Australian Government
Australian Transport Safety Bureau

Safeworking irregularity involving crew of freight train 4WM2

Near Waterfall, New South Wales, on 21 August 2019

ATSB Transport Safety Report
Rail Occurrence Investigation (Defined)
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Addendum

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Safety summary

What happened

At approximately 0030 on 21 August 2019, freight train 4WM2 operated by Pacific National stopped at signal W26U near Waterfall, New South Wales. The train crew consisting of driver A and B were directed by the Waterfall Signaller at 0200 to remarshal the train. The train could not continue and was required to return to Coalcliff to clear the main line. The train consisted of three locomotives and a rake of 50 wagons.

Remarshalling the train required one of the drivers to enter the danger zone to apply hand brakes on the wagons. Driver A requested safeworking protection from the Waterfall Signaller before entering the danger zone. Driver A walked the length of the train applying hand brakes before returning to the locomotives.

The locomotives were detached and operated to Waterfall, before travelling to Helensburgh and returning to the stabled wagons near Waterfall.

On arrival at the stabled wagons, driver B requested safeworking protection from the Waterfall Signaller. Driver B entered the danger zone to release the hand brakes from the stabled wagons. At about 0417, driver A signalled (hand signals and red marker lights) to the driver of an approaching passenger train (404A) to stop. The train was travelling on the adjacent track towards driver B in the danger zone and the driver of 404A made an emergency brake application to stop the train. The train stopped before arriving at the location driver B and there were no physical injuries.

What the ATSB found

The safeworking network rule and procedure for protecting activities associated with in-service rail traffic were not used effectively to ensure workers were protected from rail traffic. The requests for protection were informal and did not detail the required activities or protection. Both drivers of 4WM2 unknowingly entered the danger zone without appropriate protection and were at risk of being struck by rail traffic.

There were multiple parties involved in the communication and decision making relating to the movements of 4WM2. This led to confusion and misunderstanding of the required activities and likely affected the actions of the Waterfall Signaller and train crew. Additionally, not all communications were conducted in accordance with the network rules.

What has been done as a result

The train crew and Waterfall Signaller underwent re-training and assessment before returning to rail safety work.

Sydney Trains reviewed the risk management processes applied by network operations and the processes relating to incident management. Pacific National reviewed the processes for protecting in-service rail traffic and reinforced the requirements with train crew.

Safety message

Rail infrastructure managers and rail transport operators must ensure that safety critical communication is conducted in accordance with network rules. Additionally, network controllers should consider the potential dangers train crews are exposed to before requiring them to enter the danger zone.

Workers must ensure they have appropriate safeworking protection in place before entering the danger zone and are protected from rail traffic. Workers must also ensure that rest periods are utilised to manage non-work related fatigue.

Contents

The occurrence

On 20 August 2019, Pacific National (PN) were operating freight train 4WM2 between Port Kembla, New South Wales and Melbourne, Victoria.

At approximately 0030,[1] on 21 August 2019, the crew consisting of a driver A and driver B stopped at signal W26U near Waterfall, New South Wales. The Sydney Trains' Waterfall Signaller (WS) advised the crew of train 4WM2 that they would be held at the signal due to a track fault in the adjoining network.[2]

At 0158, the Train Services Delivery Manager (TSDM)[3] Freight advised the WS that train 4WM2 could not proceed and the train would need to remarshal.[4] The WS relayed the directive to the crew of 4WM2 to remarshal the train so the train could move to Coalcliff, clear of the main line.

Driver A contacted the WS at 0209 and requested safeworking protection stating 'just wondering if we can get a block[5] on the Down[6] there please over'. The WS responded with 'yeah, sure there driver, standby…ok driver I have secured points out of the Up refuge and on the main line and given you two signals at stop with blocks applied'. Driver A contacted the WS again at 0224, to confirm that protection was in place and was advised 'yeah got blocks on up here on the city side of your train on the Down signals'.

Between approximately 0220 and 0319 driver A walked in the six-foot[7] to manually apply the hand brakes on the wagons and to divide the locomotives from the rake.[8] At 0320, the crew of 4WM2 requested the block to be removed and permission to shunt the locomotives towards Waterfall.

At 0321, the WS contacted the Wollongong North Panel Area Controller (WNP) to advise of the plan to run 4WM2 to Helensburgh before returning and attaching to the stabled wagons.

The three locomotives departed Waterfall platform at approximately 0332, crossing from the Up Illawarra main line to the Down Illawarra main line to travel to Helensburgh in the Down direction.

The WS contacted the WNP at 0345, to discuss the progress of 4WM2 and make arrangements for managing approaching Up passenger service 404A. The WS and WNP determined that 404A could cross from the Up Illawarra and travel in the Up direction on the Down Illawarra.

At approximately 0359, the three locomotives departed Helensburgh station towards the rake of wagons in the Up direction on the Up Illawarra.

The WNP contacted the driver of 404A at 0409:12, to advise that they would cross to the Down Illawarra as there was a freight train remarshalling near the Waterfall accept signal (W26U).

At 0409:40, driver B contacted the WS requesting safeworking protection stating 'We're about to attach to our train again, can I please get a block on the Down? Over'. The WS responded with 'Yeah I've got blocks on the Down and blocks on the Up. So we've taken away control from north panel [WNP] and there's blocks on the Down'.

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1 Times shown in 24 hour time as Australian eastern standard time (AEST).

2 A track circuit fault within the Australian Rail Track Corporation (ARTC) network prevented freight services continuing through the Sydney Trains network. Freight services must be clear of the main line prior to the morning peak to avoid delaying passenger services.

3 See page 7 for a description of the roles and responsibility of the Train Service Delivery Managers.

4 Remarshal refers to changing the order of locomotives or wagons in a train's consist.

5 Block refers to a method of safeworking protection, see page 10.

6 The Down track refers to the direction of travel for trains heading away from Sydney, the Up track refers to trains heading to Sydney.

7 The six-foot refers to the spacing between two adjacent lines, in this case the Up and Down Illawarra main lines.

8 Rake refers to vehicles, usually not formed as a train, moved as a unit during shunting and marshalling.

Following the communication with WS, driver B entered the danger zone[9] on the Down main to reattach the locomotive. Driver A changed ends while driver B walked in the six-foot to release the hand brakes on the wagons.

