Australian Government
Australian Transport Safety Bureau

Multiple SPAD by freight train 9837

Hurlstone Park, New South Wales | 30 January 2013

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2013-003
Final – 15 November 2013

Cover photo: A Pacific National freight service on Down Goods line at Hurlstone Park

Source: Cover photo supplied by OTSI

This investigation was conducted under the *Transport Safety Investigation Act 2003* (Cth) by the Office of Transport Safety Investigations (NSW) on behalf of the Australian Transport Safety Bureau in accordance with the Collaboration Agreement entered into on 18 January 2013.

Released in accordance with section 26 of the *Transport Safety Investigation Act 2003*

Publishing information

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

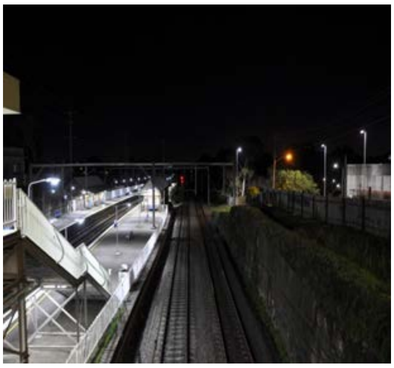
Addendum

Page	Change	Date

Safety summary

What happened

Hurlstone Park Station



Source: OTSI

At about 0229[1] on 30 January 2013, Pacific National freight train 9837, travelling from Nowra to Orange, passed signals SM109G and SM115G at stop on the Down Goods line between Dulwich Hill and Hurlstone Park in Sydney. Just prior to this a work crew had been working on the Up and Down Goods lines[2] under the protection of Absolute Signal Blocking (ASB). There were no injuries or damage.

What the ATSB found

The ATSB's investigation found that the train crew did not take action in response to the indications of three consecutive signals, resulting in the passing of two of those signals at stop without authority (also called a SPAD). It was found that the more senior co-driver had inadvertently fallen asleep on the approach to these signals. The trainee driver, in a reduced state of alertness, missed the first signal at caution, and the next signal at stop. He applied the brakes once the train passed the final signal at stop after realising this signal applied to his train.

Two persons from a litter pickup work crew were on the track just before the train passed through their worksite. Once alerted to the train's approach they moved off the tracks and to a safe place behind the platform at Hurlstone Park station.

A number of Pacific National's policies and procedures were examined to determine if any area of the management or training of the train crew contributed to the incident. Fatigue management, and in particular over- reliance on the use of bio-mathematical model scores used to roster train crew, was one area where improvement was needed. The ATSB also found that there was an absence of adequate procedures and training for drivers who were performing co-driving duties while coaching trainee drivers.

What's been done as a result

As a result of the incident Pacific National has undertaken a range of actions to improve its approach to fatigue management and the implementation of fatigue training. They have also commenced a review of SPAD risk management processes and training requirements for coach/tutor drivers. A trial has commenced of improved data loggers for the Bulk Rail fleet.

Safety message

In order to minimise fatigue-related errors, rail operators should ensure that fatigue management systems incorporate integrated and multi-layered risk control mechanisms. Rail operators should also recognise that the training of drivers by advanced drivers during operations increases exposure to workload and other risks that need to be managed. In addition, SPAD strategies devised by rail operators should have regard to broad systemic issues rather than focus simply on individual train crew actions.

---

1 All times referred to in this report are Eastern Daylight-saving Time, Coordinated Universal Time (UTC) + 11 hours.

2 Up lines typically carry train movements towards Sydney, Down lines away from Sydney.

Contents

The occurrence

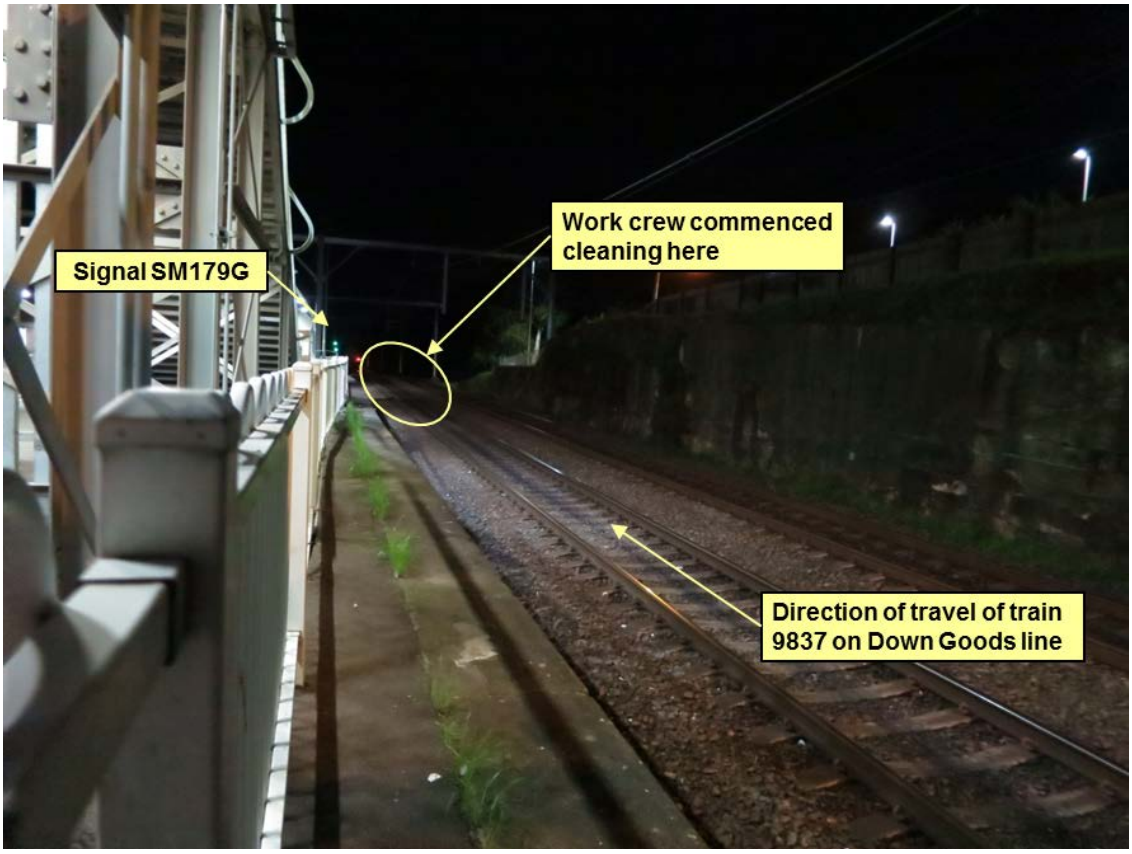
Events leading up to the occurrence

On Tuesday 29 January 2013, a train crew signed on duty at Nowra at 2300 in preparation to operate empty grain train 9837 on a regular scheduled service from Nowra to Orange. The train departed Nowra on time at 2333 with the driver at the controls on the left hand side of the cab. The co-driver was in the seat on the right hand side of the cab. The train ran without incident until it reached the Marrickville area.

At 0055 on 30 January 2013, a work crew started work at Marrickville station cleaning litter from the tracks adjacent to the station platform. After completing the cleaning of Marrickville station, the work crew drove to Dulwich Hill, cleaned that station area, and then drove to their final station for clean-up, Hurlstone Park. They arrived at Hurlstone Park at around 0150 and were seen on closed circuit television (CCTV) coming down the stairs at 0156. The work crew proceeded to clean the Up and Down Bankstown lines with the crew walking in the Down direction. They completed cleaning and reached the end of the platform at 0202. The work crew waited in the safe area afforded by the area between the lines at the end of the platform until protection arrangements were finalised for the cleaning of the Up and Down Goods lines.

The protection officer for the work crew called the area controller, located at Sydenham signal complex, at 0203 and requested authority to work on the Up and Down Goods lines adjacent to Hurlstone Park station platform 1 (Figure 1). The protection method used was Absolute Signal Blocking (ASB) whereby the area controller placed signals at stop to prevent rail traffic from entering the affected section. Due to the amount of rail traffic on the Goods lines at that time, the request was initially refused.

Figure 1: Up and Down Goods lines at Hurlstone Park station



Source: OTSI

At 0216, after the passage of a freight train on the Up Goods line, the protection officer again called the area controller to request an ASB on the Up and Down Goods lines. During the conversation, the area controller advised that more rail traffic was approaching and to wait until they had passed. The protection officer confirmed the signals and points to be used for the ASB.

After the passage of train T283, at 0219:51, the area controller applied a blocking facility[3] on signal SM109G and then at 0220:02 on signal SM115G. This action placed the preceding signal SM103G at caution. All three signals were on the Down Goods line. These blocking facilities were applied in anticipation of the full ASB being put in place once another train (T284) had passed the proposed worksite on the Up Goods line.

The area controller contacted the train controller at 0221 about the request for an ASB on the Up and Down Goods lines at Hurlstone Park. After a short discussion about approaching rail traffic, it was decided that the ASB would be authorised after the passage of T284 on the Up Goods line. At about this time train 9837 was approaching Meeks Road Junction on the Up Illawarra Local line about 3 km away.

At 0228 the area controller contacted the protection officer at Hurlstone Park. After a short discussion about implementing ASB, the ASB was authorised at 0229 for the Up and Down Goods lines at Hurlstone Park. Blocking facilities were applied to other signals protecting that area. At this time train 9837 was approaching signal SM103G, about 412 m from signal SM109G, the first signal at stop. Meanwhile two members of the work crew went onto the track and commenced picking up litter on the Up and Down Goods lines.

SPAD occurrence

A train passing a signal displaying a stop indication, without the authority to do so, is commonly referred to as a signal passed at danger (SPAD). At 0229:03 train 9837 passed signal SM103G which was displaying a caution aspect (green light over red light) whilst around the same time train T284 passed by on the adjacent Up Goods line. At 0229:43 train 9837 passed signal SM109G while it was displaying a stop (red light over red light) indication. A visible alert appeared and an alarm sounded on the ATRICS (Advanced Train Running Information Control System) at Sydenham signal complex. At 0230:00 the area controller broadcast an emergency message '9837, stop, stop, stop' over the open channel radio to attract the attention of the crew of train 9837. There was no response from the train crew to this radio message. At 0230:11 the area controller again broadcast the same message, and again there was no response from the train crew. It was later confirmed that the train radio was operational but the train crew said they had not heard the emergency message.

Meanwhile the work crew picking up litter on the track at Hurlstone Park heard a warning from their lookouts that there was a train coming towards them on the Down Goods line. At this point the train was approximately 300 m away from them. The two members of the work crew on track moved to a safe area behind the platform.

The second SPAD occurred at 0230:17 when train 9837 passed signal SM115G while it was displaying a stop indication. Shortly after passing this signal the driver reduced the throttle from power to idle. The driver made a brake application around signal SM179G which was displaying a clear indication (green light over green light) which brought the train to a stand approximately 33 m past signal SM179G (Figure 2).

---

[3] A facility or device used by a competent worker to prevent either the unintended issue of an occupancy authority, or the operation of points or signalling equipment. (Rail Industry Safety and Standards Board Glossary of Railway Terminology)

Figure 2: Signal SM179G and final position of front of 9837 after the SPAD

Source: OTSI

Post occurrence

Following the incident the two members of the work crew returned to the station platform via the steps at the end of the platform. The train crew remained inside the cab and made a number of phone calls. At 0230:55 the driver of train 9837 spoke to the area controller confirming that the train had come to a stand. Shortly afterwards the area controller spoke to the protection officer who confirmed that all members of his work crew were safe.

