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Australian Transport Safety Bureau

Collision between freight trains 2MP9 and 2MP1

Mile End, South Australia | 31 March 2015



Investigation

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Addendum

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Safety summary

What happened

At about 0730 (CDT) on 31 March 2015, intermodal freight train 2MP9 passed No. 1 signal at the southern end of the Mile End crossing loop (South Australia). The signal was displaying a 'Calling on/Low speed' indication. The train proceeded at low speed, but subsequently collided with the rear end of intermodal freight train 2MP1, which was stationary on the main line. The collision resulted in moderate track damage and the derailment of three wagons at the rear of train 2MP1. There were no injuries to train crews.

Collision site near Mile End



Source: ATSB

What the ATSB found

The ATSB determined that the signalling and communications systems were operating correctly and as designed. The investigation found that the driver of train 2MP9, on receiving a 'Calling on/Low speed' signal indication, proceeded at a speed not greater than 25 km/h, but was unable to stop the train, 'within half the distance the line ahead was clear', as prescribed by the operational rules. The driver was aware that the operational rules stipulate that 'block ahead may be occupied or obstructed', but did not expect that train 2MP1 was stationary on the track so close ahead. As he approached train 2MP1, some stumpy vegetation and a low fence initially obscured his view of the empty flat wagons at the rear of the train. When the driver finally saw the rear of train 2MP1, he immediately made an emergency brake application, but was unable to stop the train before it collided with 2MP1.

The ATSB noted that the pathing of a train by a network control officer (NCO) onto a line occupied by a preceding train, when an alternate route is available and not obstructed, presents an elevated level of risk. Similarly, well thought out and clear communications between an NCO and crew of an approaching train, as to the proximity of a train occupying the track ahead, can significantly enhance situational awareness and reduce operational risk.

What's been done as a result

The Australian Rail Track Corporation (ARTC) and SCT Logistics have implemented a range of proactive strategies for enhancing the safe operation of train movements when entering an occupied section of track under a 'Proceed restricted authority' (PRA). This includes the use of all available infrastructure to reduce risk, encouraging communications between train drivers and NCOs where clarification of operational conditions is necessary, and a review of the National Train Communications System (NTCS) for the Adelaide area.

Safety message

Train drivers should carefully consider their obligations when accepting a 'Calling on/Low speed' signal indication in relation to sighting constraints, train speed and occupation of the track ahead. In circumstances where sighting constraints may exist, drivers should consider requesting further information from the NCO before moving through the track ahead.

NCOs should carefully consider the pathing of trains under their control, and the communication of information that may mitigate collision risk when dispatching trains.

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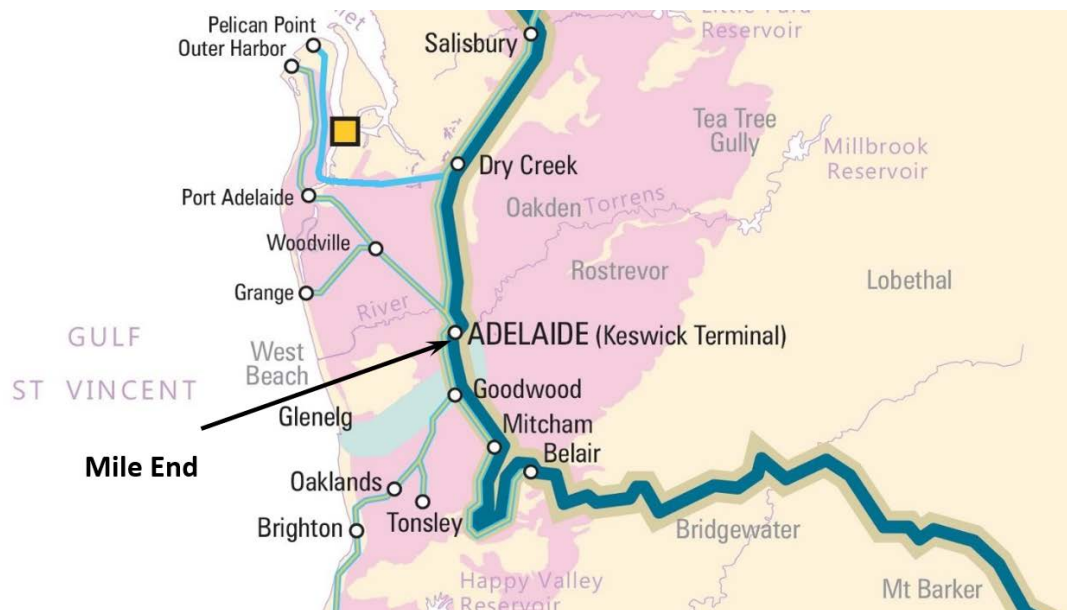
The occurrence

The two drivers involved in the occurrence booked on for duty at the SCT Logistics Penfield Rail Freight Terminal (about 33 km north of the Adelaide CBD) in South Australia at 2100¹ on 29 March 2015. They worked train 6PM9 through to Horsham in Victoria, arriving at about 0500 (EDT) on 30 March. They rested in Horsham (motel accommodation) before resuming duty at 0100 (EDT) on 31 March. The drivers were rostered to join train 2MP9, a scheduled SCT Logistics (SCT) intermodal freight service, operating from Melbourne in Victoria through to Perth in Western Australia.

Train 2MP9 arrived in Horsham at 0208 (EDT). The crew changeover occurred as planned, with the train departing at 0216 (EDT). Train 2MP9 crossed with train 2XM2 in Taillem Bend, South Australia (120.298 km)². While near Taillem Bend, the drivers of 2MP9 exchanged their respective driver/observer roles. This was the last driver exchange before the occurrence.

As train 2MP9 passed through Taillem Bend (about 0513), an Aurizon intermodal freight train (2MP1) also enroute from Melbourne to Perth was about 48 minutes ahead. Both trains continued on their journey towards Mile End (Figure 1).

Figure 1: Location map – Mile End, South Australia



Source: NatMap Railways of Australia

At about 0645, Aurizon train 2MP1 passed through Belair (22.510 km), at which time the SCT train 2MP9 was travelling the Ambleside (42.670 km) - Mt Lofty (30.972 km) section³. At about the same time, a change of shift was occurring at the ARTC Network Control Centre West (NCCW). The incoming Adelaide metro network control officer (NCO) familiarised himself with train movements coming under his control, which included 2MP1 and 2MP9.

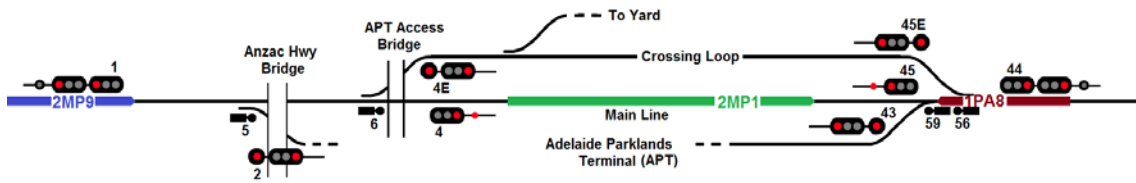
At about 0700, the NCO set No. 1 signal (Figure 2) for 2MP1 to enter the Mile End crossing loop, on the main line. No. 44 signal had been pre-selected to clear for the Indian Pacific passenger train (1PA8), coming from the north, to enter the Adelaide Parklands Terminal (APT). No. 45 signal was at stop for 2MP1.