At 0417:28, driver A called driver B on the radio to warn that they had stopped an approaching passenger train that was travelling towards their location (Figure 1). Driver A then contacted the WS to advise there was worker in the danger zone releasing the hand brakes when the passenger train approached. At the same time, the driver of 404A contacted WNP to advise that the crew of the freight train signalled 404A to stop. The driver of 404A confirmed the train was stopped and was requested to remain stationary until the WNP advised.

Figure 1: Location map

Source: Geoscience Australia and OpenStreetMaps, annotated by OTSI

Train 404A departed the location at 0423 after receiving authority and confirmation that driver B had moved clear of the Down Illawarra main line. Blocking facilities were applied following the departure of 404A to provide protection to driver B to release the hand brakes.

At 0505, 4WM2 departed towards Coalcliff with the crew relieved at 0525 at Helensburgh Station.

The WS was subjected to post incident drug and alcohol testing returning negative results for both tests. Neither driver reported the incident to PN's Integrated Planning Services (IPS) before completing their shift, as such, post incident drug and alcohol testing was not conducted.

[9] Danger zone, any area within 3 m horizontally and either above or below the outer most rail, unless constantly in a safe place.

Context

Train information

4WM2

Train 4WM2 was operating between Port Kembla and Melbourne at the time of the incident. The train consisted of three locomotives and a rake of 50 wagons. The total length was 925 m with a trailing mass of 3618 t.

Train radio

At the time of the incident train 4WM2 was not fitted with a compatible digital train radio system (DTRS), preventing the driver communicating with or broadcasting an emergency call to alert the driver of train 404A. The train radio at the time was operating on the National Train Communications System (NTCS).

PN advised the train radio software was updated across their fleet as of December 2019, as part of the Transport for NSW DTRS project.[10] The revised train radio software allows freight drivers to initiate an emergency call that can be heard by passenger trains nearby. Direct communication is still not possible between freight and passenger trains without assistance from the signaller.

404A

Train 404A consisted of a four car Oscar operated by NSW Trains between Kiama and Central station. This service was scheduled to stop at Helensburgh at 0411 and Waterfall at 0419.

The driver of 404A was advised that they would crossover at Helensburgh to travel on the Down Illawarra in the Up direction. The driver operated the train as expected and stopped in response to the crew of 4WM2.

Location

The incident occurred between Waterfall and Helensburgh. The Up and Down Illawarra main lines operate with Rail Vehicle Detection (RVD) and both permit bi-directional running. The rail corridor runs through the Garawarra State Conservation Area and the track consists of steep cuttings, embankments and areas of cleared land based on the topography (Figure 1). The area is remote with no artificial lighting excluding train lighting or hand-held torches.

The crew of 4WM2 were advised to remarshal the train while stationary at signal W26U, located in a steep cutting at 40.191 km.[11] The train length of 925 m positioned the rear of the consist at approximately 41.116 km (Figure 2).

The gradient between Waterfall and Helensburgh varies between 1 in 76 and 1 in 165. The location at which 4WM2 was required to remarshal varied between 1 in 80 and 1 in 165. The crew were concerned about leaving the wagons on the grade so applied more than the required minimum of 50 per cent hand brakes for this grade. A total of 40 hand brakes were applied from the six-foot to hold the wagons on the grade before detaching the locomotives. The hand brakes could not be applied from the cess[12] due to the cutting and ballast shoulder.

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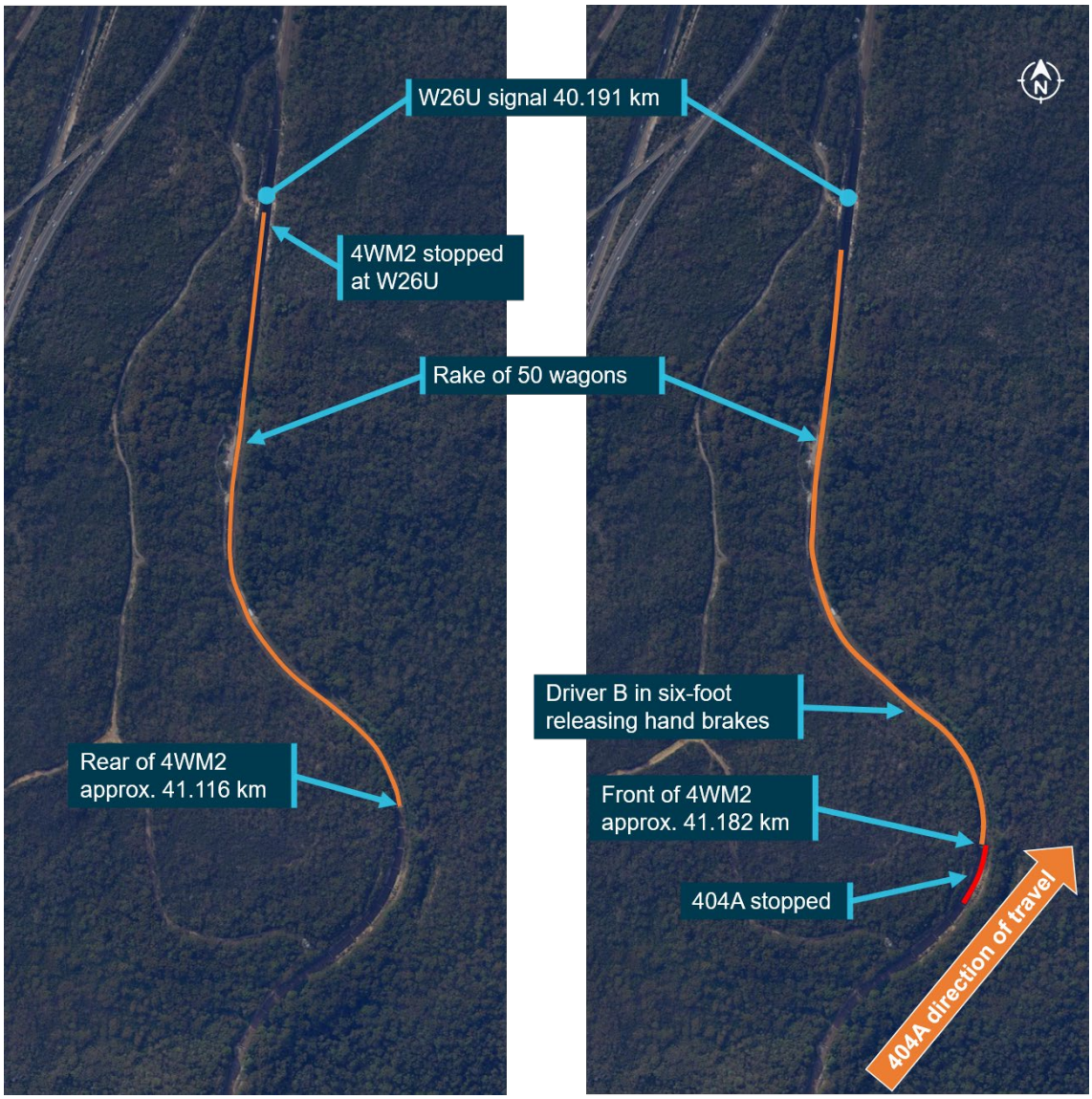
[10] The Digital Train Radio System (DTRS) project addressed recommendation 38 from the Waterfall Special Commission of Inquiry, (McInerney, PA. 2005). Recommendation 38 states 'There must be compatibility of communications systems throughout the rail network. It is essential that all train drivers, train controllers, signallers, train guards and supervisors of trackside work gangs in New South Wales be able to communicate using the same technology.'