The crew of 9837 were relieved from duty and subjected to drug and alcohol testing, the results of which were assessed as negative. The area controller was also relieved and subjected to alcohol testing, returning a negative result. No testing was conducted on the work crew immediately following the occurrence, but the company conducted drug and alcohol testing five days later, with satisfactory results.

A RailCorp[4] signal engineer attended the site at 0800 that morning to conduct signal function testing and observe signal sightings after questions were raised by the train crew of 9837 about whether signal SM103G was displaying a caution indication. It was established that the signal was operating as designed and it was certified as operational at 1502.

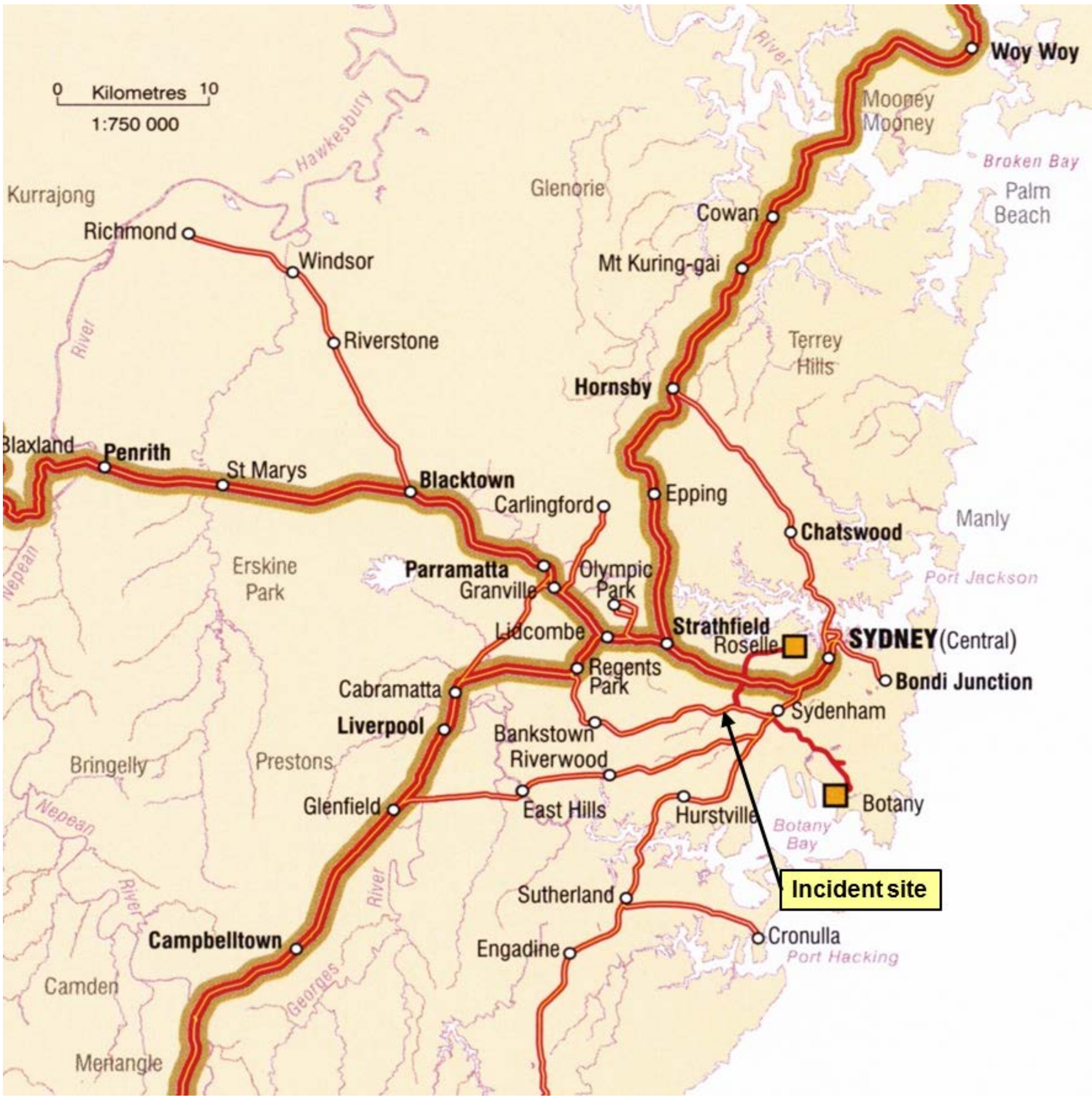
4 From 1 July 2013 Sydney Trains has responsibility for the management of RailCorp's metropolitan rail network. RailCorp will continue to be referred to in this report as they were the entity involved at the time of the incident.

Context

Incident location

The incident occurred at signals SM109G and SM115G on the Down Goods line on the approach to Hurlstone Park station which is located approximately 8.8 km by rail south-west of Central railway station, Sydney (Figure 3). Signal SM109G was at 8.230 km and signal SM115G was at 8.621 km.[5]

Figure 3: Location of Hurlstone Park



Source: NatMap, Railways of Australia, Geoscience Australia

There were two platforms at Hurlstone Park station and the rail corridor contained four standard gauge lines: the Up and Down Bankstown lines, which predominantly carried passenger trains, and the Up and Down Goods lines, which predominantly carried freight trains. The posted track speed for the Up Goods line at Hurlstone Park station was 50 km/h and for the Down Goods line was 40 km/h.

5 All kilometrages are measured from the buffer stop at No. 1 platform in Sydney Terminal.

Environmental conditions

The early hours of the morning were warm and clear. The overnight minimum temperature was 20.2 °C as recorded by the Bureau of Meteorology at Sydney Airport, approximately 5 km from Hurlstone Park station.

There was ambient light around the station and along the Up and Down Goods lines provided by the street and station lighting. There was also moonlight from a waning gibbous moon.[6] The moon had risen at 2057 the previous evening and was at an elevation of 50° behind and to the right of the train, well away from any line of sight by the train crew. It was determined that the environmental conditions did not contribute to the incident.

Development of the occurrence

The distance by rail from Bomaderry (Nowra) where the train commenced its journey to signal SM109G, the first signal at stop, is approximately 150 km. It is a further 391 m to the next signal passed at stop, signal SM115G. The only stops that the train crew made en route were at Berry when they made a required safeworking stop to pick up a miniature electric train staff and at Kiama to drop the staff off. After leaving Kiama the train passed 137 signals before reaching signal SM109G. None of these previous signals were at stop. From commencement of the shift at Bomaderry the train crew of 9837 drove for about 3 hours before passing signal SM109G.

During the journey a number of radio and phone calls were made by the train crew. At 0150 as the train was passing Waterfall the co-driver gave a progress report to the Pacific National Operations Coordinator at their Divisional Control Centre using his work issued mobile phone. Another phone call was made to this Operations Coordinator when train 9837 entered Meeks Road Junction at 0223:20. During this phone call the co-driver was informed that another locomotive would be attached to the front of the train once they reached Clyde yard. This phone conversation took a little over one minute and was concluded at 0224:25 before train 9837 passed Marrickville Junction and entered the Metropolitan Freight Network. It was shortly after this phone call was made that the co-driver fell asleep. During interview the co-driver said of the time following the phone call: 'I can't account for four minutes' and that: 'I fell asleep.' The driver said that around this time: 'things did go a little bit quiet … we settled in to the fact that we were close to where we needed to be to and probably got a little bit too relaxed.' It appears that the driver was unaware that the co-driver had fallen asleep. Phone records and signal log records correlate with the co-driver's recollection of his estimated elapsed sleep time.

The co-driver's first recollection after the phone call was when container train T284 passed in the opposite direction on the Up Goods line. The approximate time that the fronts of each train crossed was 0229. It is a requirement whenever practicable that a visual check of a passing train is followed by a radio call to the crew of the passing train to communicate the results of this check. This is known as a roll-by inspection. The co-driver recalled waking up to the sound of a passing train, and conducting the roll-by inspection. (It was determined by the investigation that the co-driver may not have been fully awake at this time). He said that as he was waking he saw that signal SM115G was at stop and that the driver had the brakes on. He next saw that there were two persons next to signal SM179G and he realised that there was a work crew in the section. The co-driver had not observed signal SM103G or SM109G.

The driver said that he had driven this section of track 4−5 times previously. Due to his limited driving experience on main lines combined with limited knowledge of this area, the driver was cautious about the identification of signals, particularly as this area was characterised by a number of adjacent lines and diminished signal spacing. With limited route knowledge, the task of correct signal identification required an increased level of attention than might be the case for an

6 Waning Gibbous – A few days after the Full Moon, the illumination of the Moon's disk as seen from the Earth begins to decrease. Source: Swinburne University of Technology Astronomy Online Encyclopaedia.

experienced driver. The train crew were also not cross-calling[7] the signals as required. Having passed signal SM103G at caution and signal SM109G at stop, without observing them, the driver became confused when he then observed signal SM115G at stop. His knowledge that a signal at stop would be preceded by a signal at caution created uncertainty as to whether signal SM115G applied to the Down Goods line. It was not until the driver observed the work crew in the rail corridor ahead that it became clear to him that he needed to stop the train. It is likely that this confusion, with no assistance from the co-driver who was asleep or just waking, contributed to the driver's actions in not applying a full brake application, and also in not responding to the emergency calls made by the area controller.

Train and crew information

Train 9837 was owned and operated by Pacific National Bulk Rail, a division of Asciano Limited. It consisted of three locomotives (8182 leading, 8132, X51) hauling 37 empty grain hoppers weighing 980 t with a total length of 733 m. The train was a regularly scheduled service between Nowra and Orange that departed from Nowra on Tuesdays and Thursdays.

The train had two Pacific National drivers, both based at the Nowra depot. They had been driving together for about two months of a three month allocation together. The train crew signed on as fit for duty at 2300 that night and were due to sign off at 0830 the following day in Orange. Both crew members were medically fit in accordance with the *National Standard for Health Assessment of Rail Safety Workers.*

The person driving the train from Nowra to Hurlstone Park was a level 3 mainline driver in training (the driver) who was being coached by a level 5 advanced locomotive driver (the co-driver). The driver had five years of experience in the rail industry with most of the time spent shunting and marshalling trains in the Port Kembla steelworks. About six months prior to the incident he started gaining mainline freight route knowledge but had not yet gained competency to drive without an experienced driver also present in the cab. He had travelled this route 4−5 times before as a driver, and about 2−3 times with this particular co-driver. On all occasions when driving it was for the same shift leaving Nowra at about 2300. He stated that he had not experienced a SPAD before. His qualifications were current as a trainee driver.

The co-driver had about 20 years of experience driving locomotives. He was a qualified driver, designated as an advanced driver, and had driven this route many times previously. As a driver he had experienced one previous SPAD about four years before this incident.

The train crew were relieved at Hurlstone Park station and subjected to a breath analysis by a Pacific National representative, returning negative results. Later that evening, the crew went to the Moss Vale Depot and undertook drug testing at 1930. The co-driver returned a negative result and despite an irregularity with the testing result for the driver it was determined to also regard the test result as negative.