¹ The 24-hour clock is used in this report and is referenced from Central Daylight Time (CDT) unless stated otherwise.

² Distances are track kilometres measured from a reference mark/post at Mile End.

³ The line between two successive interlockings or block locations.

Figure 2: Mile End signal schematic



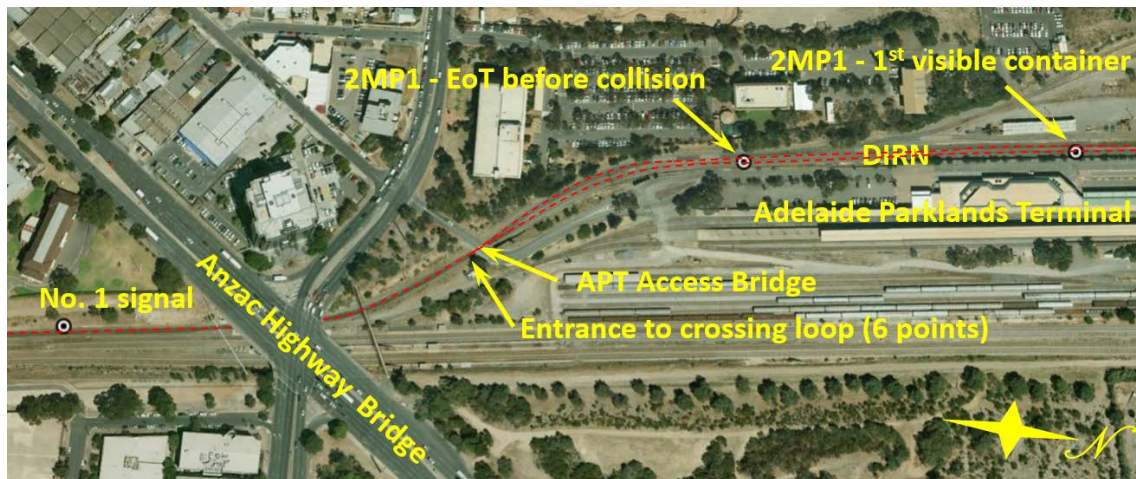
Source: ATSB

At about 0710, as train 2MP1 was transiting through the Mile End main line, train 2MP9 was passing through Belair and approaching Mile End from the south. At this time, the Indian Pacific was nearing Dry Creek (Figure 1), about 17 km to the north of Mile End. Signal No. 44 cleared to proceed at 0711:34.

2MP1 came to a stand on the main line fully within the Mile End crossing loop, about 200 m before signal No. 45. The rear end of the train was about 90 m from No. 4 signal. At about 0717 the NCO, in communication with the driver of 2MP1 (stationary Aurizon train), advised that the Indian Pacific was passing through Islington, about 8 km north of Mile End. He further advised that their train (2MP1) would be dispatched as soon as the Indian Pacific was clear of the main line and within the APT limits. At about 0723, the NCO pre-selected No. 45 signal. It was now set to automatically clear for train 2MP1 when the Indian Pacific was within the APT limits.

At about this time, train 2MP9 was passing through Hawthorn (suburb south of Adelaide), about 5 km south of Mile End. The train was now approaching NR8 signal displaying a caution/yellow aspect. This indication communicated that the next signal, No. 1 at Mile End, would be at stop. The driver continued towards No. 1 signal progressively reducing the train's speed to a near crawl (1 km/h). At about 0738, with train 2MP9 about 500 m from No. 1 signal (Figure 3), the NCO selected the Calling on/Low speed signal so as to path 2MP9 into Mile End on the main line directly behind train 2MP1. The driver saw the No. 1 Calling on/Low speed signal clear and commenced to accelerate his train towards the maximum allowable speed of 25 km/h, but ready to stop should he see an obstruction on the track ahead.

Figure 3: Site overview near Adelaide Parklands Terminal (APT)



Source: Google Earth - annotations by ATSB

The Indian Pacific passed through Torrens Junction (3.281 km north of Mile End) at about 0737 and continued towards Mile End. As the Indian Pacific passed No. 44 signal at Mile End the NCO began to brief the driver of train 2MP1 (stationary Aurizon train) regarding the pending departure of his train.

By this time, train 2MP9 had passed under the Anzac Highway Bridge. It was traversing a sweeping left curve as it approached Mile End 6 points near the APT Access Bridge (Figure 3).

Train 2MP9 continued on a very mild down grade, reaching a speed of 25 km/h before entering a sweeping right curve. Just after clearing the APT Access Bridge, the driver was able to see the track to a distance of about 150 m ahead, which initially, to him, appeared clear (Figure 4).

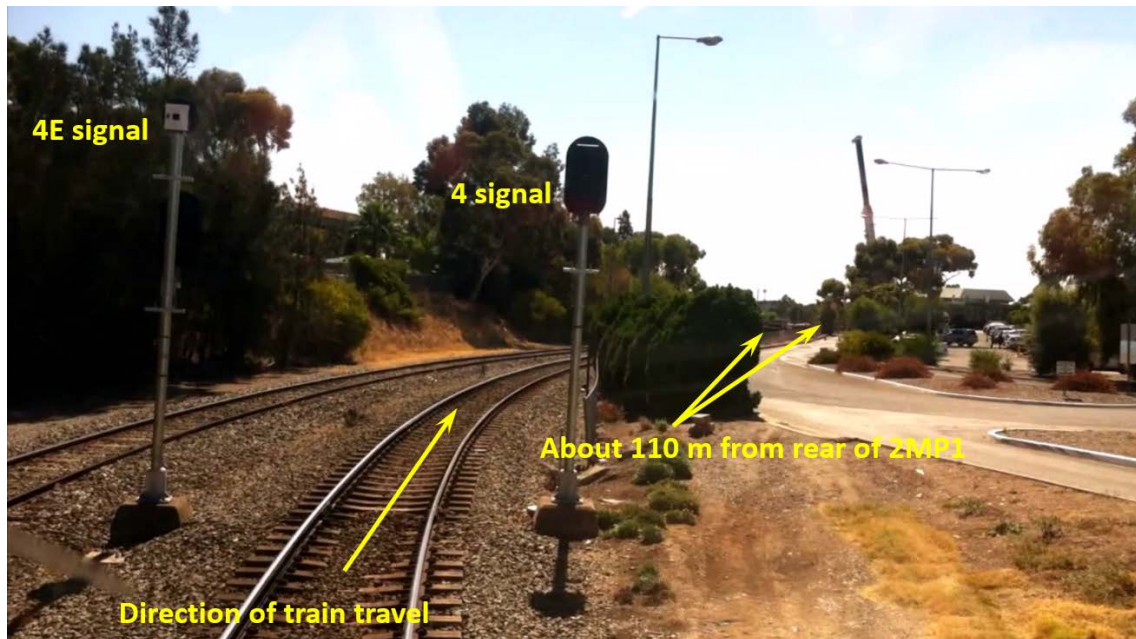
Figure 4: Cab view post-collision reconstruction, about 150 m from the rear end of 2MP1



Source: SCT Logistics, annotations ATSB

After travelling, a further 40 m (Figure 5) the driver saw what appeared to be a series of empty flat wagons on the track ahead. He applied the train's dynamic brakes (D8) and immediately followed this with an emergency brake application.