[11] The kilometre distance is measured from Platform 1, Central Station, Sydney, New South Wales.

[12] Cess, the area between the outer most rail and the fence line or 15 m in non-fenced areas.

Following the remarshalling, the lead locomotive was positioned at approximately 41.182 km on the Up Illawarra. Driver B had walked approximately 300 m along the consist when contacted to advise that train 404A had been stopped.

Figure 2: Position of 4WM2 before and after remarshalling



The image on the left shows the position of 4WM2 (orange) before remarshalling. The image on the right shows the position of 4WM2 (orange) after remarshalling and the approximate location of driver B and 404A (red) when stopped.
Source: SixMaps, NSW Spatial Services, annotated by OTSI

At Waterfall there was a stabling yard for passenger trains located on the Down (eastern) side of the station. On the Up (western) side of Waterfall station, there were a number of sidings (Up yard) available for goods (freight) trains as below with siding length:

- Up refuge loop - 867 m
- Up goods loop - 711 m
- No.1 Up siding - 239 m
- No.2 Up siding - 251 m.

The gradient in this area varies between 1 in 120 and 1 in 220 and the area is close to suburban Waterfall with some artificial lighting.

Directly involved persons

Waterfall Signaller

The WS had performed the role of a signaller since late 2011 and was qualified to operate Waterfall signal box. The signaller had undergone routine assessments relating to safety critical communications[13] with the two most recent assessments completed on 19 February 2019 and 1 May 2019.

The WS's duty periods for the 2 weeks prior to the incident on the morning of 21 August are shown in Table 1. The WS had worked seven out of eight days leading up to the occurrence, with the previous day off on 15 August after completing a night shift. The WS was on their fifth shift and second nightshift when the incident occurred.

Table 1: Actual duty times for the WS over the previous 14 days

Date	Duty start	Duty end	Duty time	Time free (of duty)
7 August 2019	1400	2200	8 hours	13 hours
8 August 2019	1100	1900	8 hours	Multiple days
9 August 2019	Rostered off			
10 August 2019	Rostered off			
11 August 2019	Annual leave			
12 August 2019	Annual leave			
13 August 2019	0600	1400	8 hours	32 hours
14 August 2019	2200	0600	8 hours	48 hours
15 August 2019	Rostered off			
16 August 2019	0600	1400	8 hours	16 hours
17 August 2019	0600	1400	8 hours	16 hours
18 August 2019	0600	1400	8 hours	32 hours
19 August 2019	2200	0600	8 hours	16 hours
20 August 2019	2200	0600		(incident occurred between 0200 and 0420)

The WS reported that when not working a night shift, they would get about 7–8 hours sleep at night. Following a night shift (ending at 0600) they would normally sleep for about 4–5 hours in the morning and then also sleep for 1.5–2 hours in the evening. They noted that their sleep during the day was never as deep or restorative as sleep at night, and they did not always achieve this planned amount of sleep.

The WS advised that they had been experiencing some personal stress relating to caring for a family member. This had been an ongoing issue for a number of months leading up to the occurrence and had required varying and unpredictable levels of attention, and that these issues had resulted in regular disrupted sleeping patterns and had presented some difficulties at times during work hours.

The WS could not recall the exact amount of sleep they obtained during the day on 20 August (following the night shift that ended at 0600). They reported they had cared for their family member during the day on 20 August, and they probably felt a bit tired, distracted and stressed. The WS advised they had considered taking the night shift off (20 August) but felt that this would

[13] Safety-critical communication is any communication, spoken or written, that if not delivered, or incorrectly delivered, or not delivered promptly, there is reasonable likelihood of a safety incident occurring. Network standard NS 0919 Network communications.

impact Sydney Trains operations and thought that they could still complete their role effectively, noting that night shifts are typically less busy than a day shift. The WS also advised that it was their perception that reporting issues with fatigue or personal matters that could influence their performance could be detrimental to the security of their employment.

Sydney Trains had a fatigue management system that included the provision of rostered duty periods and periods off duty that provided rest opportunity. It also evaluated planned rosters using a bio-mathematical model of fatigue (BMMF), and the predicted scores for the WS's roster using this model were below the limits it had set for a signaller's roster.

Driver A

Driver A had approximately 30 years' experience within the rail industry and was a qualified driver trainer. On the night, driver A was conducting a route verification of competence (VOC)[14] of driver B.

Both drivers of 4WM2 commenced their shift at 1745 on 20 August at the Sydney Freight Terminal (SFT) for a rostered shift of 9 hours 37 minutes. Delays to the journey of 4WM2 extended both drivers shifts beyond their rostered finish time of 0322. Driver A finished at 0655 (13 hours 10 minutes) and driver B finished earlier at 0612 (12 hours 36 minutes) as they elected to take a taxi home.