Train handling

Analysis of the train handling was dependent on recordings from data logging devices installed in the three locomotives. An older analogue-type Hasler tape data logging device was installed in each locomotive. Of the three devices only the second locomotive's data logger was fully functioning. The recording for the leading locomotive 8182 was incomplete in that it did not record the driver's application of the vigilance button or of the throttle. The data logger on the third locomotive had not recorded speed, throttle position or brake pipe pressure for 15 hours prior to the incident. It was a requirement that the data logging system must be operational for

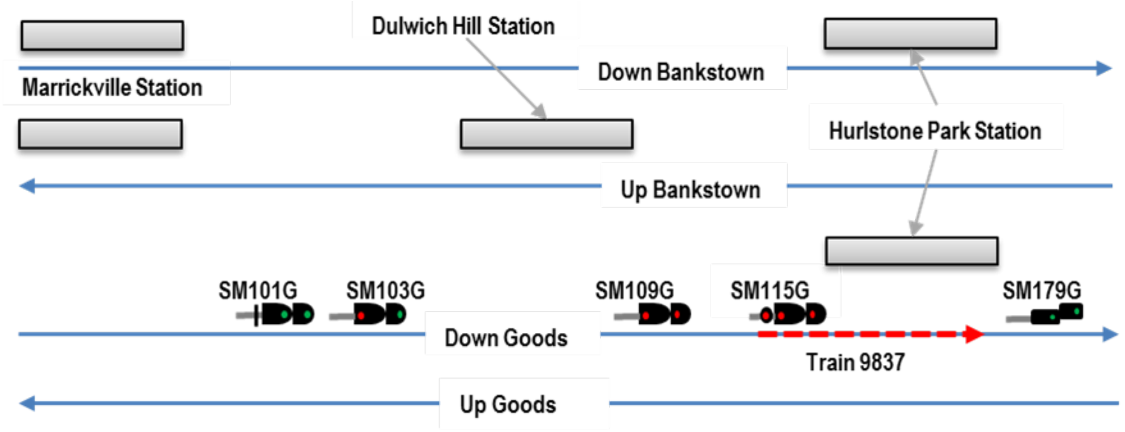
[7] The process of a driver and second person confirming and verbally calling the meaning displayed by a signal to the other crew member, and that its meaning is being obeyed.

locomotives running on the ARTC and RailCorp networks. In this case the maintenance of the devices was inadequate. It would have assisted investigation analysis if the data loggers on all locomotives had been fully functional or more modern data logging systems were installed. In investigations such as this a forward facing camera, recording vision of the track and signals ahead, would also assist the analysis process. It is noted that Pacific National is commencing a trial of updated data logging devices for their bulk rail fleet.

Analysis of the locomotives' data loggers revealed that, as the train passed through the Meeks Road turnout (about 1900 m from signal SM103G), the driver reduced speed to about 12 km/h which was below the 15 km/h speed restriction for this section of track. The driver gradually increased speed from 12 km/h to 38 km/h on approach to signal SM103G, the first signal at caution. The train then passed through the first signal at stop, signal SM 109G, at 40 km/h. Just before the next signal at stop, signal SM115G, the driver made a throttle adjustment from power to idle and passed the signal at 41 km/h. There was no brake application until the driver made a minimum reduction of approximately 50 kPa (10% of brake pipe pressure) around signal SM179G which finally brought the train to a stand.

The train came to a stand approximately 33 m past signal SM179G, which was 701 m past the first signal at stop and 310 m past the second signal at stop. Signal SM179G was not passed at stop as it was showing a clear aspect. It is an automatic signal which means it is one that cannot be controlled by the area controller but instead operates according to track circuits. The configuration of the tracks and signals at Hurlstone Park is shown below (Figure 4).

Figure 4: Diagram of configuration of track and signals on Down Goods line



Source: OTSI, not to scale and some details omitted

Network management

The Up and Down Goods lines between Marrickville and Hurlstone Park are part of the Australian Rail Track Corporation's (ARTC) Sydney Metropolitan Freight Network (MFN). They form part of a shared corridor and run adjacent to the RailCorp owned Up and Down Bankstown lines between Marrickville Junction (6.645 km) and Campsie (12.300 km). An interface agreement between RailCorp, a NSW State Government owned corporation, and the ARTC, a Commonwealth Government owned corporation, stated that RailCorp was responsible for track maintenance, signalling, train control and incident management functions in this corridor.

Train movements in this area are controlled by a combination of automatic and controlled signals under RailCorp's *Network Rule NSY500 Rail Vehicle Detection System*. All signals and points are monitored remotely from the Sydenham signal complex. At the signal complex, area controllers (signallers) operate panels, each covering a defined portion of the total area controlled from Sydenham. The incident occurred in the area controlled from the Meeks Road−Campsie panel.

Network control and worksite protection

RailCorp's *Network Rule NWT 300 Planning Work in the Rail Corridor* requires work in the danger zone to be planned and to be carried out using one of five methods of worksite protection. The methods require varying levels of authority and competencies to implement and, despite their technical differences, all are underpinned by the following fundamental safety requirements:

- work cannot occur unless the workers have access to a safe place within the rail corridor that can be easily reached in a timely manner
- the level of safety must not be reduced to allow train and track vehicle movements, or because of a lack of trained workers
- effective communication must be maintained with network control officers
- worksites must have a protection officer whose other duties must not interfere with protection duties
- the protection officer must:
  - make a safety assessment before work commences
  - ensure work is conducted safely
  - keep a record of the protection arrangements.

Any person required to enter the RailCorp rail corridor to establish a worksite must be trained and assessed as competent as a protection officer. Network Rule NWT 300 states that: 'a protection officer's primary duty and responsibility is to keep the worksite and workers safe.' Of the allowable worksite protection methods available to him as a protection officer level 4, the protection officer was using ASB for protecting the worksite at Hurlstone Park.

The procedures for the protection of track workers using ASB are prescribed under RailCorp's *Network Rule NWT 308 − Absolute Signal Blocking*. ASB is used to exclude rail traffic from a section of track to allow persons or vehicles to safely work in the danger zone[8] in that section of the track. ASB may be authorised by an area controller and involves excluding rail traffic from a worksite thereby creating a safe place by setting and keeping controlled signals on the approach to the work area at stop. Significantly, before setting signals to stop, an area controller must speak to the train controller about the request to exclude rail traffic, mainly to check if the requested ASB is in conflict with the train controller's pathing requirements. Before work on track is commenced, the protection officer must confirm with the area controller that the related signals have been placed at stop, blocking facilities have been applied and there is no rail traffic between the protecting signals and the worksite. The area controller must not clear the related signals until advised by the protection officer that the work area is clear.

In order to protect the worksite at Hurlstone Park where the work crew were performing litter pick up, the area controller placed two signals at stop and then placed a blocking facility on those signals. The electronic blocking action is a further action to prevent the inadvertent changing of the signal. In the past the placement of a block was in the form of a physical object over the signal control. In the current system it is completed by a right-click of the mouse and a further confirmation click. On approaching a controlled signal that is set to stop a train driver is required to stop the train until the signal changes, or the area controller gives permission for the driver to pass the controlled signal at stop.

The protection officer for the work crew first contacted the area controller about arranging worksite protection in the form of an ASB at 0203, approximately 26 minutes before the SPAD. This request was initially denied by the area controller as a train was about to go through the proposed worksite on the Up Goods line. At 0216 the request was made and again denied but, shortly afterwards, after allowing a train to pass through the proposed worksite, the signals requested for

---

8 The danger zone is defined as everywhere within three metres horizontally from the nearest rail, and any distance above or below this three metres, unless a safe place exists or has been created. RailCorp General Rules NGE 200 version 2.0 21 August 2005.

worksite protection were placed at stop and blocked. These signals were: on the Down Goods line SM109G and SM115G and on the Up Goods line SM208G, SM210B and SM216B. As an additional measure 260 points were placed in the reverse position to prevent trains traversing between the Bankstown lines and the Up Goods line. The placement of these signals at stop some 10 minutes before the SPAD meant that when the ASB was finally granted at 0228 there were no trains in the section. Indeed during a recorded conversation between the protection officer and the area controller when ASB was granted, the protection officer indicated that train 9837 was approaching and would stop at the signals.

The actions of the area controller and the protection officer were not strictly in accordance with procedures in that they did not communicate confirmation that the section was clear of rail traffic. This was a requirement of RailCorp's *Network Rule NWT 308* which stated that before work starts the protection officer needs to confirm with the signaller (area controller) there is no approaching rail traffic between the protecting signals and the proposed worksite, and that any rail traffic has passed complete beyond the worksite and will not return.

The area controller did not confirm with the protection officer that blocking facilities were applied. The area controller said to the protection officer: 'OK, alright the Up freighter's gone. OK I've got 109 and 115 on the Down Goods at stop.' During this conversation the protection officer did not confirm that these signals had been blocked. Again Network Rule NWT 308 states that it should be confirmed that blocking facilities have been applied. Although this lack of communication played no part in causing the incident it highlights a continuing problem.[9] Clear and unambiguous communication during the application of protection for persons to enter the danger zone is essential. The responsibility, as outlined in the network rules, lies with both parties. Safety critical messages should be repeated back and understanding confirmed so that both parties are sure that the message is agreed upon.

When the protection officer was granted ASB by the area controller at 0229 train 9837 was approaching signal SM109G and would SPAD this signal at 0230:43. This meant that just as the two work crew members had gone onto the tracks to clean the Up and Down Goods lines they were notified by their lookout to get off the tracks as a freight train was approaching. The short time elapsing between the granting of ASB and the train entering the worksite led to the protection officer thinking that he had nominated the wrong signals to be blocked. It also led to the shift manager at the Rail Management Centre believing that the area controller had not checked that the section was clear before issuing ASB. The area controller was breath tested before it was confirmed that the ASB was applied in conformance with procedures.

Network Rule NWT 308 also required that prior to authorising ASB the signaller must tell the train controller at the Rail Management Centre about the request to exclude rail traffic. A review of the voice recording between the area controller and the train controller indicated this was discussed. The conversation between the area controller and train controller lasted for over a minute and they can be heard to be identifying train 9837 approaching. The train controller can also be heard reminding the area controller to make sure he had the necessary signals at stop and the section was clear of rail traffic before he authorised the ASB.

Advanced Train Running Information Control System

The Advanced Train Running Information Control System (ATRICS) is used throughout the RailCorp network and has been in use at the Sydenham signal complex since 2002. It provides a diagrammatic display which allows controllers to interact directly with the rail network by controlling signals, points and other signalling equipment through the click of a mouse. It is a non-

9 Recent reports where worksite protection communication issues feature can be found at the ATSB website (see Newbridge (2010), Jaurdi (2011), Bogan Gate (2011) and Maitland (2011)).

vital[10] centralised traffic control system which enables real time monitoring and control of the signals and points. The area controller's area of responsibility is displayed over multiple LCD monitors. The Meeks Road−Campsie control panel is shown in Figure 5.

Figure 5: Sydenham signal complex – Meeks Rd-Campsie control panel

Source: OTSI

Area controllers have two main means available for manipulating signals and points for some other commands (such as placing blocks) on the network. The changes are made by:

- clicking directly on the symbols representing the signalling equipment that controllers select from a number of commands located in a series of cascading menus. Anecdotal evidence indicates that this is the method preferred by area controllers
- selecting from a drop down menu controllers make a selection from the menu bar at the top of the screen, similar to the menus on Microsoft® packages.

Area controllers issue work on track authorities and proceed authorities through their panel by interacting with the ATRICS screen using a computer mouse to open menus and select the relevant signal or set of points. Not all signals can be controlled by the area controller. Automatic signals are activated by the presence of a train and are also differentiated in appearance to drivers by having the top signals light group offset horizontally with respect to the bottom signal light group. On the ATRICS screen automatic signals appear as triangles and controlled signals as circles (Figure 6). The status of tracks, signals and the presence of trains are displayed in various colours.

---

[10] 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.

The two signals passed at stop by train 9837 were controlled signals and the final signal passed, signal SM179G, was an automatic signal displaying a clear indication.