Figure 5: Cab view post-collision reconstruction, about 110 m from the rear end of 2MP1



Source: SCT Logistics, annotation ATSB

He was unable to stop the train before colliding with the rear end of 2MP1 (Figure 7) at an estimated speed of 22 km/h.

Figure 6: Cab view post image reconstruction, about 60 m from rear end of 2MP1



Source: SCT Logistics, annotation ATSB

Figure 7: Collision site - lead locomotive SCT009 in the background



Source: ATSB

About 9 seconds after the collision, the NCO contacted the driver of 2MP9 to advise that the train (2MP1) in front would be getting a signal shortly. The driver of 2MP9 responded indicating that he had already run into the back of train 2MP1.

Events post-collision

Following the collision, the NCO restored No. 45 signal to prevent the unintentional dispatch of Aurizon train 2MP1. The NCO then proceeded to close the track to other rail traffic and checked on the well-being of the drivers of both trains 2MP1 and 2MP9. The drivers of Aurizon train 2MP1 advised they were uninjured. The crew of SCT train 2MP9 advised they were shaken but otherwise uninjured. The driver of 2MP9 then de-trained, assessed the extent of collision damage and passed a damage report to the NCO and the management of SCT Logistics.

Accident investigation and recovery personnel were dispatched to site. The drivers and NCO were tested for the presence of drugs and alcohol. Recovery personnel commenced necessary restoration works with the track being re-opened to traffic later that day.

Context

Location

The collision occurred almost adjacent to the interstate Adelaide Parklands Terminal (APT), located at Mile End. The APT is about 2 km southwest of the Adelaide CBD, in South Australia. Leader Street and Victoria Street level crossings are located south of the Mile End crossing loop, 590 m and 1,160 m from No. 1 signal respectively. The two at-grade crossings are controlled by flashing signals, boom barriers and audible signals.

Figure 8: Site overview



Source: Google Earth - annotations by ATSB

Train and train crew information

Train 2MP9 was a regular SCT Logistics intermodal freight service that operates between Melbourne and Perth. The train was configured with three locomotives at the head of the train (SCT009 leading, then SCT011 and SCT012 trailing) followed by 61 wagons. The train had an overall length of 1,641 m and a gross mass 3,807 t.

Locomotive SCT009 was equipped with a data logger (Loco-log) used for capturing information such as date/time, speed, brake pipe pressure, throttle position and distance travelled.

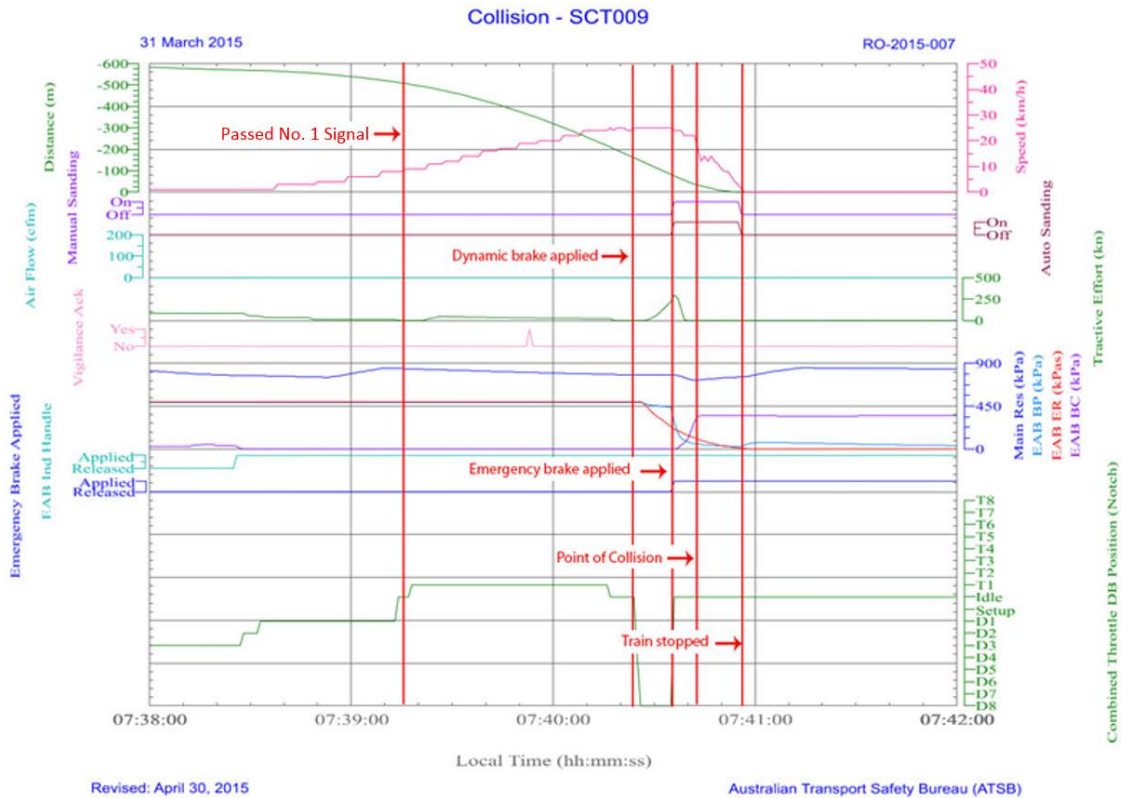
Train 2MP1 was an Aurizon intermodal freight service that also operates between Melbourne and Perth. The train was configured with two locomotives at the head (6027 leading and 6006 trailing) followed by 51 wagons. The train had an overall length of 1,452 m and a gross mass 2,968 t.

Train 2MP9 – train management prior to collision

Analysis of data extracted from the Loco-log (SCT009) for train 2MP9 (Figure 9) established:

- As the train approached No. 1 signal, the driver progressively reduced the train speed and reached a near crawl (1 km/h) before commencing to accelerate.
- When train 2MP9 passed No. 1 signal it was travelling at a speed of 8 km/h and continued to accelerate, reaching a maximum speed of 25 km/h. The driver then set the throttle to idle.
- Eight seconds later the driver applied the dynamic brakes (D8) and immediately followed this with an emergency brake application.
- About 6 seconds after the emergency brake application, a sharp decrease in train speed was evident, probably coinciding with the time that train 2MP9 collided with train 2MP1.

Figure 9: Graph derived from Loco-log SCT009



Source: Data SCT Logistics, graphed by ATSB

- About 15 seconds later (post-collision), train 2MP9 was at stop.
- Loco-log data established that while approaching Mile End, the driver of 2MP9 was actively controlling/maintaining the train's speed by applying a range of throttle commands.

Train crew

The driver in control of train 2MP9 commenced working in the rail industry in 1984. He was a qualified diesel/locomotive fitter before becoming a train driver in 2010. At the time of the collision, he was appropriately qualified and route certified. The observer had about six years train driving experience. He was appropriately qualified and had travelled over the route on six previous occasions. At the time of the occurrence, he was undertaking the final phase of route certification training.