The roster for driver A in the week prior to the incident is shown in Table 2. They were on their third shift in a row on the night of the occurrence.

Table 2: Actual duty times for driver A over the previous 7 days

Date	Duty start	Duty end	Duty time	Time free (of duty)
14 August 2019	Annual leave			
15 August 2019	Annual leave			
16 August 2019	Annual leave			
17 August 2019	Annual leave			
18 August 2019	1800	0200	8 hours	16.5 hours
19 August 2019	1830	0330	9 hours	14.2 hours
20 August 2019	1745	0655		

Driver A reported that following a night shift they would normally sleep until midday and then also normally sleep for a couple of hours in the afternoon or evening prior to the next shift. The driver reported having a nap prior to commencing on 20 August but could not recall the exact amount of sleep. Driver A advised that they felt fine when they commenced on the night of the occurrence although probably felt a bit tired as the shift progressed. At the time, driver A's commute was about 1-1.5 hours each way.

Driver B

Driver B had approximately 15 years' experience operating trains in Australia and overseas and transferred to PN from another Australian operator in early 2018. Driver B was not qualified to operate the route and was under observation of driver A.

The roster for driver B in the week prior to the incident is shown in Table 3. They were on their second shift in a row on the night of the occurrence.

[14] Driver must be competent for a route to operate trains on that route. In this case driver B's route knowledge was being verified by driver A.

Table 3: Actual duty times for driver B over the previous 7 days

Date	Duty start	Duty end	Duty time	Time free (of duty)
14 August 2019	2038	0748	11.1 hours	24 hours
15 August 2019	Barracks – rest period for return trip 16 August			
16 August 2019	0845	2037	11.9 hours	More than 48 hours
17 August 2019	Rostered off			
18 August 2019	Rostered off			
19 August 2019	0330	1230	9.0 hours	29.2 hours
20 August 2019	1745	0612		

Driver B reported that they typically sleep around 8 hours when not on night shift. The driver advised that they would try to have a nap around 1400 and sleep for a 2-3 hours prior to a night shift but may not always have a nap. Driver B could not recall if they had napped or the amount of sleep prior to commencing on 20 August but advised that they felt pretty good when signing on. The driver advised that they probably felt a bit tired during the wait period at signal W26U. At the time, driver B's commute was about a 1 hours each way.

Network operations

Sydney Trains as the rail infrastructure manager (RIM) is responsible for the safe operation of rail traffic across their network. Within the Sydney Trains Rail Operations Centre (ROC) there are a number of roles that assist co-ordinating movements of trains through the network and responding to incidents.

Train Service Delivery Manager

There are seven TSDMs within the ROC with each TSDM responsible for a defined network area, the boundaries for the relevant TSDMs are:

- Main – Central to Emu Plains, Richmond, Olympic Park and the City Circle
- North – Sydney Terminal to Berowra via Strathfield and Central to Hornsby via North Shore
- Central Coast – Berowra to Hamilton
- Illawarra – Bondi Junction to Waterfall (yard limit[15] inclusive) and Central to Macarthur, Merrylands and Lidcombe
- South West – Bomaderry to Waterfall (yard limit exclusive) and Lithgow to Emu Plains
- Freight – Monitors freight operations across the entire Sydney Trains network and liaises with the relevant TSDM to advise of any issues involving freight
- Desk – assists other TSDMs with administrative functions and relieves for rest breaks.

The TSDMs are responsible for planning and monitoring train movements, developing, implementing and co-ordinating alternative train working during service disruptions.

The TSDMs liaise with the various signalling staff within the area of their control to advise of changes to standard working or in response to an incident. The Illawarra, South West and Freight TSDMs were all involved in communication relating to the movements of 4WM2 at different stages through the night.

Train 4WM2 stopped at signal W26U which was the yard limits for Waterfall and within the boundary of the TSDM Illawarra.

[15] Yard limit - a defined operational limit on a running line.

Network Incident Manager

There are three Network Incident Managers (NIM) within the ROC responsible for monitoring the rail network, operationally leading and managing the response to incidents on the network. The NIMs manage a defined area with each NIM covering the following TSDM areas;

- North – Main, North and Central Coast
- South – Illawarra and South West
- Desk – assists North and South NIMs with administrative functions, relieves for rest breaks and responding to incidents and disruptions.

Duty Control Manager

The Duty Control Manager (DCM) forms the central functional and strategic operational lead within the ROC. The TSDMs and NIMs both report to the DCM.

Network rules

Sydney Trains requires that activities completed within their network are completed in accordance with their network rules and procedures. These rules apply to all rail transport operators (RTO) while within the Sydney Trains network.

Network communications

Communications within the rail network must be completed in accordance with the relevant network rules, procedures and standards. Network rule *NGE 204 Network communication* prescribes the rules for spoken and written communication within the Sydney Trains network. The principles of NGE 204 are that network communication must be:

- Clear, brief and unambiguous
- Relevant to the task at hand
- Agreed to its meaning before acted upon.

Communication must also be confirmed to ensure that the messages were received correctly if the message relates to safety critical information including:

- a Condition Affecting the Network (CAN)
- a Proceed Authority
- an instruction not to proceed
- a work on track authority
- a work on track method
- work on track Train Running Information
- Special working.

Persons completing safety critical communications must not assume the receiver understands the message before the receiver confirms they understood the message. If the meaning of spoken communication is not understood, the receiver must ask for it to be repeated.

If a person cannot communicate directly with an intended receiver, a message may be relayed to the receiver by a qualified worker.[16] The message must be relayed exactly as received.

It is also a requirement that if recorded communication devices are available, they must be utilised when communicating safety critical information.

[16] Qualified worker – a worker certified to carry out the relevant task, the WS and driver A and B were qualified workers.

Monitoring network communications

Network standard *NS 0919 Network communications* required organisations whose workers communicate within the Sydney Trains network to monitor and review network communications.

Sydney Trains monitored network communications through random and routine assessments that focused on both technical and behavioural markers. Based on the assessment there may be either: no further action or participants may require coaching and further development.