Figure 6: ATRICS replay, showing train 9837 approaching signal SM109G

Source: RailCorp

The ATRICS system has a replay capability which investigators used to review the operation of the system and trains on the night of the incident. Figure 6 shows train 9837 approaching the first of the two stopped and blocked protecting signals, SM109G.

Examination of the ATRICS replay revealed that, when the area controller utilised a command in ATRICS to block signals SM109G and SM115G, the track beyond those signals, in the usual direction of travel, changed from white to blue, indicating a block on the section. The colour changes demonstrate there is recognition of physical changes to the track conditions at the software level.

The ATRICS can display the number of the next train approaching an area controller's area, but only if the train number has already been entered into the system by an area controller managing an adjacent area. It does not show a train's kilometrage or exact location relative to signals or worksites. Hence the positions of the Goods Lines and their signals relative to the Bankstown Lines, signals and platforms are not reflected on the Meeks Road−Campsie panel.

For any given signal the ATRICS display only shows proceed and stop aspects, not all possible aspects. This means that, in the event of doubt or dispute over a signal indication, the signal is booked out of use until its operation can be verified through function testing by signal engineering staff. This needed to be done in this case for signal SM103G.

Area controller information

Employment and training records showed that the area controller commenced training as an area controller in February 2000 and since May 2006 had been working in the Sydenham signalling complex. He was deemed fully qualified and was certified in all relevant systems of safe working. He was also deemed competent to operate various signalling control panels at the signalling complex, including the Meeks Road−Campsie panel. This panel covers rail operations between Meeks Road and Campsie and has signalling control over the rail territory on both the Up and Down Goods lines, the primary role with the greatest amount of territory and interaction, and also a portion of the Up and Down Bankstown lines.

On 29 January 2013, the area controller had signed on for duty at 2135 to commence an 8−hour shift on the Meeks Road−Campsie panel. Shortly after the incident, the area controller was relieved and replaced by another area controller. A network operations supervisor (NOS) was dispatched to the signal box and on arrival carried out a breath analysis of the area controller which returned a negative result. Before the area controller could be drug tested it was determined by RailCorp that his actions did not contribute to the occurrence, so he was not subjected to any post-incident drug or additional alcohol testing.

Signal information

The two signals passed at stop in this incident are of the type frequently used across the RailCorp rail network, double colour light signals. According to RailCorp signalling standards, signals are located to give a clear sighting distance for approaching trains, equivalent to a minimum of six seconds at line speed.[11] The signals are designed so that the distance between sighting the first warning signal and the stop signal to which it applies shall be such that a train travelling at its highest authorised speed can be stopped before the stop signal.

An analysis of the signal indications and sighting information for the signals on the Down Goods line is summarised in Table 1 below. All of these sighting distances and sighting times meet the relevant RailCorp signalling standard.

Table 1: Signal information for Down Goods line signals approaching Hurlstone Park

Signal	Indication	Sighting distance	Sighting time[12]	Speed of train[13]
SM103G	caution	191 m	17 s	38 km/h
SM109G	stop	283 m	25 s	40 km/h
SM115G	stop	177 m	15 s	41 km/h

Source: Signal indications and sighting distances were provided by RailCorp

As the train crew indicated they had not observed signal SM103G at caution, this signal was examined by a RailCorp signalling engineer to determine whether it was operating correctly. After a delay, due to uncertainty of whether RailCorp or ARTC was responsible for the signals, the RailCorp signal engineer was contacted at 0559. He attended the site at 0800 and examined signal SM103G. No faults were found with the signal. Electrical testing on the lamp voltages, circuits and control relays also found no fault. The aspect of the signal was also tested and was found to be working to design, which at caution meant that the signal would display a green over red aspect.

The signal engineer also conducted signal sighting tests on 31 January 2013 at 0400 to replicate the conditions on the morning of the incident. He found signal SM103G to be operational with: 'no obstructions or impediment to sighting.' There was clear sighting differentiation between this signal and another nearby signal SM171B on the Down Bankstown line. There was no report of any signal malfunction or problem with signal visibility with any other signal in the vicinity of the incident.

NSW Office of Transport Safety Investigations (OTSI) investigators travelled in the front cab of a locomotive on 7 March 2013 at 2200 and conducted an inspection of the signals during similar lighting conditions experienced during the incident. Photographs were taken of the key signals (Figure 7). They observed that the signal indications were clearly visible, there were no physical impediments to visibility, and that ambient or background lighting was unlikely to have caused any confusion between signals.

---

11 RailCorp Infrastructure Engineering Standard – *Signalling, Signalling Systems – Basic Principles and Configuration Standard*, March 2006.

12 Sighting time calculated at line speed of 40 km/h.

13 Calculated speed from data logger analysis by ATSB.

Figure 7: Signals approaching Hurlstone Park

Source: OTSI

Worksite protection for track cleaning

As mentioned previously RailCorp was responsible for track maintenance functions for the metropolitan rail network. The cleaning of litter on stations and in the rail corridor adjacent to platforms was contracted out by RailCorp to Swetha International Pty Ltd (Swetha). This contract commenced in 2010 and covered 265 stations within the metropolitan rail network.

The scope of the contract consisted of collecting, removing and disposing of litter on the tracks and surrounding station platforms at nominated frequencies for each specific location. 'This will include at some locations dedicated freight lines and where there are tracks with no station platform (e.g. Hurlstone Park).'[14] The scheduled frequency for cleaning at Hurlstone Park station was once every two weeks.

In addition to the requirements for ASB in the network rule, the contract required Swetha to provide all staffing including: 'an appropriate level of work site protection and required protection officers and lookouts where applicable to complete the works.'[15] In accordance with this additional requirement, the protection officer at Hurlstone Park posted two lookouts in addition to himself. Swetha was also responsible for organising access into the rail corridor and railway stations to perform the work.

The six person Swetha work crew commenced cleaning operations at Marrickville station after an ASB was granted at 0055. They were to complete the cleaning of three stations and the associated track areas and would have expected to complete their shift at 0400. The work crew consisted of the leading hand who was a protection officer class 4, two persons designated as lookouts who held qualifications as protection officer class 2 and class 1, and three others. All persons had completed the Rail Industry Safety Induction training course.

For track workers on the Up and Down Goods lines at Hurlstone Park there were a number of obstructions affecting visibility of approaching rail traffic. Looking towards Dulwich Hill, the direction that train 9837 was approaching from, these obstructions included an overhead road bridge and the platform buildings. In some areas warning lights were positioned to indicate approaching rail traffic. The warning lights located on the Dulwich Hill side of Hurlstone Park were not visible to the track workers on the Up and Down Goods lines.

In some locations on the network there are safeguards such as automatic derailing mechanisms that prevent a train from entering a safety critical area without authority. There were no such protections in place at the signals passed by train 9837. It was not practical to install these mechanisms at every signal. The passing of two signals at stop by train 9837 into an area that was occupied by a work crew was an occurrence that highlights the vulnerabilities of a system that relies on a vigilant train crew. The fact the work crew was using two persons as lookouts, even though there was no requirement in the rules to do so, was fortunate in that it ensured the two

---

14 RailCorp *Station Corridor Cleaning Agreement* No.CW22532 p.5.

15 Ibid. p.7.

persons working on the tracks were warned of the approaching train and had ample time to get clear.

In accordance with the Rail Safety (Adoption of National Law) Regulation 2012 (NSW), an operator must require its rail safety workers involved in, or reasonably suspected of having been involved in, certain incidents to undergo drug and alcohol testing. Such testing must be undertaken within 3 hours immediately after the incident. The incidents to which the requirement applies are prescribed in the Rail Safety National Law National Regulations 2012.

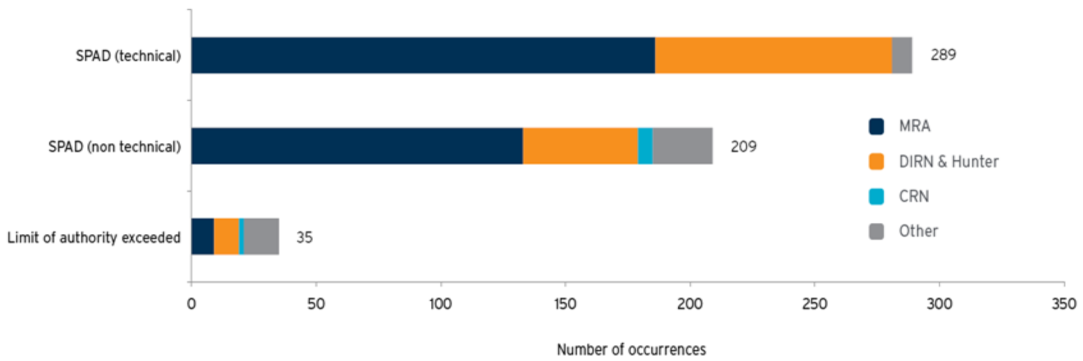
All the track workers were permitted to go home without being tested. At the request of their employer, Swetha, drug testing of the work group was eventually undertaken on 5 February 2013. The results were negative with the exception of one sample which identified an anomaly which was consistent with the sample being affected by a disclosed medication taken by the employee.

Related SPAD occurrences

RailCorp provided information about previous SPADs that had occurred at these signals for the period 1 January 2005 until 30 January 2013. The signals were not identified as signals that are frequently passed at stop, referred to as multi-SPAD signals. There were no SPADs recorded as having occurred at signal SM109G, but there were two SPAD incidents recorded at signal SM115G. Both involved freight services in the early months of 2012.The first occurred on 23 January 2012 when a freight service passed the signal by 10 metres and the next on 1 March 2012 when a freight service passed the signal by 100 metres. Information recorded on both incidents indicated the previous caution signal being SM109G had no bottom indication, that is, the bottom red light was not illuminated. In both cases the drivers did not react appropriately to a faulty signal, which is to treat a defective signal as if it were red.

The Independent Transport Safety Regulator of NSW (ITSR) published an annual summary of SPAD occurrences in NSW which summarised the safety performance of the NSW rail network and considered historical trends. Figure 8 below shows the number of SPAD events in 2011−2012. For analysis purposes, SPADs are categorised into a technical SPAD, non-technical SPAD or limit of authority exceeded events. The most common type is technical SPAD with 289 occurrences. Technical SPADs involve a signal changing its indication from proceed to stop as the train is approaching the signal giving the driver insufficient time to stop the train. The SPAD event where train 9837 passed two signals at stop approaching Hurlstone Park falls under the category of a non-technical SPAD. In 2011−2012 there were 209 of these occurrences. The third type is the limit of authority exceeded occurrence. This is an event such as when a train passes a stop board in a yard. In 2011−2012 there were 35 of these occurrences.

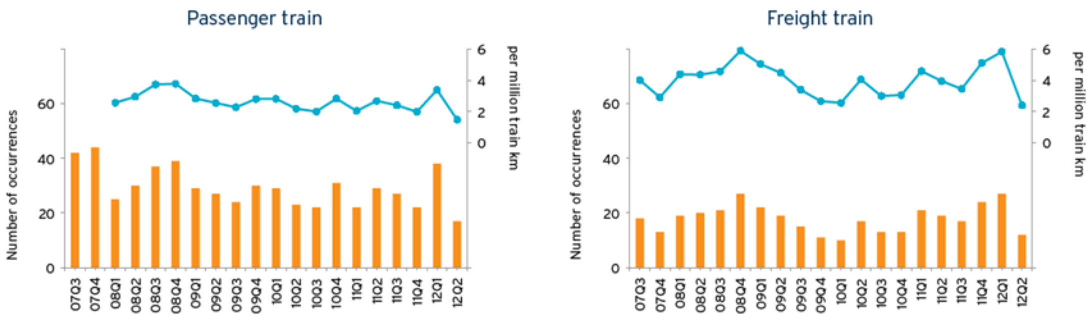
Figure 8: SPADs on the NSW rail network, 2011−2012



Source: ITSR Rail Industry Safety Report 2011−2012. (MRA− Metropolitan Rail Area, DIRN – Defined Interstate Rail Network, CRN – Country Regional Network)

SPAD data presented in Figure 9 summarise occurrences that involved non-technical SPADs on the NSW rail network for the five years from 2007−2008 to 2011−2012. The rate of SPADs for freight trains over the period (3.9 per million train km travelled) was much greater than that for passenger trains (2.3 per million train km travelled) despite freight trains travelling over track with a greater proportion of unsignalled track.