Environmental conditions

At about 0730, the weather at Kent Town (2 km east of the Adelaide CBD) was fine. Temperature was about 14°C and the wind calm. No rain had fallen in the preceding 24-hour period. Sunrise occurred at 0727. The sun was almost due east and provided good visibility. Environmental conditions leading up to the occurrence were not extraordinary and were considered unlikely to have contributed to the collision.

Track information

The track from Melbourne through to Mile End (Adelaide) substantially comprised a single line (bi-directionally signalled) with crossing loops strategically located throughout its length. The crossing loop at Mile End (Figure 2) was documented⁴ as having an available standing room of 1,656 m.

⁴ ARTC's Code of Practice for Operations and Safeworking, Network Interface Co-ordination Plan, TA02 Issue 2.2.

The measured distance between signals 4 and 45 (Main Line) and between 4E and 45E (Crossing Loop) was 1,750 m.

The Mile End crossing loop was controlled by fixed colour light signals using track circuits for train detection. From No. 1 signal (Figure 3 and Figure 10) at the southern end of the Mile End crossing loop, the track leading into the collision site basically comprised two relatively tight sweeping curves, the first to the left followed by a curve to the right. The track is on a very mild down grade before entering the crossing loop. Sighting along this section of track was intermittently obstructed by fixed infrastructure (Anzac Highway Bridge and APT Access Bridge) in addition to low bushes and a small tree.

Figure 10: No. 1 signal showing position of Calling on/Low speed aspect



Source: ATSB

Code of Practice – Operational rules

ARTC's *Code of Practice for the Defined Interstate Rail Network – Glossary* (Clause 3.2) defines an *Occupancy authority* as falling into one of two groups:

Proceed authority (PA): A formal authority for a train to proceed in the forward direction under normal operating conditions where exclusive occupancy of the track section to which it applies is guaranteed.

Proceed restricted authority (PRA): A formal authority for a train to move in the forward direction at restricted speed to enter the limits of a preceding train or track obstruction.

Clause 2.4.2 of ARTC's *Code of Practice for the Defined Interstate Rail Network – Operations and Safeworking, Rules* prescribes the separation requirements for a train operating under a PRA as:

The safe working system **shall** allow the authorisation of a train to enter a route where one of the following conditions apply:

- (a) The route is proved clear taking into account rollingstock gauge limits and an allowance for overhang.

- (b) The route is occupied by another train that is not moving.
- (c) The route is occupied by another train that has departed and is not returning.


















At Mile End, occupancy authorities were communicated to train drivers using colour light signals. No. 1 signal at Mile End (Figure 10) controls northbound trains entering the main line (6 points set normal) and entering the crossing loop (6 points set reverse). No.1 signal comprises a group of coloured lights that convey the status of the track (block) ahead and communicates information such as permissible track speed and/or restrictions that define the way a train should be driven.

The correct display and interpretation of the signal by the train driver is essential for a train to move safely through the block ahead.

The indications and meaning that can be displayed by No. 1 signal at Mile End are described in the *Code of Practice for the Defined Interstate Rail Network – Volume 3 - Operations and Safeworking Part 1: Rules*, January 2013 (Table 3.1).

Table 1: Signalling Systems – Fixed Signal Indications, Meanings and Application

System	Speed Signalling	
PRINCIPALS	Top light	Indicates route, condition of block ahead for normal speed and likely condition of the subsequent block.
	2 nd light	Indicates route, condition of block ahead for medium speed and likely condition of the subsequent block.
	3 rd light	Where a 3 rd light is displayed indicates block ahead may be occupied, proceed at low speed prepare to stop.

Name	Normal Speed		Medium Speed		Low Speed	
(CLEAR)	 	1. PA – Block is clear 2. Normal speed 3. Next signal at caution or clear for normal speed	 	1. PA – Block is clear 2. Medium speed 3. Next signal at caution or clear for medium or normal speed		Not Applicable
(CAUTION)	 	1. PA – Block is clear 2. Normal speed 3. Next signal at stop	 	1. PA – Block is clear 2. Medium speed 3. Next signal at stop		Not Applicable
(STOP)	 	Stop	 	Stop	 	Stop
(CALLING ON/LOW SPEED)		Not Applicable		Not Applicable	  	PRA – Block may be occupied or obstructed Proceed at low speed Prepare to stop short of obstruction

Source: ARTC

In Table 1, a Calling on/Low speed when given, stipulates ‘A speed which will enable a train movement to be stopped within half the distance the line is seen to be clear ahead, but which does not exceed 25 km/h’ (ARTC Code of Practice, Issue 2 May 2002). The driver in control of the train is required to be able to stop short of any obstruction on the track ahead.

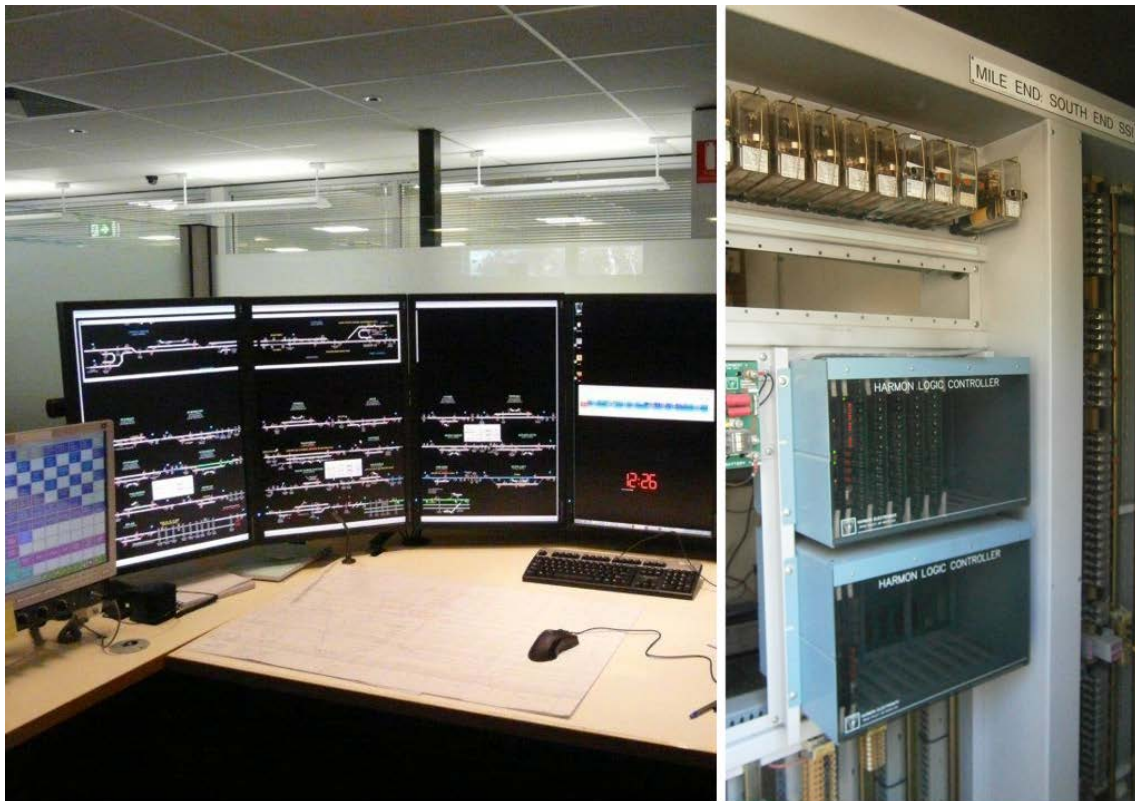
With respect to this occurrence, No. 1 signal at Mile End was displaying a Calling on/Low speed indication, authorising a train (2MP9) to proceed at low speed and enter a route occupied by another stationary train (2MP1).

