manner that defeated the design redundancy.
- Brake circuit modification – no documented record was made of the modification.

20.3. Task / environmental conditions

These are the conditions in existence immediately prior to or at the same time as the incident. These are the conditions that directly influence human and equipment performance in the workplace. These are the circumstances under which the errors and violations took place and can be embedded in task demands, the work environment, individual capabilities and human factors.

- The drift has a grade of 1:8 making the potential energy of gravity available.
- The drift has a concrete floor
- The drift is wide enough for vehicles to pass
- The grader stopped near 20 or 22 manhole
- The grader design requires the engine to be running for steering control
- The grader design requires the engine to be running to move the grader blade

20.4. Organisational factors

These underlying organisational factors produce the conditions that affect performance in the workplace. They may lie dormant or undetected for a long time within an organisation and the repercussions may only become apparent when they combine with the local conditions and errors or violations to breach the system's defences. These may include fallible management decisions, processes and practices.

Organisational Factor types:

TR Training

- Grader operator training includes brake testing before using the grader for work
- Maintenance personnel did not receive grader specific training
- The personnel using the software to develop the MNM maintenance strategy, did not identify the hidden failure potential in the grader park brake system. This was despite the training manual for the use of the software specifically referring to the hazard of hidden failures

OR Organisation

- DMS did not communicate the result of their FMEA on the grader braking system in 2011 to MNM
- DMS did not notify MNM that the park brake test procedure in the grader safety file did not test the park brake in isolation
- DMS did not notify MNM that a park brake test valve was as available
- DMS did not notify MNM that a park brake test valve should be installed into the grader
- MNM did not use the documented park brake test method supplied by PPK in the upgraded safety file after the grader overhaul work in 2015

PR Procedures

- The procedure used by MNM for weekly brake tests does not allow the maintenance person to identify the condition of the park brake
- The MNM maintenance programme did not test the condition of the park brake in isolation using a test valve or any other method

- There was no requirement for the inspection and testing of pneumatic check valve operation for the grader
- Maintenance work orders for the grader do not contain sufficient information to verify the quality of the work.

DE Design

- Park brake application applies the service brakes, requiring isolation of service brakes to identify park brake condition.
- Service brake design has dual circuits to prevent a single fault causing total loss of service brakes
- The modification to the pneumatic circuits defeated the design redundancy

RM Risk Management

- The MNM risk assessments have not identified the effect on park brake testing of the linkage between the park brake and the service brake

MC Management of Change

- The modification to the service brake pneumatic circuit was not subject to the MNM procedure for management of change
- The modification to the main pneumatic circuit was not subject to the MNM procedure for the management of change
- Modifications made to the brake circuits were not recorded in shift reports or the maintenance work order system

21. Safety and Health Management System

21.1. Management Structure and OHSE Responsibilities

s.73 Irrelevant inf is the site senior executive, the most senior officer who has responsibility for the coal mine.

s.73 Irrelevant infor is the Maintenance and Engineering Manager and is accountable to provide leadership in the development and implementation of engineering and maintenance standards at the mine.

s.73 Irrelevant informa is the Mechanical Engineering Manager, appointed by the Underground Mine Manager under CMHSA section 60, to control and manage the mechanical activities at the mine.

22. Findings

22.1. s.73 Irrelevant inform location

There is no evidence to clearly specify s.73 Irrelevant infor exact location when the grader commenced to run-away. s.73 may have been in the cab of the grader, or standing on the floor of the drift.

For the service brakes to release in the time available, the reduction in air pressure in the pneumatic circuits may have been the result of an attempt to start the grader engine. The operator performs engine start attempts from the cab of the grader.

The inlet valve found open to the air receiver points to the possibility s.73 Irrelevant info dismounted from the grader to access compressed air services to refill the receiver.

22.2. Evidence

s.73 Irrelevant info was in the cab

The evidence to support that s.73 Irrelevant info was on-board the grader attempting to start the engine when the runaway down the drift commenced is:

1. The transmission lever was in the neutral position.
    a. This is the normal position when starting the grader.
2. The run/stop toggle switch was in the run position.
    a. Experienced vehicle operators turn this switch to the Stop position when the engine is off to preserve starting air pressure. The operator switches it to the run position when planning to start and operate the vehicle.
3. The only way for s.73 Irrelevant inf to move from near 20 or 22 manhole to near 30 manhole in the available time is the movement of the grader.

s.73 Irrelevant inf was on the ground

1. The evidence to support that s.73 Irrelevant info was on the ground is the position of the inlet valve on the air receiver is to receive air to recharge the receiver. This valve is usually only opened by the operator after a hose has connected the inlet valve and the air supply point.

22.3. Findings

When the grader stopped in the drift at MNM, its braking systems should have prevented a runaway occurring. No feasible action the operator takes, or omits to take, whether on or off the grader, can initiate the runaway of a properly maintained machine.

The runaway occurred because:

1. MNM were not testing the park brake independently of the service brakes.
2. Excessive wear on the friction discs of the park brake, negated its failsafe design and made it unserviceable.

3. The modification in the pneumatic circuit for the service brakes, changing the circuit to a single system supplying all the service brakes, defeated the requirement for simultaneous faults in each circuit to cause total loss of the service brakes.
4. The defective valve in the service brake circuit allowed engine start attempts to reduce the brake circuit's air pressure enough for the springs to release the service brakes.

Contributing factors to the runaway are:

- The blade was in the raised position.
- When the engine is not running, hydraulic steering assistance is not available.
- When the engine is not running, using the brake pedal releases air out of the brake circuit, reducing resistance to the spring releasing the brakes.