Pacific National monitored network communications through the following:

- auditing of local channels (PN controlled yards and terminals)
- checking through their critical control verification process (safety engagements)
- assessments by driver trainers as part of the VOC process.

Monitoring and reviewing network communication provides an indication of the performance of the persons involved in safety critical communication at that point in time.

Protecting activities associated with in-service rail traffic

Sydney Trains utilise network rule *NTR 432 Protecting activities associated with in-service rail traffic network proce*dure to provide protection for workers required to attend rail traffic while in-service. Network procedure *NPR 750 Protecting activities associated with in-service rail traffic* is associated with NTR 432 and details the requirements for requesting and authorising protection, conducting work and removing protection as detailed below.

Requesting protection

The qualified worker must inform the signaller of their name, role, train details and the type of activity requiring protection. They must also identify the lines requiring protection, advise the location of work and ask the signaller to protect all points of entry into the portion of track.

The signaller must confirm all protection request details and confirm the location of the worksite. The signaller must also determine if the work requires involvement of more than one signaller to ensure that all rail traffic is excluded. If more than one signaller is required, the signallers must determine who will be the authorising signaller. In this case, protection was required on both the Up and Down main line between Waterfall and Helensburgh and as such required involvement of two signallers.

The signaller (authorising signaller) must:

- make sure that blocking facilities have been applied to exclude all rail traffic.
- confirm the location of the last rail traffic to enter the affected portion of track.
- ensure that there is no approaching rail traffic.

The authorising signaller must tell qualified worker:

- that blocking facilities have been applied.
- the affected portion of track is protected.
- location of the last rail traffic and confirm there is no approaching rail traffic.

The qualified worker must confirm the assurances and details with the authorising signaller.

Authorising protection

The signaller authorises protection to the qualified worker after confirming the assurances and issues a unique protection number for the protection. The qualified worker must make sure that the protection is authorised and they have been issued with a unique protection number prior to entering the danger zone.

Conducting in-service inspections

The qualified worker must ensure that a safe place[17] exists or protection has been authorised prior to entering the danger zone.

Removing protection

The qualified worker must advise the signaller of their location, train details and unique protection number and confirm that all workers are clear of the danger zone. The signaller must confirm the qualified workers details and the workers are clear of the danger zone before removing protection.

Safeworking protection

The primary method for protecting rail traffic and workers attending rail traffic was the use of fixed signals and signal blocking.

Absolute signal blocking

Absolute signal blocking (ASB) is a method of protection to prevent unauthorised rail traffic entering a protected area. Signalling staff must manipulate the appropriate absolute signals[18] and points to provide protection in accordance with the relevant network rule (NTR 432 or NWT 308).[19]

There must be two absolute signals at Stop at all potential entry points with a block (physical or electronic) applied to prevent the inadvertent activation of the signal or authorisation of rail traffic.

In addition, Sydney Trains required the signaller to complete and record all associated protection details utilising form *NRF 018 Absolute Signal Blocking (ASB)*. The form provided the signaller with a list of requirements and could act as a memory aid to ensure the protection was completed successfully.

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[17] Safe place, an area where a worker or their equipment cannot be struck by rail traffic. A safe place can be created within the danger zone, through the use of recognised protection arrangements.

[18] Absolute signals must not be passed by rail traffic without authority from the signaller and in accordance with any applicable rule or condition.

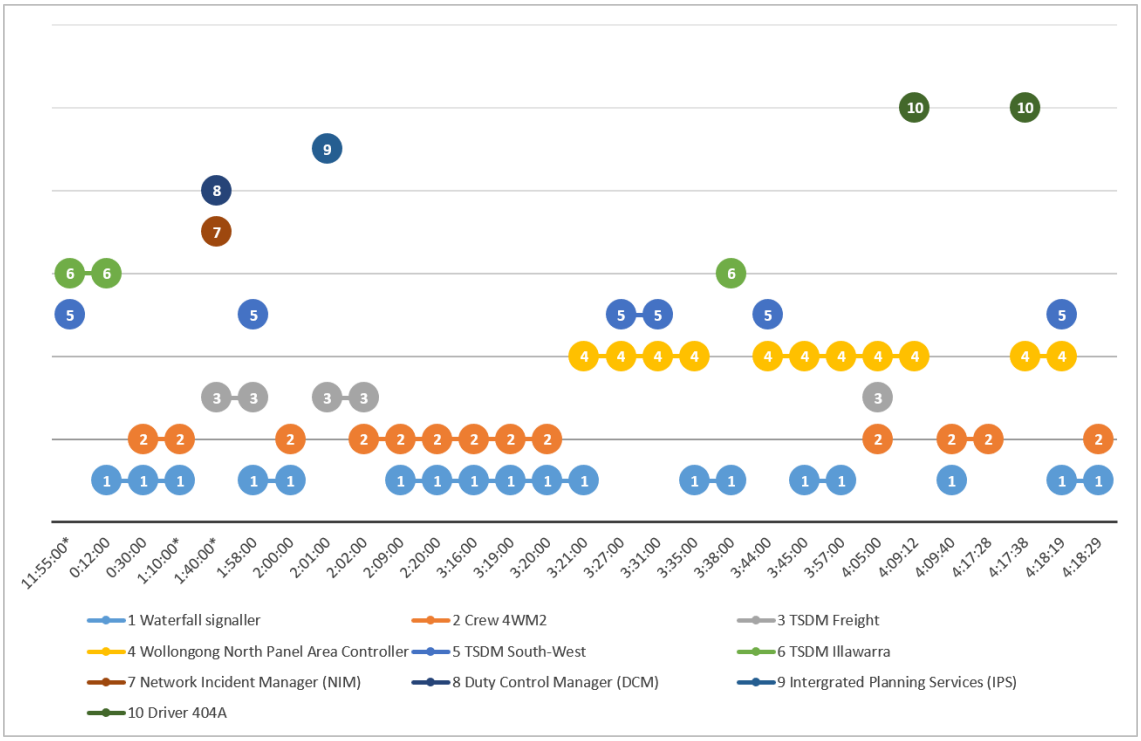
[19] Sydney Trains utilise NTR 432 for protection of in-service rail traffic and NWT 308 Absolute Signal Blocking for the protection of worksites not associated with rail traffic.