The signalling events were consistent with the PRA provisions documented in the ARTC Code of Practice.

Signalling and communications – Mile End crossing loop

Signals and points at Mile End were remotely operated from a network control centre located at Mile End in South Australia, using the ARTC’s Phoenix control system (Figure 11, left photo – Adelaide metro network control board). The Phoenix system is a non-vital⁵ CTC⁶ system that provides real time monitoring and control of field hardware including signals, points, track circuits and the associated management of train movements. The system also includes an event logger to capture signal, points, track and train movement data.

Figure 11: Adelaide metro network control board (left photo) and Harmon vital logic controller (right photo)



Source: ARTC

The fail-safe⁷ interlocking functions for the Mile End crossing loop were achieved using a vital logic controller (VLC). The Harmon VLC (Figure 11, right photo) was programmed to facilitate the safe movement of trains and incorporates two distinct levels of computer coding:

1. The *executive code*, is common to each class of VLC and comprises the software routines that:
 - a. Ensure that all vital outputs are fully controlled.

⁵ Non-vital: Signalling equipment and circuits are considered non-vital where failure to function correctly would not cause an unsafe outcome of the signalling system. Non-vital equipment and circuits do not affect the safe operation of the signalling system.

⁶ Centralised Traffic Control (CTC): A safe working system of remotely controlling points and signals at a number of locations from a centralised control room.

⁷ The capability of an item or a system to ensure that failure in a predictable or specified mode will result only in that item or system reaching and remaining in a safe condition.

- b. Verifies the state of vital inputs and outputs.
- c. Removes power to vital outputs in all cases where a system failure has occurred, thereby placing field equipment into a safe mode.

The manufacturer embeds the executive code within the VLC.

2. The *geographic code* depicts the track layout (geography) and the railway's operational rules/procedures. Specialist software engineers conversant in the geographic coding language enter geographic coding. The railway owner defines the requirements for a specific track layout in a '*Control Table*', which is a documented version of the signal interlocking requirements. Software engineers then translate and enter the control table information into the VLC.

As previously mentioned, if a train is occupying the track ahead, a Calling on/Low speed signal may only be cleared if that train is stationary. Examination of the Mile End control tables established that this interlocking requirement was achieved by verifying that the main line had been occupied for at least 3 minutes.

Examination of event logger data (Phoenix control system) established that train 2MP1 had been standing on the main line for about 27 minutes before No. 1 signal (Calling on/Low speed) was cleared for train 2MP9. The driver of train 2MP9 confirmed that No. 1 signal (Calling on/Low speed) cleared for his train as it approached No. 1 signal. He indicated the signalling system appeared to function correctly.

Based on the interview with the train driver, an examination of the signalling control tables and a review of the Phoenix event logger data files, the ATSB was satisfied that the signalling system operated correctly for train 2MP9.

Network Control Centre West (NCCW)

Mile End is the interface between two ARTC geographical areas of control, with individual NCOs being responsible for south and Adelaide metro boards (areas). The south board NCO controls train movements from (but not including) Mile End to Wolseley. The Adelaide metro board NCO controls train movements from (and including) Mile End to Dry Creek North/Dry Creek and to Pelican Point. Voice communication between trains and ARTC's network control centre was achieved using ARTC's National Train Communications System (NTCS).

Network control officer (NCO)

The NCO involved with the occurrence commenced his employment with the railways in 1979. He had extensive experience and had been engaged as train controller/NCO from about 1997 onwards.

The NCO's records established that he had been assessed as meeting the medical standards prescribed by the *National Standard for Health Assessment of Rail Safety Workers*. He was appropriately qualified to control the Adelaide metro board. At interview, the NCO reported being in good health and well rested prior to signing on for duty on 31 March 2015. There was no evidence to suggest that the NCO's performance was affected by fatigue.

Post derailment the NCO underwent drug and alcohol testing, the results of which were negative.

2MP9 train driver actions

The primary task for the driver of train 2MP9 was to safely negotiate the track ahead, including the correct interpretation of No. 1 signal and the correct application of the relevant operational rules. In this regard, the driver's actions could be broadly influenced by:

- the level of route knowledge, training, experience and/or task competency
- factors affecting the driver's attention to the primary task

- fatigue, medical condition and/or toxicology (drugs and alcohol)

Route knowledge, training, experience and task competency

A review of the driver's records established that he was:

- Certified and current for the route – Horsham to Mile End, including the section of track from No. 1 signal through to the point of collision.
- Trained and current with respect to operational rules.
- Experienced as a train driver – had been driving for about 5 years. It was further established that he had a sound understanding of locomotive/train dynamics because of his background as a qualified diesel/locomotive fitter. Accordingly, it was concluded that the driver was competent to perform the driving task.

A review of Loco-log data (Figure 9) established that after passing No. 1 signal and prior to making an emergency brake application, the driver maintained a speed below 25 km/h. However, the speed of the train was such that the driver could not stop 2MP9 before colliding with the rear of train 2MP1.

During interview, the driver affirmed that he was familiar with the route and had regularly traversed the section of track where the collision occurred. He accurately explained the meaning of the Calling on/Low speed indication. The driver described that when given a Calling on/Low speed indication, the train must not exceed 25 km/h and must be controlled so that it can stop short of any obstruction, within half the visible sighting distance ahead.

Based on a review of the driver's qualifications as well as interview evidence, it is unlikely that the driver's route knowledge, training, experience and/or task competency were factors that contributed to the collision.

Attention: workload and distraction

Workload

Human performance is highly variable and subject to a number of influencing factors. The term 'cognitive workload', refers to a measure of the type or nature of work being undertaken with regard to its demands on an individual's cognitive resources. Cognitive workload can be in *overload* where the demands on the working memory are excessive, or in *underload*, brought about by periods of relative inactivity and boredom⁸. Factors influencing workload can include the quantity and complexity of concurrent or consecutive tasks, as well as time requirements for their completion. An individual's familiarity with a task will also influence their cognitive workload.

Distraction

Distraction can be understood as a type of inattention, where a person's attention is diverted by a particular event or object. Driver distraction has been more specifically defined as 'the diversion of attention away from activities critical for safe driving toward a competing activity (occurring) voluntarily or involuntarily.'⁹

Driver distraction can involve a range of factors either inside or outside a vehicle that draw on limited human physical, visual and cognitive resources, and can result in a degradation of the driver's performance. For example, eating, drinking, operating devices integral to (or brought

⁸ National Transport Commission. (2008). *National Rail Safety Guideline. Management of Fatigue in Rail Safety Workers*. Available from: [http://www.ntc.gov.au/Media/Reports/\(B8FFAA63-E7F4-D48E-385C-2D87B3332177\).pdf](http://www.ntc.gov.au/Media/Reports/(B8FFAA63-E7F4-D48E-385C-2D87B3332177).pdf)

⁹ Regan, M.A., Hallett, C. & Gordon, C.P. (2011). Driver distraction and driver inattention: Definition, relationship and taxonomy. *Accident Analysis and Prevention*, 43, 1771-1781.

into) the vehicle (such as a mobile telephone), smoking, or conversing with another occupant are all activities that may distract from the driving task¹⁰.