Figure 9: Signal passed at danger (non-technical) on the NSW rail network, 2007−08 to 2011−2012



Source: ITSR Rail Industry Safety Report 2011−2012. (MRA− Metropolitan Rail Area, DIRN – Defined Interstate Rail Network, CRN – Country Regional Network)

The ITSR found that the number of crew performance SPADs on the metropolitan rail area had decreased over the five-year period despite an increase in train movements. ITSR analysed the rates of non-technical SPAD events per million kilometres for the three years to December 2010 and found that the SPAD rate for freight trains in NSW was around 30% higher than that of passenger trains.[16] Some potential contributing factors to a higher rate of freight train SPAD events include increased mass and velocity of freight trains and differing mental workload conditions associated with the freight and passenger train driving task.

The ATSB and state investigation agencies have conducted a number of investigations into SPAD events. In the five years from 1 January 2008 to 31 December 2012 the ATSB has investigated and published 4 reports into SPAD events. All these events occurred in NSW. Over the same time period the Office of Transport Safety Investigations (OTSI) in NSW published 4 reports and in Victoria the Office of the Chief Investigator (OCI) 3 reports. In the majority of cases the significant contributory factor was the actions of the train crew. To a lesser extent other contributory factors were identified such as: train braking performance, signal sighting and signal design. A summary of these events is shown in Table 2.

[16] Independent Transport Safety Regulator (2011). *Managing signals passed at danger.*

Table 2: Published SPAD reports by Australian and state government investigation agencies, 2008−2012.

Agency	Date	Train Type	Location	Contributory Factors (Summarised)
ATSB	11/03/2008	Freight	Gloucester, NSW	Insufficient sighting distance between signals.
OTSI	07/01/2009	Passenger	Homebush, NSW	Driver misinterpreted which signal applied to his line, fatigue and signal placement.
OTSI	24/01/2009	Passenger	Unanderra, NSW	Driver was distracted by a noise, fatigue, and guard not in position.
OTSI	10/05/2009	Track Machine	Goobang, NSW	Driver lack of route knowledge and experience.
ATSB	09/09/2009	Passenger	Junee, NSW	Driver expectation, distraction and possibly fatigue. Prioritisation of operational tasks, signal lamp voltage and signalling design standards.
OCI	19/01/2010	Passenger	Clifton Hill line, Flinders Street station, VIC	Possible driver distraction.
ATSB	05/02/2011	Passenger	Henty, NSW	Driver did not apply sufficient braking effort to enable train to be stopped.
ATSB	25/02/2011	Freight	Yerong Creek, NSW	Train braking performance.
OCI	30/11/2011	Passenger	Flinders Street station, VIC	View of the signal compromised.
OCI	23/12/2011	Passenger	Southern Cross station, VIC	Driver cognitive performance and loss of situational awareness.
OTSI	07/03/2012	Freight	Gunnedah, NSW	Driver misreading of two consecutive stop signals as a single signal causing him to misinterpret where he should stop.

Source: OTSI

Related worksite protection occurrences

This incident at Hurlstone Park involved the passing of two signals at stop by train 9837 and as such was classified as a non-technical SPAD. It involved worksite protection issues as well. The signals that were placed at stop and subsequently passed were placed at stop for the purpose of providing worksite protection. Two recent examples of worksite protection occurrences involving track workers undertaking the same task of litter pickup being struck by trains, or nearly so, are summarised below. The contractor undertaking the work in both cases was the same as at Hurlstone Park on 30 January 2013.

On 13 April 2010 a track worker was struck by a passenger train and killed while performing litter pickup on the tracks at Kogarah station. The other four members of the work group scattered from the path of the train and avoided injury. The investigation found that the track worker was struck because the area controller did not identify that the train was already in the section approaching Kogarah and had passed the protecting signals before he applied blocking facilities. These workers were also working under the Absolute Signal Blocking (then known as Controlled Signal Blocking) method of worksite protection.

A few months later, on 29 October 2010, the driver of a passenger train travelling through Bankstown station applied emergency braking due to the presence of a work crew on the tracks. There were no injuries as a result of the incident. The incident was the result of the work crew performing work in the danger zone with no protection in place and no effective lookout. This situation arose due to the protection officer losing his focus on his primary responsibility for the safety of his team when distracted by other tasks, and due to imprecise and ambiguous communication with his workers when giving a critical safety instruction.

Safety analysis

Introduction

The SPAD of signals SM109G and SM115G which were placed at stop in order to protect a worksite was a serious incident. Precursor events such as this can lead to derailments, collisions, injury and death.

The investigation into this SPAD examined the functioning of the signal system, the implementation of worksite protection, the actions of the work crew on track and the actions of the train crew. It was established that the signalling system worked as designed and the implementation of worksite protection and the actions of the work crew did not contribute to the occurrence. Consequently, the analysis principally focuses on the factors that contributed to the SPAD incident including the actions of the crew of train 9837, fatigue management, organisational procedures for SPAD reduction and train crew management.

SPAD Management

Managing SPADs is an important consideration for any rail organisation. In 2009 Pacific National Bulk Rail issued a safety notice to their train crews due to their performance in respect to SPADs, 'deteriorating at an alarming rate.'[17] This safety notice comprised guidance for ensuring that, on approaching stop points, the train speed was sufficiently slow to enable stopping at signals; directed cross-calling of such signals; and indicated that drivers should not be communicating via the telephone while driving. A few months after this notice was issued the co-driver was assessed as competent on a range of performance tasks including: verbally providing an overview of the SPAD strategy, cross-calling and confirming restrictive signal aspects, and stopping trains using the SPAD strategy technique.

A more comprehensive SPAD Strategy[18] documented in June 2012 incorporated the preceding safety notice. Neither driver nor co-driver had undertaken training in this updated SPAD Strategy prior to the occurrence. The strategy outlines practices for avoiding a SPAD when a train is placed under a restrictive signal or is approaching a known stopping location. These practices include:

- cross-calling of signals
- both crew members stopping other activities and concentrating on stopping the train
- crew discussions about the signals
- reducing train speed to come to a stop before the signal.

The strategy document indicates that At Fault SPADs are the result of train crew error, and lists a number of crew behaviours which might contribute to an At Fault SPAD. The SPAD Strategy does present more comprehensive guidance than the preceding safety notice. However it does not represent, and is not intended to be, a holistic SPAD management strategy. As such, in the absence of any such overarching SPAD management strategy incorporating integrated, error-tolerant systems of work, and having regard for the broader, systemic issues known to contribute to SPAD events, this document's focus on attributing fault to individual crew actions and in detailing costs of previous SPAD events can be of only limited value in managing the occurrence of SPADs.

---

17 Pacific National Divisional Safety Notice (Bulk Rail) (Feb 2009). *Signals Passed at Danger (SPAD): New prescribed defensive driving requirements when approaching stopping locations.* DSN No: BR-0901.

18 Asciano Bulk Rail *SPAD Strategy* (Jun 2012). Briefing Number: SB0115. Version 1.

Two types of SPADs, At Fault SPADs and Technical SPADs, are described in this strategy. This differs from the categorisation adopted by ITSR[19] which comprises three types: Crew/Train Performance SPAD, Returned in Face of Driver (RIFOD) SPAD, and Runaway SPAD. ITSR has described a number of factors which are known to contribute to the occurrence of SPADs, including errors and violations, work environment/operational factors, individual/personal factors, and organisational factors. The ITSR paper emphasises the importance of looking beyond the immediate causes or individual actions to determine the underlying factors resulting in SPAD occurrences.

For instance, research undertaken by the United Kingdom RSSB[20] examining over 2000 SPAD events over a period of five years found that SPAD risk related to work scheduling factors, including the:

- number of consecutive shifts, whereby the risk remained relatively steady over the first 4−5 consecutive shifts, then increased rapidly until after 10 consecutive days, when the risk was more than double the initial value
- time on task (defined as time since the last break), wherein the risk steadily rose over the first 1.5 hours on task, with a level trend over the following 3 hours, then rising sharply after 4.5 hours on task
- time of day, where driving between midnight and 4am was found to be associated with elevated SPAD risk.

Subsequent United Kingdom RSSB research[21] examining a later five year period established similar patterns, where the relative risk of a SPAD for freight drivers increased between the hours of midnight and 05:59 by a factor of two. With regard to time on task, freight operators' risk of SPAD peaked between 3 and 4 hours, and then rose further at over 7 hours. The United Kingdom RSSB has recommended greater consideration of timing of breaks within shifts, specifically ensuring that breaks are of at least 15 minutes duration, and that continuous driving time is restricted to 4 hours to reduce accident risk.[22]

Noting the work scheduling factors identified above as increasing risk of SPAD, Pacific National's rostering and fatigue management practices were examined.

Work scheduling and fatigue management

Interview evidence indicates that the co-driver had inadvertently fallen asleep shortly after ending the phone call to the Divisional Control Centre. He awoke to the sound of train T284 passing by on the Up Goods line, and commenced the performance of a roll-by inspection. It is likely that during this phase the co-driver's attentiveness was impaired by the grogginess and disorientation associated with sleep inertia[23] as he progressed from sleep to wakefulness.

---

[19] Independent Transport Safety Regulator (2011). *Managing signals passed at danger.*

[20] McGuffog, A., Spencer, M., Turner, C. & Stone, B. (2004). *T059 Human factors study of fatigue and shift work, Appendix 1: Working patterns of train drivers – Implications for fatigue and safety.* Rail Safety and Standards Board (United Kingdom). This study considered SPAD data from Jan 1998 to May 2003. http://www.rssb.co.uk/SiteCollectionDocuments/pdf/reports/Research/T059_app1_final.pdf

[21] Robertson, K., Spencer, M., McGuffog, A. & Stone, B. (2010). *Fatigue and shiftwork for freight locomotive drivers and contract trackworkers. Appendix F: Analysis of data from signals passed at danger.* Rail Safety and Standards Board (United Kingdom). This study considered SPAD data from Jan 2003 to Dec 2007. http://www.rssb.co.uk/SiteCollectionDocuments/pdf/reports/Research/T699_appf_final.pdf

[22] Rail Safety & Standards Board (2008). *Understanding Human Factors. A guide for the railway industry.* http://www.rssb.co.uk/SiteCollectionDocuments/pdf/understanding_human_factors_a_guide_for_the_railway_industry.pdf

[23] Sleep Inertia: 'A transitional state of lowered arousal occurring immediately after awakening from sleep and producing a temporary decrement in subsequent performance: Tassi, P & Muzet, A. (2000). Sleep Inertia. *Sleep Medicine Reviews, 4 (4),* 341-353.

The co-driver did not observe signal SM103G at caution or signal SM109G at stop. He observed signal 115G at stop and saw the workers in the rail corridor ahead at around the same time as the driver.

Given the co-driver's unintentional sleepiness leading up to the incident, as well as the established links between work scheduling factors and SPAD risk, Pacific National's systems for work scheduling and the management of fatigue risk were investigated.