Safety analysis

Network communication and decision making

The communications relating to the decisions and movement of 4WM2 were assessed to understand the events leading up to the occurrence (Figure 3). It was found that while recorded network communication devices were available, not all communications, decisions or directions relating to 4WM2 were made utilising recorded communication devices as required by NGE 204.

Figure 3: Communication timeline



The timeline shows the parties involved with the decision making and communication relating to 4WM2. Times shown with an asterisk (*) are approximate times. Communication shown at 04:17:28 was driver A advising driver B of 404A by radio.
Source: Sydney Trains recorded data, modified by OTSI

The TSDM Illawarra advised the WS at 0012 to hold train 4WM2 at the Waterfall accept signal (W26U) due to the track fault in the adjoining network. The TSDM discussed that 4WM2 would be too long for the goods loop or refuge loop at Waterfall and that the train may need to 'run around [remarshal] on the Up main'. The TSDM suggested the train might be held for less than an hour.

Around 0140 the DCM requested the involvement of the NIM Desk to resolve service disruptions once it was determined freight traffic would be unable to transit through Sydney Trains network. The NIM Desk and TSDM Freight determined that 4WM2 would need to remarshal and return to Coalcliff as it would be too long for the sidings at Waterfall.

The TSDM Freight contacted the WS at 0158 to advise of the directive to remarshal 4WM2. The WS began to repeat the message when the TSDM responded with 'they should be all over that procedure'. The WS broadly relayed the message to the crew of 4WM2 to remarshal as received.

It was a requirement of NGE 204 that messages were understood before acting on the message. In this case, the WS relayed a message that they did not understand the full meaning of. The crew of 4WM2 received the message from the WS not realising that the WS did not understand applying hand brakes required workers to enter the danger zone. Neither party explicitly clarified the requirements or meaning of messages before acting on the requests.

The TSDM Freight contacted the TSDM South West around 0158 to advise them of the plan for 4WM2; the TSDM South West responded with 'Illawarra owns it [TSDM Illawarra]'. The TSDM Illawarra was not advised that 4WM2 would be remarshalling and was not involved again until 0338.

Prior to being directed to remarshal, the crew of 4WM2 reported discussing alternatives with the WS and IPS. The following alternatives had been discussed:

- dividing the consist and storing across two sidings at Waterfall, or
- utilising the Waterfall yard to remarshal the train.

The TSDM Freight contacted IPS to discuss the train path for 4WM2 and advised that 4WM2 would be remarshalling. IPS questioned why the plan of utilising Waterfall yard to store the train had changed. The TSDM Freight advised that they had been directed for the train to remarshal by higher management.

The decision for 4WM2 to remarshal and return to Coalcliff while at signal W26U was not made in consultation with or communicated to all parties. Train 4WM2 was stationary within the area of control of the TSDM Illawarra. The remarshalling movement crossed into and out of the TSDM South West's area of control. Following the initial communication directing the train to remarshal, TSDM Freight was not involved in the movements until 0405. The three TSDMs and NIM while co-located in the ROC did not communicate effectively to discuss the movement prior to or during the remarshalling.

The TSDM Illawarra contacted the WS at 0338 enquiring about the movements of 4WM2 and raised that 404A would be approaching shortly. During the call the TSDM Illawarra reported they had been unaware that 4WM2 was remarshalling and that it had apparently been arranged by the TSDM Freight.

The lack of clear communication and consultation between relevant parties resulted in different levels of understanding among all involved. This likely affected the actions of the WS and crew of 4WM2.

Drivers are required to attend rail traffic while in the rail corridor, in particular, when there is a fault preventing the train moving to a safer location. Train 4WM2 did not have a fault and the dangers the drivers would be exposed to should have been considered before the drivers were directed to remarshal the train.

An alternate and safer location had been discussed between some of the individuals but was dismissed as it would have required the consist to be divided. The Waterfall Up sidings were available and had a number of benefits over remarshalling on the Up Illawarra:

- the sidings provide some separation from rail traffic on the main line.
- the track alignment, gradient, ballast and clearances would make it safer to walk.
- some artificial light was present.

The change to the perceived plan held by the crew of 4WM2 of utilising Waterfall Up yard possibly created further confusion and distraction. Stabling or remarshalling at Waterfall would likely have placed less pressure (perceived or actual) on the crew as the train could have cleared the main line quickly and remarshalling in the yard required fewer hand brake applications. Additionally, there were engineering controls[20] in the yard to arrest potential uncontrolled movements should the hand brakes have failed or if insufficient hand brakes had been applied.

[20] Catch points - a set of points designed to prevent unauthorised access to a section of track by intentionally derailing the vehicle.

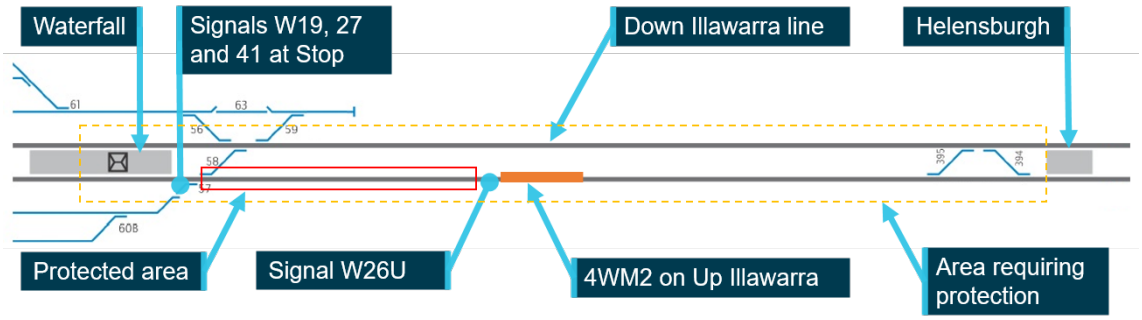
Safeworking irregularity

Driver A requested safeworking protection after being directed to remarshal the train. The request for protection of 'just wondering if we can get a block on the Down there please over' was not clear that the driver wanted protection on the Down Illawarra main line. The drivers' request did not detail the required activity, identify the lines requiring protection, the location of the work or request that all points of entry were protected. The WS applied the following protection in response to the initial request:

- Set signal W19 and W27U at Stop in the Down direction on the Up Illawarra.
- Secured the points out of the refuge and set signal 41 at Stop in the Down direction.
- Applied blocks to signals W19, W27U, 41 and points 57.