The lead locomotive SCT009 was fitted with an event logger. It recorded data such as date/time train speed, distance travelled, traction effort, throttle position and operation of the vigilance system.¹¹ The driver recalled that as train 2MP9 approached the collision site (rear end of train 2MP1), he was concentrating on driving the train, including observing the track ahead. An examination of the loco-log established that:

- The driver was actively controlling/maintaining the train's speed on approaching No. 1 signal, Mile End. He reduced the train's speed, to a near crawl (1 km/h) before the signal cleared.
- When No. 1 signal cleared – Calling on/Low speed, he accelerated the train up to the permitted speed of 25 km/h.
- He maintained the train's speed at or below 25 km/h.
- He responded quickly and positively on seeing the rear end of train 2MP1, making an emergency brake application.

In this occurrence, there was no evidence to indicate that the driver's attention to the task, and thus his capacity to perceive and interpret important information (observing train 2MP1), was negatively affected by workload or distraction.

Fatigue

In the context of human performance, fatigue is a physical and psychological condition primarily caused by prolonged wakefulness and/or insufficient or disturbed sleep.¹² Fatigue can have a range of influences on performance, such as decreased short-term memory, slowed reaction time, decreased work efficiency, reduced motivational drive, increased variability in work performance, and increased errors of omission.¹³ Fatigue impairment has been identified as causal in many transport related accidents.

The driver involved in this occurrence was based at the SCT Logistics depot, Penfield. Examination of the roster shows that he had been on annual leave for 20 days prior to commencing duty at 2100 on 29 March 2015. He worked train 6PM9 through to Horsham in Victoria – arriving about 0500 (EDT) on 30 March. He rested in Horsham before resuming duty at 0100 (EDT) on 31 March, when he joined train 2MP9. For the first part of the journey (through to Tailem Bend), he worked as the observer. At approximately 0500, he swapped with the active driver and then drove train 2MP9 from Tailem Bend through to Mile End.

At the time of collision the driver had been in control of the train for about 2 ½ hours and was about 6 ½ hours into the rostered shift. When interviewed, the driver indicated that he had obtained a good sleep and was well rested prior to commencing shift. He had not noted feeling any effects of fatigue in the period prior to, or at the time of collision.

On balance, considering the driver's hours worked, sleep opportunity, time of day, and his recorded driving responses/actions, it is considered unlikely that the driver was impaired by fatigue at the time of the occurrence.

¹⁰ Young, K.L., Regan, M.A., & Hammer, M. (2003). Driver Distraction: A review of the literature. *Monash University Accident Research Centre*. Available from: <http://www.monash.edu.au/miri/research/reports/muarc206.pdf>

¹¹ Vigilance system - A system that will react by directly initiating an emergency brake application if an acknowledgment input is not received within a specified time increment.

¹² National Transport Commission (2008). *National Rail Safety Guideline. Management of Fatigue in Rail Safety Workers*.

¹³ Battelle Memorial Institute (1998). *An Overview of the scientific literature concerning fatigue, sleep, and the circadian cycle*, Report prepared for the Office of the Chief Scientific and Technical Advisor for Human Factors, US Federal Aviation Administration.

Medical and toxicology

The driver and observer's health records confirmed their health assessments were current. Both drivers had been assessed as meeting the required standard prescribed by the *National Standard for Health Assessment of Rail Safety Workers*. The ATSB's investigation found no evidence to suggest that any medical or physiological factors had affected the driver or observer's performance leading up to, or at the time of the collision.

Post-collision both drivers underwent drug and alcohol testing, the results of which were negative.

Other occurrences involving *Calling on/Low speed movements*

The ATSB has previously investigated one similar occurrence, (RO-2010-013), at Yass Junction, New South Wales on 9 December 2010. That incident involved a Calling on signalling related incident that resulted in the collision between two-grain trains, 3234N and 8922N.

The investigation concluded:

- The driver of train 3234N was operating the train at a speed too fast for the prevailing conditions and intent of the Calling on signal.
- At the time of the collision, it was dark with moderate rain. Sighting distance was limited by the curvature of the track, embankments, and the effective illumination of the train's headlight.
- The driver had expected to be told by the network controller if a train was stopped ahead so he could anticipate the location of the rear end of the train and drive accordingly.
- While not contributing to the incident, the ARTC definition of restricted speed (at that time) required considerable judgement on the part of train drivers.¹⁴

The ATSB found that the speed of the train (being too fast for the prevailing conditions), was the primary factor in the Yass Junction collision. However, the ATSB also noted that providing the train crew with information regarding the status of the track ahead, probably offers an opportunity to reduce risk, by improving train driver awareness of upcoming risks.

¹⁴ Restricted speed in South Australia for a 'Calling on/Low speed signal' – has always mandated a speed not greater than 25 km/h and that the driver can stop short of any obstruction. Restricted speed in NSW is not governed by an upper (defined) speed limit.

Safety analysis

Based on a review of evidence gathered during this investigation, the ATSB concluded that:

- There were no mechanical deficiencies with train 2MP9 which contributed to the collision.
- The signalling and communication systems operated correctly and as designed.
- Train 2MP9 proceeded past No. 1 signal and travelled at a speed not greater than 25 km/h.
- The driver of train 2MP9 was unable to stop the train, in accordance with the operational rules, and collided with the rear of train 2MP1.

The following safety analysis focuses on factors that may have influenced the train driver's awareness and sighting of train 2MP1.

Conspicuity of the rear of train 2MP1

Conspicuity refers to those characteristics of an object or condition that determine the likelihood that it will come to the attention of an observer. Some of the key attributes that contribute to the conspicuity of an object are its brightness, contrast and physical size. In general terms, objects that stand out from their visual background are more easily noticed, and, when all else is equal, larger objects are generally easier to see and hence more conspicuous than smaller objects¹⁵.

The driver and observer of train 2MP9 both remarked that they had not seen the empty flat wagons at the rear end of train 2MP1, or the end-of-train (EoT) marker¹⁶, until their train was about 110 m from the rear end of 2MP1 at which time the driver made an emergency brake application.

Train 2MP1 had been marshalled¹⁷ with a number of empty flat wagons at the rear of the train; the last having an end-of-train (EoT) marker attached. It is common practice, and in most cases desirable¹⁸, for lightly loaded or empty wagons to be marshalled to the rear of a train. In this case, this configuration reduced the conspicuity of the rear of train 2MP1.

It was also noted (post-collision) that the rear end of train 2MP1 was partially obscured by stumpy vegetation and a low fence (Figure 4). As is evident in Figure 4, after passing under the APT Access Bridge the train driver and observer could see parts of the track ahead as it swept gradually to the right. However, the vegetation (part of which is outside the ARTC rail corridor) and fence obscured parts of the track. It was likely that with intermittent opportunities to observe the track ahead, the empty flat wagons at the end of train 2MP1 were not sufficiently conspicuous against the visual background as to be perceived by the crew of 2MP9. Thus, the driver did not recognise the need to slow the train (below 25 km/h) as there was no apparent obstruction in his visual field.