Fatigue analysis

In the context of human performance, fatigue is understood to be a physical and psychological condition primarily caused by prolonged wakefulness and/or insufficient or disturbed sleep.[24] The National Transport Commission recognises five main factors contributing to fatigue impaired work performance, including:

- the duration of a duty period (time on task), and the rest breaks within and between shifts
- inadequate sleep (or sleep debt), which results from inadequate duration and quality of prior sleeps
- circadian effects, which involve working and sleeping against natural body rhythms that normally program people to sleep at night and be awake and work during the day
- the type or nature of the task being undertaken (workload)
- the work environment.

These factors can be compounded by a person's body clock, environmental conditions, stress, age and personal health and fitness.[25] 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.[26] Fatigue impairment has been identified as a causal factor in accidents and incidents including SPADs.

Crew sleep prior to journey

Both the driver and co-driver were rostered on duty from 2115 on 28 January 2013 to 0600 on 29 January 2013. They both then had a 17−hour break before recommencing duty at 2300 on 29 January 2013. Both had been rostered off between 24 and 27 January 2013. During the break between 0600 and 2300 on 29 January 2013, the driver estimated having obtained between 8 and 9 hours of sleep in two phases, between 0700 and 1400, and between 1930 and 2130. The co-driver estimated having obtained 11.5 hours sleep, in two phases, finally waking at approximately 2000. There was some evidence of poor sleep quality during this period due to a noisy sleeping environment.

Neither driver nor co-driver recalled feeling tired or lethargic at the commencement of their shift on 29 January 2013. Considering the length of the rest break between shifts and their reported obtained sleep it is unlikely that the train crew were experiencing any symptoms of fatigue at the commencement of the shift. In terms of assessing likelihood of fatigue impairment at the time of the SPAD event, it is also important to consider time of day effects as well as nature of task effects, including the potentially increased cognitive workloads associated with both the trainee driver role and the coaching role undertaken by the co-driver.

---

24 National Transport Commission (2008). *National Rail Safety Guideline. Management of Fatigue in Rail Safety Workers.* p.5.

25 Ibid.

26 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, United States Federal Aviation Administration.

Time of day

The period between 0200 and 0600 is well established as a period of reduced performance, due to the effects of the circadian cycle which predisposes humans to sleep during the night and be wakeful during the day. When we reverse these activities and work through the night and sleep during the day, we compromise the quality and the quantity of sleep, as well as the quality of the work performed. Thus time of day creates an additional element of fatigue risk in 24−hour rail operations.

Duration and nature of tasks

The journey that train 9837 was making between Nowra and Orange is approximately 450 km in length and normally takes about 9.5 hours, but has occasionally extended to up to 11.5 hours. It was perceived by the crew to be a long shift. At the time of the SPAD event, the trainee driver had been driving continuously for approximately 3 hours. He also had a relatively long drive to work in the vicinity of 45 to 50 minutes.

People have finite cognitive resources to attend to and to process information. As people become skilled in a task, that task's demand for cognitive energy diminishes,[27] thereby increasing their capacity to attend to other information. When tasks are novel, as would be the case for people undertaking training, the cognitive workload is increased. Attention to that task sustained over long periods of time contributes to the development of task-related fatigue impairment. The combination of time of day, time on task, and the cognitive demands of learning a route suggests that the driver would have been at elevated risk for task-related fatigue impairment at the time of the SPAD event. The ATSB determined that the driver was fatigue- impaired around the time of the incident due to the above factors.

Interview evidence indicated that the dual role performed by the co-driver (as second person as well as coaching the trainee driver) was also associated with a sustained higher-than-usual level of cognitive effort, with limited opportunity for rest and recovery. Consequently, considering the combination of sustained workload over time, and time of day, the co-driver was also considered to be fatigue-impaired at the time of the SPAD event.

After passing through the Meeks Road turnout, about seven minutes before the incident, the driver increased power and the co-driver made a phone call which lasted for a little over one minute. After this phone call the atmosphere in the cab, according to the driver, was relaxed, and quiet. Communications between the crew did not recommence following the end of the co-driver's phone call. There were no immediate tasks except for acknowledgement of the vigilance button at intervals of every minute or so. The data logger showed no change to the throttle or brake and the train gradually increased speed from 15 to 40 km/h. It was during this period of relative inactivity and lack of interaction that the co-driver is believed to have fallen asleep.

As 9837 approached signal SM103G a freight service, T284, passed in the opposite direction on the Up Goods line, initiating the requirement for a roll-by inspection. The investigation could not verify that a roll-by inspection was conducted or that a radio call took place to inform the other driver of the results, as radio calls between trains are not recorded. Interview evidence indicated that it is more likely the co-driver was in a drowsy and disoriented state at this time, consistent with a state of sleep inertia. This period of degraded performance coincided with the approach to signal SM103G at caution, and probably resulted in the co-driver's non-observation of the signal and the likely lack of action regarding any roll-by inspection.

The driver also did not observe signal SM103G at caution or signal SM109G at stop. Whilst it is possible that he also succumbed to sleep for a brief period, there was insufficient evidence to establish this possibility. What has been established is that he was experiencing a reduced state

---

27 Kahneman, D. (2011). *Thinking Fast and Slow.* Farrar, Straus & Giroux: New York.

of alertness, which, in combination with his limited route knowledge and lack of support from the then sleeping co-driver, probably contributed to his non-observation of these two signals.

Fatigue Management Principles

There is a regulatory requirement for rail operators to prepare their risk management program by accounting for, and assessing, any fatigue-related risks to safety arising from a wide range of factors. Modern fatigue risk management requires a number of elements and levels of risk control.

Dawson and McCulloch[28] as well as the National Transport Commission[29] have proposed the following hierarchy of fatigue risk controls:

- **Level 1: Sleep Opportunity −** Training, Scheduling Rules; Fatigue Modelling; Sleep/Medical Disorder Screening
- **Level 2: Sleep Obtained −** Training; Prior Sleep Wake Data; Sleep/Medical Disorder Screening
- **Level 3: Behavioural Symptoms −** Training; Symptom Checklists; Physiological Monitoring; Self Report Behavioural Scales
- **Level 4: Fatigue-related Errors −** Fatigue/Error Proofing Strategies; SMS Error Analysis System
- **Level 5: Fatigue-related Occurrences −** SMS Incident/Occurrence Analysis System.

While not a regulatory requirement the model suggests that, in order to ensure that an operator's system is well defended against fatigue-related occurrences, appropriate control mechanisms should be implemented at each level of the hierarchy.[30] Using this hierarchy, Dawson, Chapman and Thomas[31] have described two broad approaches to reducing fatigue-related risk, those being fatigue reduction strategies and fatigue-proofing strategies.

Fatigue reduction strategies

Fatigue reduction strategies are the techniques designed to reduce the likelihood that a fatigued individual is operating in the workplace. This is typically achieved through managing shift length and break length between shifts, thereby ensuring adequate sleep opportunity corresponding to a level 1 risk control. At levels 2 and 3 the measures reduce the likelihood that a fatigued individual either signs on or remains in the workplace by identifying them and precluding them from work on the basis of insufficient sleep (level 2) or the presence of behavioural indicators of fatigue (level 3).

Employment of Fatigue Reduction Strategies by Pacific National

Pacific National provided evidence of practices consistent with control mechanisms at level 1 of the above model, including fatigue awareness training, fatigue modelling (using FAID[32]) for roster design, as well as sleep disorder screening. Pacific National had in place a Fatigue Management Policy statement, a Fatigue Management Standard incorporated within Pacific National's Integrated Safety Management System, a Fatigue Management Procedure and an Employee User Guide on fatigue management. The Pacific National Fatigue Management Policy statement focused on two broad fatigue management controls, those being roster management and fatigue awareness training.

Similarly, the Fatigue Management Standard outlined the use of a 'fatigue management index' (FAID) 'to ensure that employees are provided with adequate rest opportunity between shifts.' The

---

28 Dawson. D. & McCulloch, K. (2005). Managing fatigue: It's about sleep. *Sleep Medicine Reviews, 9,* 365-380.
29 National Transport Commission (2008). *National Rail Safety Guideline. Management of Fatigue in Rail Safety Workers.*
30 National Transport Commission (2008).
31 Dawson, D., Chapman, J. & Thomas, M.J.W. (2012). Fatigue proofing: A new approach to reducing fatigue-related risk using the principles of error management. *Sleep Medicine Reviews, 16,* 167-175.
32 Fatigue Audit InterDyne: A bio-mathematical model designed to predict aggregated fatigue risk over a roster. Fatigue risk is interpreted by way of a number related to fatigue risk, known as the Fatigue Index or FAID score.

Pacific National Fatigue Management Procedure states that, 'no employee will be expected to commence or complete a shift if the employee advises they have not had sufficient rest between shifts or the employee indicates they are fatigued during a shift.'[33] The Fatigue Management Standard also makes reference to the use (where available) of sign-on procedures to ensure employees are fit for duty prior to commencing shift. This would represent a level 2 and/or 3 risk control as a mechanism to ensure that employees had obtained sufficient sleep, and were observed to be functioning effectively at the beginning of a shift. From the evidence provided, Pacific National had not implemented at Nowra the sign-on procedures for train drivers commencing shift that were available at some other depots.

Recognising that operational requirements will sometimes necessitate changes to planned rosters, and in accordance with the Rail Safety National Regulations,[34] Pacific National routinely made comparison of individuals' planned working hours with actual working hours. The analysis applied to this process relied solely on the use of the FAID score to establish individual fatigue likelihood. Problems associated with the use of the FAID score to determine individual fatigue risk will be discussed in a later section of this report. There was no evidence provided to indicate that Pacific National had a process to collect information on sleep obtained by drivers before and after long shifts. Such information could be used to inform fatigue management practices.

Fatigue-proofing strategies

Fatigue-proofing strategies represent level 4 risk controls. Recognising that some individuals will slip through the controls at levels 1 to 3, which aim to prevent a fatigued individual from commencing or continuing work, fatigue-proofing strategies aim to reduce the likelihood that a fatigued individual will make an error that leads to accident or injury. Thus, these strategies make the system of work more resilient or tolerant to fatigue-related error.[35] Fatigue-proofing strategies can include engineering controls such as vigilance monitoring systems, but also team and individual level techniques such as increased supervision or social interaction, and increased frequency of breaks or task rotation, as well as strategic napping where appropriate.[36]

For rail operations incorporating long driving shifts, fatigue risk is increased, as demonstrated by the United Kingdom Rail Safety and Standards Board which found correlations between the duration of continuous driving and mental tiredness during a shift.[37] Further, research examining safety risks associated with shift length and timing has suggested that with increasing shift length, risk of a safety incident also increases, such that relative to 8−hour shifts, 10−hour shifts are associated with 13% increased risk, and 12−hour shifts with a 27% increased risk of a safety incident.[38]

Time of day is also an important factor. The increase in fatigue and the deterioration in performance with time on task have been shown to occur more rapidly overnight.[39]

Therefore, when rail operations combine long driving shifts with overnight operations, the associated fatigue risk is elevated. This increases the importance of additional fatigue-proofing strategies to effectively manage the risk of fatigue-related error. For example, regular rest breaks (10 minutes every hour) have been found to prevent accumulation of accident risk during sustained activities in industrial settings, where the relative risk of an accident in the last half hour

---

33 Pacific National (Jan 2013). Fatigue Management Procedure FMP-001-06 p.3.

34 Rail Safety National Law National Regulations 2012 – 21.1.2013 Part 5 – Rail safety workers, S29 (2)(b)(i).

35 Dawson, D., Chapman, J. & Thomas, M.J.W. (2012). Fatigue proofing: A new approach to reducing fatigue-related risk using the principles of error management. *Sleep Medicine Reviews, 16,* 167-175.