The protection applied by the WS protected the train on the Up Illawarra main line in the Down direction (Figure 4).

Figure 4: Safeworking protection diagram



The image shows a line diagram for the track between Waterfall and Helensburgh. The area protected by the WS is shown with a red box, the area that required protection is shown in the orange box. Protection was required on both Up and Down Illawarra main lines in both directions.
Source: Sydney Trains, modified and annotated OTSI

Both Driver A and the WS appeared to be working on the assumption that the other knew what was required without seeking clarification. The driver sought confirmation of the block at 0224 and the WS responded with 'yeah got blocks on up here on the city side of your train on the Down signals'. The driver did not detect that the WS stated there was no protection on the country (Helensburgh) side of their train.

There were a number of other activities competing for the driver's attention that may have distracted them from the safeworking aspect of remarshalling. These include determining the number of hand brakes required to hold the wagons (3618 t) on the grade, completing brake holding (retention)[21] test and uncoupling the locomotive prior to the move.

The initial request for protection did not meet the requirements of NPR 750 and the WS did not identify the request was for protection under NPR 750.

Had the request been completed in accordance NPR 750, or the WS identified that workers were required to enter the danger zone, it is probable that additional protection would have been applied. In addition, the use of form NRF 018 Absolute Signal Blocking may have assisted if it had been used. The protection required the involvement of the WS and WNP to ensure that all points of entry were protected from rail traffic. This did not occur and the WNP was unaware of the remarshalling until 0321. The WNP facilitated the remarshalling movement but was not involved in protection arrangements for 4WM2.

[21] An air brake examination to check that the brakes on the last three vehicles of a train will remain applied for a predetermined time in the event of a break-away. Rail Industry Safety and Standards Board (RISSB)

After the locomotives had travelled to Helensburgh and returned to the stabled consist, driver B requested protection. The request for protection was informal, did not specify the required protection and was requested in a similar manner to driver A. The WS advised the driver that 'I've got blocks on the Down and blocks on the Up. So we've taken away control from north panel (WNP) and there's blocks on the Down'. The WS was referring to the protection on the Up main in the Down direction. Having not identified workers needed to access the danger zone in the first instance, the WS repeated the protection applied previously.

Driver B completed a Take 3[22] form noting '750 block' as the method of safeworking protection before entering the danger zone. The driver believed that the requirements of NPR 750 had been met, assuming that their request had been understood as a request for protection on both the Up and Down Illawarra main lines.

Both drivers entered the danger zone unknowingly with no protection on the Down Illawarra in either direction and were at risk of being struck by rail traffic. No trains passed through the area while driver A was in the danger zone.

Driver A signalled to the driver of 404A to stop by switching the marker lights to red and displaying a stop hand signal[23] from the drivers cab. The driver of 404A responded to the stop signal and made an emergency brake application stopping on approach to the location of driver B.

Fatigue and alertness

Introduction

Fatigue can have a range of adverse influences on human performance, including slowed reaction time, decreased work efficiency, reduced motivational drive, increased variability in work performance and more lapses or errors of omission (Battelle Memorial Institute, 1998), as well as various effects on decision making (Harrison and Horne, 2000).

Sleep is vital for recovery from fatigue, with both the quantity and quality of sleep being important. Most people need at least 7–8 hours of sleep each day to achieve maximum levels of alertness and performance. Research has shown that obtaining less than 5 hours sleep in the previous 24 hours is inconsistent with a safe system of work (Dawson and McCulloch, 2005), with some research indicating less than 6 hours sleep can increase risk (Thomas and Ferguson, 2010, Williamson and others, 2011).

In addition to sleep, a number of other factors can increase fatigue, including time of day, time awake and the nature of work activities. Working during the window of circadian low or tough, from about 0200 to 0600, has been associated with increased sleepiness, slower response times and increased errors and incidents (Battelle Memorial Institute, 1998).

Waterfall Signaller

In this case, it is unclear exactly how many hours of sleep the WS had in the 24 or 48 hours prior to the incident. However, based on the available information, it is likely that they had less hours of sleep than normal following a night shift, and this sleep was disrupted. In addition, it is likely that the WS was experiencing a level of cumulative fatigue due to non-work related factors. The incident also occurred during the period between approximately 0200 and 0420. Overall, based on this information, due primarily to non-work-related factors, the WS was probably experiencing a level of fatigue that has been demonstrated to adversely influence performance.

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[22] Pacific National utilise a pocket book known as a Take 3 for risk assessing a task and recording the controls.

[23] A signal given by hand movements, in this case, both hands raised above the head. In an emergency, vigorous waving of arms, any coloured light or flag or other material will indicate stop to the driver of approaching rail traffic. Rail Industry Safety Induction Handbook, Sydney Trains.

Conducting night shift work undoubtedly increases the potential for fatigue, and most people will not be able to sleep as effectively during the day as during their normal sleep periods at night. However, fatigue risk can be reduced to an acceptable level with the use of a set of appropriate risk controls. In this case, Sydney Trains had limited the WS's overnight duty periods to 8 hours and ensured there was a significant period of time off duty between duty periods.

Fatigue management is a responsibility shared between the organisation and employees. Employees are responsible for utilising the provided rest periods and managing their non-work related fatigue. In addition, they must report if they are affected by fatigue or unfit for duty in any other way.

In this case, the WS had not advised their employer of the potential for them to be affected by fatigue prior to commencing duty on the night of 20 August. It should be recognised that most people generally underestimate their level of fatigue (Battelle Memorial Institute 1998). Although it appeared the WS had some level of concern about their fitness for duty, it is likely that they did not fully appreciate the extent to which their performance could be affected.