Expectancy

Another factor, which can influence performance, is expectancy. An individual's expectations of events can significantly influence their interpretation of information in the environment. Research has established that individuals often fail to notice unexpected events, even ones that are important. Even when objects are designed for visual distinctiveness, they will be missed if they do not fit within an individual's expectations. Overcoming the powerfulness of expectancy is

¹⁵ Olsen, P.L., Dewar, R. & Farber, E. (2010). *Forensic Aspects of Driver Perception and Response (3rd ed.)*. Lawyers and Judges Publishing Company: Tucson. p91.

¹⁶ The end-of-train marker, a device fitted to indicate the trailing end of the last vehicle of a train.

¹⁷ To arrange the order of vehicles in a train's consist.

¹⁸ Desirable due to factors affecting dynamic behaviour of a train in transit.

challenging, particularly because people will generally assume that, by looking in the right direction, unexpected objects and events will grab their attention.¹⁹

Interview evidence indicated that upon observing No. 1 signal displaying a Calling on/Low speed indication, the driver and observer believed that the train ahead of them was most likely moving out of the section. At interview after the collision, the driver and observer stated they could not understand why the NCO had attempted to path their train (2MP9) close in behind 2MP1, as there was very little room for 2MP9. The driver also commented that while the NCO was not procedurally obliged to advise them regarding the position of train 2MP1, had the NCO briefed the driver, he would have approached the site more cautiously, probably at a crawl speed. It was evident that the train crew were not expecting a train so close ahead.

Network control officers' actions

Two of the primary tasks for a network control officer (NCO) are safe and efficient pathing of trains.

As trains 2MP1, 2MP9 and the Indian Pacific (1PA8) approached Mile End they came under the jurisdiction of the Adelaide metro network controller. The NCO examined the geographic positioning of the three trains, considered the pathing opportunities, and decided that train 2MP1 should be held at Mile End to allow the Indian Pacific (1PA8) to be pathed into the Adelaide Parklands Terminal (APT). The NCO expected these two movements to complete before train 2MP9 was to move through Mile End. He pre-selected/stored the routes accordingly. While the signalling system allows routes to be pre-selected/stored, for safety reasons, the interlocking enforces a substantial timeout period if pre-selected/stored routes are cancelled. Therefore, once the NCO had pre-selected/stored routes for 1PA8, 2MP1 and 2MP9, his decisions were somewhat locked in place.

The Indian Pacific (1PA8) did not arrive at the APT as early as the NCO had anticipated. This delay resulted in the NCO electing to hold 2MP1 on the main line within the limits of the Mile End crossing loop, with 2MP9 approaching on the main line behind.

The NCO was busy communicating with the driver of 2MP1 and was intently focussed on the timely dispatch of 2MP1 as soon as 1PA8 was within the APT limits. This was probably for two reasons; firstly to keep train 2MP1 moving and facilitate the efficient pathing of 2MP9 through the Mile End crossing loop. The second reason was to limit the time that train 2MP9 would block the Leader Street and Victoria Street level crossings during the busy morning peak. To move 2MP9 off the level crossings and onto the main line of the Mile End crossing loop, the NCO recognised the need to get 2MP1 moving and out from the crossing loop.

It was evident from network control voice recordings that all communications had been with the driver of train 2MP1 – the NCO's perceived priority. The NCO was providing information regarding the progress of train 1PA8 to expedite the efficient pathing of all three movements, and subsequently clear train 2MP9 off the level crossings. However, there was no similar information communicated to the crew of 2MP9 until moments after the collision.

For signalled movements there was no requirement for the NCO to advise either driver of the status of the track ahead. A correctly functioning signalling system will provide protection for a 'Proceed authority' (PA), but it cannot do so absolutely for a 'Proceed restricted authority' (PRA). While a PA can only be provided if the track ahead is clear, a PRA by the nature of the operational rules allows for joint track occupation, which results in a reduction of defences against train conflicts.

While the signalling system and rules provide protection for train movements, the sweeping curve, stumpy vegetation and low fence, combined with the reduced physical conspicuity of train 2MP1

¹⁹ Chabris, C. & Simons, D. (2010). *The Invisible Gorilla and other ways our intuition deceives us*. Harper Collins: Hammersmith.

inhibited the driver of train 2MP9 from perceiving the train ahead. In the absence of any additional information alerting 2MP9's driver as to the proximity of train 2MP1, the driver assumed the track ahead was clear, and was unable to stop in accordance with the half-distance sighting rule, to avoid the collision.

It was also evident that when pre-selecting routes for 1PA8, 2MP1 and 2MP9, the NCO had not expected a delay to 2MP1 departing the main line in Mile End. The intent was for the Indian Pacific (1PA8) to clear into the APT, for 2MP1 to continue on from Mile End and for 2MP9 to pass largely unimpeded onto the main line at Mile End.

Without presuming the contribution of other factors, an alternative and potentially safer option for the NCO may have been to path train 2MP9 onto the loop track at Mile End. This option would have removed the occupancy conflict that occurred due to the delayed departure of train 2MP1.

It is likely that adoption of defensive pathing solutions and the timely communication of information to train crew are both strategies that could reduce safety risk to rail operations.

National Train Communications System

The ARTC National Train Communications System (NTCS) was (in part) designed to emulate an open channel ('party-line') communication system so that train drivers and track workers could maintain awareness of activities close to their area of operation. However, due to the high volumes of radio traffic and the potential for this to cause train driver distraction, this function was not enabled for the Adelaide metro area. Consequently, due to the configuration of the NTCS system, the driver of 2MP9 did not hear any dialogue between the driver of 2MP1 and the NCO regarding the pathing of train 2MP1 and 1PA8. The driver of 2MP9 was therefore not fully aware of activities close to his area of operation – in particular the position of train 2MP1 on the Mile End main line.

Findings

From the evidence available, the following findings are made with respect to the collision between freight trains 2MP9 and 2MP1 at Mile End, South Australia on 31 March 2015. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance.

A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing factors

- The train was travelling too fast for the prevailing conditions and the driver of train 2MP9 did not see the rear of train 2MP1 in sufficient time to stop and avoid the collision.
- The driver of 2MP9 was unaware, and did not expect that train 2MP1 was stationary on the track ahead.
- **Vegetation and a low fence adjacent the Mile End crossing loop partially obscured the view that the crew of train 2MP9 had of the empty flat wagons at the rear of train 2MP1. [Safety issue]**
- **The practice of pathing a following train onto a line occupied by a preceding train, when an alternate route was available and not obstructed, presented an elevated level of risk. [Safety issue]**

Other factors that increased risk

- **The practice of pathing a following train onto the same line occupied by a preceding train, without pre-warning the driver regarding the train ahead, presented an elevated level of risk. [Safety issue]**
- **The design of the NTCS in screening Adelaide metro broadcast communications prevented the driver of 2MP9 from gaining an appreciation of activities close to his area of operation, in particular the position of train 2MP1 along the Mile End main line. [Safety issue]**

Other findings

- The signalling and communications systems were operating correctly and as designed.
- Operational rules for a 'Calling on/Low speed' signal allow for the dispatch of a train into a route that is occupied by another train at stop.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of these safety issues and actions are repeated separately on the ATSB website to facilitate monitoring by interested parties. Where relevant the safety issues and actions will be updated on the ATSB website as information comes to hand.