36 Rail Industry Safety and Standards Board (2012). *RISSB Guideline on Fatigue Risk Management Version 3(Draft).*

37 Turner, C & Stone, B.M. (2004). *T059 Human factors study of fatigue and shift work, Appendix 2: Review of coping strategies to mitigate fatigue of train drivers.* http://www.rssb.co.uk/SiteCollectionDocuments/pdf/reports/research/T059_app2_final.pdf

38 Folkard, S., Lombardi, D.A., & Tucker, P.T. (2005). Shiftwork: Safety, Sleepiness and Sleep. *Industrial Health, 43,* 20-23.

39 Williamson, A., Lombardi, D.A., Folkard, S., Stutts, J., Courtney, T.K. & Connor, J.L. (2011). The link between fatigue and safety. *Accident Analysis and Prevention, 43,* 498-515.

of a two−hour period of continuous work was approximately twice as likely as in the first half hour.[40]

Employment of fatigue-proofing strategies by Pacific National

At the time of the event, the driver of train 9837 had been driving continuously for a period of approximately 3 hours without a break, and without swapping roles with the co-driver. This is often the case when driving for the purposes of gaining experience on a route. Interview evidence indicates that the crew had planned to swap over at Clyde. Pacific National provided evidence of the provision of fatigue management training for employees which included material on the use of regular breaks. The driver had not yet undertaken this training and it had been some four years since the co-driver had done so. Outside of this competency training, there was no documented policy or guidance material provided to crews to either prescribe or to suggest how breaks and task rotation were to be managed to support driver performance during long driving shifts.

Pacific National assessment of roster

Pacific National provided advice to the effect that when developing rosters, it considers a range of factors including enterprise agreement requirements regarding hours of work and rest, travel considerations and leave requirements, as well as operational requirements, training requirements and staff requests.

While development of the drivers' roster may have included consideration of these elements, the assessment of the suitability of the roster for managing fatigue risk was based primarily on the use of a bio-mathematical fatigue modelling program known as the Fatigue Audit Interdyne (FAID). Bio-mathematical models attempt to predict the effects of different working patterns on subsequent job performance, with regard to the scientific relationships among work hours, sleep and performance.[41] FAID 'assigns a recovery value to time away from work based on the amount of sleep that is likely to be obtained in non-work periods, depending on their length and the time of day that they occur.'[42] That is to say, FAID does not predict fatigue per se but rather predicts a sleep opportunity, demonstrating only that the organisation has provided employees with an adequate opportunity to sleep, producing a work-related fatigue score.[43]

An organisation using FAID to assess its fatigue risk must first conduct a fatigue hazard assessment, taking into account the fatigue-related hazards specific to the role or task, and determining the acceptable level of fatigue tolerance for that role or task. Without this assessment, the FAID program defaults to a Fatigue Tolerance Level (FTL) of 80. When using the default FTL of 80, scores between 70 and 80 would be considered to be in the FAID Yellow Condition, and scores over 80 would be considered to be in the FAID Red Condition[44]. Pacific National was unable to produce evidence of having conducted such a fatigue hazard assessment for driver, trainee driver or trainer driver roles. Further, based on available evidence, Pacific National's analysis of the suitability of the rosters appeared to rely solely on the FAID score. Pacific National's Fatigue Management Procedure states that: 'they will make best endeavours not to roster over a FAID score over 100 and when planning a roster, recognise that FAID scores between 80 and 100 are considered in the high range,' and 'where possible crew planners are to endeavour to roster employees with a lower fatigue score.'[45]

---

40 Tucker, P., Folkard, S. & Macdonald, I. (2003). Rest breaks and accident risk. *The Lancet, 361,* 680.

41 Dawson, D., Noy, Y.I., Harma, M., Akerstedt, T. & Belenky, G. (2011). Modelling fatigue and the use of fatigue models in work settings. *Accident Analysis and Prevention, 43,* 549-564.

42 Roach, G.D., Fletcher, A. & Dawson, D. (2004). A model to predict work -related fatigue based on hours of work. *Aviation, Space, and Environmental Medicine, 75(3),* 61-69.

43 Dawson et al (2011).

44 The red condition indicates a level above the Fatigue Tolerance Level and the yellow condition within 10 points below this level. Interdynamics (2012). *FAID v2.1 User Guide.*

45 Pacific National Fatigue Management Procedure FMP-001-06 p.4. January 2013.

Pacific National's Fatigue Management Procedure[46] discusses FAID scores as indicators of individual fatigue levels and uses FAID scores of 80 and 100 as absolute thresholds, so that a score above 80 would trigger 'monitoring train crew with FAID scores between 80 and 100', with completion of a risk assessment or evaluation required for scores of over 100.

When evaluating rosters, there are a number of documented limitations with over-reliance on bio-mathematical models such as FAID. Because the distribution of fatigue across a given population of employees working the same roster is significant, it is difficult to generalise from the average data generated by a bio-mathematical model.[47] As noted by ITSR:

> …fatigue models are appropriate to use as one tool to help evaluate group rosters to help identify how aspects of fatigue exposure are distributed. Model outputs... should never be the sole basis for a safety risk management decision regarding work hours.[48]

ITSR also stated that: 'a FAID score of less than 80 does not mean that a work schedule is acceptable or that a person is not impaired at a level that could affect safety.'[49] The United States Federal Railroad Administration (FRA) also cautioned against reliance on a FAID threshold score of 80, finding that scores lower than 80 can be associated with 'extreme fatigue.'[50]

Pacific National was unable to produce evidence of what the monitoring for train crew with FAID scores of above 80 comprised, or whether this monitoring had taken place for the crew of train 9837, whose individual scores had both fallen within the FAID Red Condition over the preceding fortnight.

FAID, along with other bio-mathematical models, is a useful tool to account for hours of sleep opportunity provided, thereby providing an indication of fatigue exposure across a group of employees. It cannot account for the hours of sleep actually achieved by individuals, nor for the quality of that sleep. These additional factors necessitate the use of multiple layers of controls to manage fatigue-related risk.

Overall, Pacific National's fatigue management system was limited by its over-reliance on the use of a bio-mathematical model to predict individual fatigue risk, based solely on sleep opportunity, without due consideration to a multiple layered fatigue risk management strategy.

Cross-calling of signals

Pacific National's SPAD strategy emphasises the cross-calling of all signals as a key risk control for single human error. Where a single crew member might either miss or misinterpret the aspect of a signal, the second crew member is in a position to correct the error. Cross calling occurs when one crew member verbally identifies the aspect of the signal, such as green over red, and the other crew member verbally confirms that this is understood. Cross-calling of signals is intended to assist the train crew in ensuring the next signal is seen and correctly understood; the activity also provides a confirmation that both crew members are awake. It is a prescribed practice under Pacific National's Integrated Safety Management System which states:

> To ensure the continuing safe operation of Pacific National trains, the following actions must be observed:
>
> - all train crew members are to call all signals regularly and routinely

46 Pacific National (2013). Bulk Services Bulk Rail NSW & VIC Fatigue Management Procedure. FMP-001-06.

47 Dawson et al (2011).

48 Independent Transport Safety Regulator (2010). *Transport Safety Alert 34 - Use of bio-mathematical models in managing risks of human fatigue in the workplace.*

49 Ibid.

50 Federal Railroad Administration (2010). *Procedures for Validation and Calibration of Human Fatigue Models: The Fatigue Audit InterDyne Tool.*

- all train crew members should ensure that each has recognised and understood signal aspects
- non-driving train crew members should satisfy themselves that the driver is taking appropriate and timely action to ensure that signal indications and/or sectional authorities are obeyed, particularly restrictive aspects and orders. [51]

Both members of the train crew were aware of this requirement and both stated they did not fully comply with it. Only signals that were not at full clear were called when they were working together. The co-driver explained that because there were so many signals in the metropolitan network that he thought it was impractical to cross call every signal. While this practice was not in accordance with the Pacific National requirements, the co-driver said that he was confident that the driver would raise any potential operational problem with him. He was also very confident in the train handling ability of the driver. Both the driver and co-driver were assessed as competent in respect to cross-calling of signals.[52] [53]

The practice of not cross-calling all signals contributed to the reduced communication between the crew leading up to the SPAD event. In hindsight, both drivers identified that, due to the driver's limited knowledge of the track between Marrickville and Clyde, this was an area where it may have been especially beneficial to cross call signals. Anecdotal evidence is that many train crews routinely do not cross call all signals. As suggested by the train crew, for sections of track with frequent signals, it becomes a repetitive action which adds to workload. Usually there is no sanction for taking this short cut and no safety repercussions. A review by Pacific National of operating procedures for cross-calling all signals may identify an opportunity for improvement.

Expectancy

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 challenging, particularly because people will generally assume that, by looking in the right direction, unexpected objects and events will grab their attention.[54]

The train crew said they did not expect to have any signals at stop as they had not encountered any there previously. The co-driver had driven through this area on numerous previous occasions. He noted that he had never previously observed signals SM109G or SM115G displaying an aspect other than clear or proceed. Even when previously driving through this area up to five times per week, he could not recall ever having stopped at signals SM109G or SM115G.

The driver, who was learning the route, had travelled through this area just 4 or 5 times previously. He could not recall seeing these signals displaying either a caution or a stop aspect on those occasions. The co-driver's previous experience would be sufficient to influence his expectations of a clear run through this area, but it is unlikely that the driver's limited previous experience would be sufficient to do so.

It is possible, given his expectation of a clear run through this area, the co-driver relaxed more than he otherwise would have. With relaxing came reduced vigilance in the tasks of observing signal indications and coaching the driver, thus contributing to the onset of sleep at this critical time.

---

[51] Pacific National 'Safeworking responsibilities of train crew' Generic Procedure 006.7 –R02 issued April 2009.

[52] Pacific National Bulk Rail Performance Checklist 5, 10 May 2011.

[53] Pacific National Bulk Rail Performance Checklist 2, 8 September 2011.

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

Role of co-driver

The use of two person train crew is an important measure to mitigate the risk of train driver error. It is thought that two drivers are less likely to miss an important signal than a single driver, thereby providing a redundancy in the system. Two drivers can also employ the tactic of cross-calling of signals to assist in remaining alert to signal changes. When one of the drivers is unfamiliar with the route and is undergoing training the use of two drivers as a way to mitigate risk may be less effective.

In order for drivers to learn a particular route, and eventually be assessed as competent to drive a nominated route, they first act as a co-driver and observe the actions of the driver. Eventually they are expected to drive the route under the supervision of an advanced driver. The role of the more experienced advanced driver during a journey is to ensure that no major errors are made and to assist the trainee driver learn the route. This is a process that a trainee driver goes through to become familiar with all the landmarks of a particular route such as the signals, sighting distances, changes in track speed, upcoming gradients, curves and how the train must be controlled in response to the conditions. The advanced driver needs to remain alert to the actions of the trainee and coach the trainee driver through the relevant features of the route ahead. Both crew members said that once they departed Nowra they were talking their way through the journey as a way for the driver to learn this route.

There is an increased responsibility placed on an advanced driver when a trainee is driving. For long shifts such as the one faced on this occasion there is little time available for a break or rest during the journey. During the journey the advanced driver also needs to attend to other duties as a co-driver, but the co-driver's essential task is to remain vigilant to the actions of the trainee driver.