The WS also advised that they perceived there could be some negative consequences associated with reporting that they were fatigued or not fit for duty. Such reservations are common in some organisations, and the ATSB did not fully examine the extent to which this was a commonly perceived problem amongst other Sydney Trains employees. However, this incident provides a reminder to all organisations and safety-critical workers of the importance of reporting concerns about their fitness for duty if their sleep has been adversely affected in the period prior to commencing work.

Although it is likely that the WS was experiencing fatigue, it is unclear based on the available evidence that the fatigue contributed to the limitations in their performance involved in this incident. It is likely there were that other factors including the personal stress and distraction and poor communications relating to the occurrence impacted their performance.

Crew of 4WM2

Both drivers of 4WM2 commenced their shift at 1745 on 20 August. Delays to the journey of 4WM2 extended both drivers' shifts beyond their rostered finish time of 0322. Driver A finished at 0655 (13 hours 10 minutes) and driver B finished earlier at 0612 (12 hours 36 minutes). However, both drivers had sufficient sleep opportunity prior to commencing their shift.

The first safeworking irregularity occurred within the drivers' rostered shift with the second occurring close to their rostered finish time. The drivers' shift extended approximately two hours after the safeworking irregularity in which time the remarshalling was completed and the crew were relieved.

There was a period of low workload between approximately 0030 and 0200 while stationary at signal W26U. Both drivers reported that during that period they probably felt a bit tired. It is possible that the combination of a period of low workload, time of night and time on shift may have increased their risk of fatigue-related errors. However, based on the available information, there was insufficient evidence to conclude that the drivers were experiencing a level of fatigue known to affect performance.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to the safeworking irregularity involving the crew of freight train 4WM2 on 21 August 2019.

Contributing factors

- The safeworking network rules and procedures for protecting activities associated with in-service rail traffic were not effectively utilised by the either crew of train 4WM2 or the Waterfall Signaller to ensure workers in the danger zone were protected from rail traffic.
- There were multiple parties involved in the decision making and communications relating to the movements of train 4WM2. A lack of clear communication lead to confusion and misunderstanding of the required activities.
- The Sydney Trains and Pacific National personnel did not ensure that network communications were conducted in accordance with network rule NGE 204.

Other factors that increased risk

- Primarily associated with non-work related factors, the Waterfall signaller was probably experiencing a level of fatigue that has been demonstrated to adversely influence performance.
- The location the crew of 4WM2 were directed to remarshal the train placed the crew at increased risk as the area was remote, poorly lit and difficult to access.

Other findings

- The Waterfall Up sidings were available as a safer and practical alternative to either stow or remarshal the train until normal operations resumed.

Safety actions

Safety action not associated with an identified safety issue

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Proactive safety action by Sydney Trains

Sydney Trains advised that the following proactive safety actions had been taken:

- The Waterfall Signaller completed training and coaching in the establishment of protection associated with in-service rail traffic before returning to full duties.
- Reviewed the risk management processes applied by Network Operations to the management of controls nominated as critical, including critical control nomination, type and frequency of assurance activities, control effectiveness rating and control improvement activities.
- Reviewed the risk management process applied by Network Operations to the network hazard identified as 'Person in path of rail vehicle / Worker in path of rail vehicle - Absolute Signal Blocking (ASB) incorrectly implemented/maintained', in the context of conducting protection activities associated with in-service rail traffic.
- Reviewed the processes as they relate to incident management and the duties, responsibilities, interdependencies and relationships between Duty Control Managers, Network Incident Managers, Train Service Delivery Managers, Area Controllers, Signallers and Qualified Workers.
- Reviewed the processes relating to the assessment of the ongoing competence of Signallers engaged in protection activities associated with in-service rail traffic.
- Reviewed the processes as they relate to the assessment of the ongoing competence of Drivers engaged in protection activities associated with in-service rail traffic.

Proactive safety action by Pacific National

Pacific National advised they reviewed the process for the protection of in-service rail traffic inspection and activities and ensured the requirements of both Pacific National and the Network Owners, were reinforced and understood by all required train crew.

General details

Occurrence details

Date and time:	21 August 2019 – 0417 AEST	
Occurrence category:	Incident	
Primary occurrence type:	Safeworking irregularity	
Location:	2 km south of Waterfall, New South Wales	
	Latitude: 34º 09.237' S	Longitude: 150º 59.798' E

Train 1 details

Train operator:	Pacific National	
Registration:	4WM2	
Type of operation:	Freight	
Departure:	Port Kembla, New South Wales	
Destination:	Melbourne, Victoria	
Injuries:	Crew – Nil	Injuries: - Nil
Damage:	None	

Train 2 details

Train operator:	NSW Trains	
Registration:	404A	
Type of operation:	Passenger - regional	
Departure:	Kiama, New South Wales	
Destination:	Sydney Terminal, New South Wales	
Injuries:	Crew – Nil	Passengers – Nil
Damage:	None	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- Drivers of 4WM2
- Pacific National
- Sydney Trains
- Waterfall Signaller.

References

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Harrison H & Horne JA (2000). The impact of sleep deprivation on decision making: A review, Journal of Experimental Psychology, vol. 6, pp. 236–249.

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Rail Industry Safety and Standards Board (2020). Glossary of Terms.

Sydney Trains (2015). Rail Industry Safety Induction Handbook, v5.1.

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Thomas MJW & Ferguson SA (2010). Prior sleep, prior wake, and crew performance during normal flight operations, Aviation, Space, and Environmental Medicine, vol. 81, pp. 665–670.

Williamson A, Lombardi DA, Folkard S, Stutts J, Courtney TK & Connor JL (2011). The link between fatigue and safety, Accident Analysis and Prevention, vol. 43, pp. 498–515.

Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the following directly involved parties:

- Drivers of 4WM2
- Office of the National Rail Safety Regulator
- Pacific National
- Sydney Trains
- Transport for NSW

- Waterfall Signaller.

Submissions were received from:

- Office of the National Rail Safety Regulator
- Pacific National
- Sydney Trains.

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- independent investigation of transport accidents and other safety occurrences
- safety data recording, analysis and research
- fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, international agreements.

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

An explanation of terminology used in ATSB investigation reports is available on the ATSB website. This includes terms such as occurrence, contributing factor, other factor that increased risk, and safety issue.