End of train conspicuity

Number:	RO-2015-007-SI-01
Issue owner:	Australian Rail Track Corporation.
Operation affected:	Rail: Infrastructure.
Who it affects:	All rail transport operators throughout Australia.

Safety issue description:

Vegetation and a low fence adjacent the Mile End crossing loop partially obscured the view that the crew of train 2MP9 had of the empty flat wagons at the rear of train 2MP1.

Response to safety issue by: Australian Rail Track Corporation

In response to this safety issue, the Australian Rail Track Corporation have responded:

The vegetation is located on private property, the fence is approximately 1.2 metre high chain mesh. Even if removed the increase in sighting distance would be minimal.

The precursor to the incident – over speed operation for the available sighting distance (speed at point of impact 22 km/h) clearly indicates that achieving a minimal increase in sighting distance would not have prevented the collision.

ATSB assessment of response

The ATSB considers greater proactive action should be taken by the ARTC to resolve this safety issue. While the ATSB acknowledges ARTC's viewpoint that the collision was 'over speed operation for the available sighting distance', the removal of vegetation and other obstructions to sighting may have allowed the more timely recognition of the train ahead (2MP1) by the driver of 2MP9 and may have prevented the collision or reduced the extent of damage sustained.

ATSB safety recommendation to the ARTC

Action number: RO-2015-007-SR-008

Action status: Released

The ATSB recommends that the ARTC takes action to improve the sighting distances available within the Mile End crossing loop by removing unnecessary vegetation and other obstructions.

Current status of the safety issue

Issue status: Not addressed

Justification: The ATSB considers greater proactive action should be taken by the ARTC to resolve this safety issue.

Train pathing

Number:	RO-2015-007-SI-03
Issue owner:	Australian Rail Track Corporation.
Operation affected:	Rail: Infrastructure.
Who it affects:	All rail transport operators throughout Australia.

Safety issue description:

The practice of pathing a following train onto a line occupied by a preceding train, when an alternate route was available and not obstructed, presented an elevated level of risk.

Proactive safety action taken by: Australian Rail Track Corporation

Action number: RO-2015-007-NSA-005

In response to this safety issue, the Australian Rail Track Corporation have advised of the following proactive safety action:

ARTC will issue a Network Control Centre Notice to all control centres directing that when operationally possible maximum use of available and suitable infrastructure should be made to reduce risk while optimising train running.

Current status of the safety issue

Issue status: Adequately addressed

Justification: The ATSB is satisfied that the actions proposed by the ARTC, for maximising the use of available and suitable infrastructure will reduce the risk of this type of safety issue.

Pre-warning train driver of occupied track

Number:	RO-2015-007-SI-04
Issue owner:	Australian Rail Track Corporation and SCT Logistics.
Operation affected:	Rail: Infrastructure and Rolling stock.
Who it affects:	All rail transport operators throughout Australia.

Safety issue description:

The practice of pathing a following train onto the same line occupied by a preceding train, without pre-warning the driver regarding the train ahead, presented an elevated level of risk.

Proactive safety action taken by the ARTC and SCT Logistics:

Action number: RO-2015-007-NSA-006

In response to this safety issue, the Australian Rail Track Corporation have advised:

C light / Low speed signal indications are a Proceed Restricted Authority the definition of which and conditions of use is adequately covered in the CoP.

The improved safety case for vital track side signal systems over verbal authorities has been long established; the gains primarily come from minimising the human input and associated human error (i.e. misinformation or misinterpretation of information) between Network Control and Train Crews.

The current rules and conditions are considered appropriate as they place the onus for safety on the person best placed to manage the situation – the train driver.

Train crews have an existing obligation to seek clarification of situations or signal indications that they do not readily understand and NCO's have and will continue to provide clarification as requested.

In response to this safety issue, SCT Logistics have advised of the following proactive safety action:

SCT have issued instructions to train crews advising that they should seek clarification from the ARTC Network Control Officer of situations or signal indications that they do not readily understand.

Current status of the safety issue

Issue status: Adequately addressed

Justification: The ATSB is satisfied that the actions proposed jointly by the ARTC and SCT Logistics will reduce the risk of this type of safety issue.

National Train Communications System (NTCS) – Broadcast communications

Number:	RO-2015-007-SI-05
Issue owner:	Australian Rail Track Corporation.
Operation affected:	Rail: Infrastructure.
Who it affects:	All rail transport operators throughout Australia.

Safety issue description:

The design of the NTCS in screening Adelaide metro broadcast communications prevented the driver of 2MP9 from gaining an appreciation of activities close to his area of operation, in particular the position of train 2MP1 along the Mile End main line.

Proactive safety action taken by: Australian Rail Track Corporation

Action number: RO-2015-007-NSA-007

In response to this safety issue, the Australian Rail Track Corporation have advised of the following proactive safety action:

A review of the current “fencing” configuration will be undertaken, however it must be recognised that the complexity of the network and population of locomotives that may be logged into the system may result in a significant increase in calls to locomotives while within the Metro NCO's area not in close geographic proximity, these calls may result in distraction and could result in a negative safety outcome when trains are operating in a higher risk metropolitan environment.

Current status of the safety issue

Issue status: Safety action pending

Justification: At the time of this report release, the safety action advised by the ARTC was yet to be fully implemented.

General details

Occurrence details

Date and time:	31 March 2015 – 0740 CDT	
Occurrence category:	Accident	
Primary occurrence type:	Collision	
Location:	Mile End, South Australia	
	Latitude: 34° 56.448' S	Longitude: 138° 34.911' E

Train details

Train operator:	Aurizon	
Registration:	2MP1	
Type of operation:	Intermodal Freight	
Persons on board:	Crew – 2	Passengers – Nil
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Substantial	

Train operator:	SCT Logistics	
Registration:	2MP9	
Type of operation:	Intermodal Freight	
Persons on board:	Crew – 2	Passengers – Nil
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Minor	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- The Australian Rail Track Corporation
- SCT Logistics

References

ARA Glossary for the National Codes of Practice and Dictionary of Railway Terminology

Bureau of Meteorology - Weather Observations for Adelaide, South Australia (31 March 2015)

RISSB Glossary of Railway Terminology – Guideline

Code of Practice for the Defined Interstate Rail Network – Volume 2 – Glossary

Code of Practice for the Defined Interstate Rail Network – Volume 3 – Operations and Safeworking Part 1: Rules

Submissions

Under Part 4, Division 2 (Investigation Reports), 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. Section 26 (1) (a) of the Act 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:

- SCT Logistics
- The Australian Rail Track Corporation
- The Office of the National Rail Safety Regulator
- The crew of train 2MP9 and the Network Control Officer involved in the occurrence.

Submissions were received from SCT Logistics, the Australian Rail Track Corporation, the Office of the National Rail Safety Regulator and the driver of train 2MP9. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: 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 that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to operations involving the travelling public.

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

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine 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.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Notifications 1800 011 034

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Investigation

ATSB Transport Safety Report Rail Occurrence Investigation

Collision between freight trains 2MP9 and 2MP1
Mile End, South Australia, 31 March 2015

RO-2015-007

Final – 16 December 2015