22.4. Related findings

- The brake testing procedure used by MNM did not identify the condition of the friction discs of the park brake.
- The risk management process used by MNM did not identify the risk that the service brakes could mask faults in the condition of the park brake.
- MNM has a documented test procedure, provided to them by PPK in 2015, that could identify the condition of the friction discs in the park brake.
- MNM did not incorporate this procedure into their testing of the park brake.
- MNM personnel interviewed were not aware of the availability of a test valve to allow the service brakes to be isolated when testing the park brake.
- A mine owned by a related entity, had such a test valve fitted to the grader at that mine.
- The grader operator's brake testing procedure would not test the condition of the park brake.
- The processes used by industry service providers such as DMS, KGB and PPK to communicate hazards which the provider have identified and any recommended component changes, did not inform MNM.

23. Actions taken by DNRME after the accident

23.1. MRE & Directives issued to Moranbah North Mine

IOM Sherwood on 22nd February 2019 issued a directive to s.73 Irrelevant inf to withdraw from service MNMGR001 until approval in writing be provided by IOM Scully, so an inspection of GR001 can be undertaken.

IOM Sherwood on 28 February 2019 issued a directive to s.73 Irrelevant ir to isolate MNMGR001 until approval in writing be provided by IOM Kennedy, so an inspection of GR001 can be undertaken.

On 5 March 2019, IOM Kennedy issued a directive to s.73 Irrelevant ir for site to review both of the graders equipment current Approval Documentation - safety file dossiers to ensure that the pneumatic and hydraulic schematics match as built and supplied to site.

Site to review the introduction verification documentation to ensure pneumatic and hydraulic schematics match as built and supplied to site.

On 25 July 2019 IOM Scully issued a directive to s.73 Irrelevant, for site to review the SHMS to ensure that work orders are regularly audited and that coal mine workers, are aware of their responsibilities to adequately and accurately record all work related history information.

On 25 February 2019, IOM Scully issued a Safety Newsflash titled "Uncontrolled vehicle movement fatality". This safety alert provided some information on how the incident occurred, and made the following recommendations to coal mines:

All underground mines should immediately review procedures for:

- *The use of mobile plant, including the operation of multiple vehicles on inclines and parking of vehicles*
- *checking of mobile plant*
- *verifying ongoing effectiveness of braking systems*

In particular, underground mine grader braking systems should be reviewed to:
- *confirm systems are fit for purpose*
- *ensure test plans are in place to ensure that all braking system components on underground graders are functioning as intended.*

Note: *Braking systems include service brakes, parking brakes, emergency brakes and other braking systems, the failure of which may cause a risk to persons.*
Original equipment manufacturers (OEMs) should be consulted to ensure that correct test procedures are used for the aforementioned tests.

24. Recommendations:

1. SSEs' should ensure that plant design is considered in every fit for purpose assessment of the plant.
2. SSEs' should ensure their vehicle maintenance personnel are trained in the possible failure modes of each braking system and the actions to take to prevent such failures causing injury.
3. SSEs' should ensure their vehicle operators are trained in the possible failure modes of each braking system and the actions to take to prevent such failures causing injury.
4. SSEs' should ensure that the brake testing procedures used by vehicle operators and maintainers, test the serviceability of each brake system.
5. SSEs' should ensure the risk management processes used by the mine are identifying and controlling all the hazards involved in the operation and maintenance of equipment.
6. SSEs' should ensure that modifications made to equipment are risk assessed, managed, recorded and communicated.
7. SSEs should ensure the instructions in their procedures are suitable for all foreseeable circumstances operators encounter and are compatible with equipment capabilities.
8. SSEs' should ensure that they have a process to review technical bulletins for plant and apply the findings to any potentially affected plant items at the mine.
9. Equipment suppliers and service providers should ensure they have robust processes in place to communicate to industry the hazards they have identified.
10. SSEs' should ensure that when there is the possibility of interaction between pedestrians and vehicles in a drift, recessed manholes are installed in the drift.

25. Glossary of Terms

TERM	DESCRIPTION
Ground engaging tools	These are the implements fitted to the grader to perform work, the blade and the rippers.
Pneumatic circuit	An interconnected set of components that convert compressed gas (usually air) into mechanical work. Incudes an air compressor or compressor fed tank
Service Brakes	Brakes design for use during normal operation of a machine
Park Brake	Brakes designed for use when the machine has stopped and is to be left unattended.
Emergency Brake	Brakes designed for use if there is total loss of service brakes
Fail safe brakes	Brakes designed to apply using inexhaustible energy supply, such as a spring.
Non fail safe brakes	Brakes designed to apply using an exhaustible energy supply, such as air or hydraulic fluid.
Brake discs	A circular disc or plate
FMEA	Fault Mode Effect Assessment – a structured approach to discover potential failures that may exist within a design of a product or process.

26. Appendices

1. Autopsy report – (to be received)
2. DNRME Lotus Notes
3. MNM Drift Services 19–30CT
4. Data Analysis spreadsheet
5. ROI s.73 Irrelevant informati
6. Data Analysis spreadsheet
7. ROI s.73 Irreleva
8. ROI
9. ROI
10. MNM Control Room Log
11. ROI s.73 Irrelevant
12. QAS – electronic report
13. Death of Coal Mine Worker at Moranbah North Mine
14. Prestart Grader 002
15. Torque Report
16. s.73 Irrelev interview documents
17. GR002 7 Days Mech Inspec offline 20190215
18. Mechanical inspection and testing timeline
19. Roster s.73 Irrelevant i