The co-driver was designated as an advanced locomotive driver. In the role description Pacific National use the term coach/tutor driver and it is designated as a level 5, one level below the highest designated level − driver trainer/assessor level 6.[55] The principal difference is a level 5 driver does not have the authority to assess or determine the competency of the drivers they supervise.

The co-driver said that he had not received specific training to perform the task of coaching trainee drivers. Pacific National has no specific training program or competency check for the task of coaching/tutoring trainee drivers. The position description for the level 6 driver trainer includes the requirement for a certificate 4 in workplace training and assessment. There is no requirement for this as a level 5 coach/tutor driver. This means that the driver in the role as coach/tutor needs to rely on their own knowledge and experience in making a judgement as to how they impart this route knowledge while performing the duties of a co-driver. In this instance the co-driver led a crew decision to cross call only signals displaying an aspect other than full clear. Had the co-driver been provided with specific training as to the increased risks associated with the training environment, he may have made a more informed decision about the implementation of this risk control. The development of this may assist the coach/tutor drivers perform the role with more understanding of the specific requirements involved. Pacific National has stated that a review of training requirements is underway as outlined in the Safety Actions section of the report.

Vigilance control system

Currently there is no automatic warning system available to NSW freight train crews in the case of a SPAD, nor is there any device installed in freight locomotives to automatically halt the train if this situation occurs. Passenger trains in much of the Sydney metropolitan rail area are fitted with train stops on most signals. These are activated if a train passes the signal at stop then a nearby

55 Pacific National Bulk Rail Enterprise Agreement 2009.

trackside arm strikes a train stop lever fitted to the front of the train which releases brake pipe air and applies the train's brakes.

RailCorp is trialling Automatic Train Protection (ATP) which is a form of automatic train control which may prevent or reduce the impact of SPADs for passenger trains. The introduction of ATP was one of the recommendations from a special commission of inquiry into a fatal passenger train derailment at Waterfall in 2003.

In South Australia ARTC is also developing an Automatic Train Management System (ATMS) for freight trains which will result in the minimising of risks such as those faced in this incident. According to the ARTC:

> In addition to its safety design, ATMS will have an additional feature of enforcement on locomotives should authorities not be followed. In this event, the driver will be given both audio and visual warnings of the potential breach in authorities followed by a count down initiated by ATMS. If the train driver does not bring the train back within the braking curve in advance of the authority limits within the time allowed, the train will automatically apply the brakes.[56]

One engineering safety device currently installed in freight locomotive cabs as a defence against fatigue or incapacitation of the driver is an intermittent action reset device or vigilance control system. It is intended to confirm a driver's level of consciousness in that, if they are unable to press a button within a time period, a penalty brake application is made to bring the train to a halt. The penalty brake application is not the reason why train 9837 finally stopped. If this was the case there would be evidence of a full brake application. Instead, only a partial brake application was made.

At the right hand of the driver was a vigilance button which needed to be pressed at random variable intervals of between 25 and 45 seconds. The vigilance timing cycle commences after the locomotives brakes are released. If the driver has not pressed the button within the interval a light is activated for 10 seconds then, after a further five seconds, the light flashes before an audible alarm sounds for five seconds. Thus, the total time available to the driver in which to react varies between 45 and 60 seconds. If the driver fails to respond the train's brakes are applied and the train is brought to a halt. The system is also task linked to the throttle, where a movement will reset the timing cycle up until the light illuminates. After the time cycle expires (light illuminates) the button must be pressed to reset the system.

The acknowledgement of the vigilance system by the driver is normally recorded on a trace on the data logger of the lead locomotive. For locomotives running on the ARTC and RailCorp networks, it is a requirement that the data logging system must be operational. In this case the maintenance status of the devices was inadequate to provide a full analysis. When the vigilance system was tested by Pacific National on the 1 March 2013 no faults were detected.

The previous recorded action by the driver was approximately eight minutes before the final brake application. It was a throttle application after passing through the Meeks Road turnout section where he had reduced speed to 12 km/h. After this there is no further recorded action by the driver until just prior to signal SM115G when he adjusts the throttle from power to idle. Train 9837 took about 37 seconds to travel the 412 metres between signal SM103G and SM109G. It then took a further 35 seconds to travel the 391 metres between signals SM109G and SM115G.

A number of procedures are in place if the vigilance system runs in a non-operational state. Although there was no recorded evidence showing the vigilance system was operational, none of the procedures for an inoperable vigilance system were activated, thus indicating the system should have been operational at the time of the incident. No emergency braking (drop in brake pipe pressure to approximately zero) was recorded at the time of the incident, indicating that no

[56] ARTC website http://atms.artc.com.au/faqs/, accessed on 19 June 2013.

penalty brake was applied by the vigilance system. The co-driver also said that he thought the vigilance system was working for the whole trip and that the driver was using it correctly.

The available evidence indicates that the driver was responding as required to the activation of the vigilance system. It is also plausible that he continued to respond to the vigilance system requirements in a reduced state of alertness, as has been implicated in other SPAD events.[57]

57 See for example: NSW Transport Safety Bureau, *Independent Inquiry Report, Coal Train Collision, Beresfield NSW, 23 October 1997*.

Findings

On 30 January 2013, a Pacific National freight train passed two signals at stop, SM109G and SM115G, which were protecting a work crew who were performing litter pickup on the tracks next to Hurlstone Park station. Fortunately the work crew had posted lookouts who warned them of the train's approach which allowed them to get clear of the tracks. There were no injuries or damage as a result of the incident.

From the evidence available, the following findings are made with respect to the incident and 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 crew did not observe signals SM103G at caution and SM109G at stop, which resulted in them missing information about the next signal, SM115G, which was also at stop.
- The train crew were fatigue-impaired due to a combination of factors: time of day, time on task and the sustained cognitive workload.
- The co-driver's expectation that he would not have a stop signal at the incident location probably allowed him to relax, reducing his vigilance of the signal indications and the driver's actions, and contributing to the onset of sleep at this critical time.
- **Pacific National's fatigue management system is over-reliant on the use of a bio-mathematical model to predict individual fatigue risk, being based principally on rostered work hours without due consideration to higher level fatigue risk management strategies. *[Safety issue]***
- **Pacific National Bulk Rail division did not provide training on fatigue management to the driver. *[Safety issue]***
- The driver of train 9837 was learning the route under the guidance of an advanced driver, the co-driver. This lack of route knowledge probably influenced his decision not to brake before signal SM115G which was displaying a stop indication.
- **Pacific National Bulk Rail does not provide coach/tutor drivers with sufficient training and direction as to how to perform their role. *[Safety issue]***
- The train crew did not cross call all signals as required by Pacific National's Integrated Safety Management System.

Other factors that increase risk

- **Pacific National's SPAD strategy focuses on individual crew actions and the costs of SPADs, rather than developing integrated error tolerant systems of work with regard for the broader systemic issues known to contribute to SPAD events. *[Safety issue]***

Other findings

- All signals associated with the incident were functioning as designed and there were no signal sighting issues.

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.

Depending on the level of risk of the safety issue, the extent of corrective action taken by the relevant organisation, or the desirability of directing a broad safety message to the rail industry, the ATSB may issue safety recommendations or safety advisory notices as part of the final report.

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.

Fatigue management system

Number:	RO-2013-003-SI-01
Issue owner:	Pacific National
Type of operation:	Rail operations
Who it affects:	All rail operators

Safety issue description:

Pacific National's fatigue management system is over-reliant on the use of a bio-mathematical model to predict individual fatigue risk, being based principally on rostered work hours without due consideration to higher level fatigue risk management strategies.

Response to safety issue and/or Proactive safety action taken by: Pacific National

Pacific National is in the process of releasing an updated Fatigue Management Standard to meet the requirements of Regulation 29 of the National Law. Pacific National Bulk rail will consider the appropriate use of these bio-mathematical tools as part of the fatigue risk management review process.

ATSB comment/action in response:

The Australian Transport Safety Bureau notes the response provided and is satisfied that the action initiated by Pacific National will, when completed, address the safety issue.

Fatigue management training

Number:	RO-2013-003-SI-02
Issue owner:	Pacific National
Type of operation:	Rail operations
Who it affects:	All rail operators

Safety issue description:

Pacific National Bulk Rail division did not provide training on fatigue management to the driver.

Response to safety issue and/or Proactive safety action taken by: Pacific National

Pacific National Bulk rail has commenced a review of the delivery and implementation of fatigue training to safety critical personnel to ensure relevant personnel have received the appropriate training.

ATSB comment/action in response:

The Australian Transport Safety Bureau notes the response provided and is satisfied that the action initiated by Pacific National will, when completed, address the safety issue.

Training for coach/tutor drivers

Number:	RO-2013-003-SI-03
Issue owner:	Pacific National
Type of operation:	Rail operations
Who it affects:	All rail operators

Safety issue description:

Pacific National Bulk Rail does not provide coach/tutor drivers with sufficient training and direction as to how to perform their role.

Response to safety issue and/or Proactive safety action taken by: Pacific National

Pacific National will review training requirements for coach/tutor drivers and is currently considering development of a more comprehensive coach/mentor training package. In addition Pacific National Rail is currently reviewing an improved system called JobReady to assist in the management and monitoring of training via personalised training plans based on job roles.

ATSB comment/action in response:

The Australian Transport Safety Bureau notes the response provided and is satisfied that the action initiated by Pacific National will, when completed, address the safety issue.

SPAD strategy

Number:	RO-2013-003-SI-04
Issue owner:	Pacific National
Type of operation:	Rail operations
Who it affects:	All rail operators

Safety issue description:

Pacific National's SPAD strategy focuses on individual crew actions and the costs of SPADs, rather than developing integrated error tolerant systems of work with regard for the broader systemic issues known to contribute to SPAD events.

Response to safety issue and/or Proactive safety action taken by: Pacific National

Noting previous comments in regard to the purpose of the Bulk Rail SPAD Strategy document, Pacific National has commenced a review of its existing SPAD risk management processes and will consider the findings of this report.

ATSB comment/action in response:

The Australian Transport Safety Bureau notes the response provided and is satisfied that the action initiated by Pacific National will, when completed, address the safety issue.

General details

Occurrence details

Date and time:	30 January 2013 – 0230 EDT	
Occurrence category:	Incident	
Primary occurrence type:	Multiple SPAD	
Location:	Hurlstone Park, New South Wales	
	Latitude: 33° 54.627’ S	Longitude: 151° 7.892’ E

Train details

Train operator:	Pacific National	
Registration:	9837	
Type of operation:	Freight	
Persons on board:	Crew – 2	Passengers – Nil
Injuries:	Crew – Nil	Passengers – Nil
Damage:	None	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- Pacific National Bulk Rail (a division of Asciano Limited)
- RailCorp
- Swetha International Pty Ltd
- The Bureau of Meteorology
- The Office of the National Rail Safety Regulator
- The RailCorp area controller
- The train crew of 9837
- The Swetha work crew

References

ARTC (2013). *Advanced Train Management System.* http://atms.artc.com.au/faqs/, accessed on 19 June 2013.

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, United States Federal Aviation Administration.

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

Dawson, D., Chapman, J. & Thomas, M.J.W. (2012). Fatigue proofing: A new approach to reducing fatigue-related risk using the principles of error management. *Sleep Medicine Reviews, 16,* 167−175.

Dawson. D. & McCulloch, K. (2005). Managing fatigue: It's about sleep. *Sleep Medicine Reviews, 9,* 365−380.

Dawson, D., Noy, Y.I., Harma, M., Akerstedt, T. & Belenky, G. (2011). Modelling fatigue and the use of fatigue models in work settings. Accident Analysis and Prevention, 43, 549−564.

Federal Railroad Administration (2010). *Procedures for Validation and Calibration of Human Fatigue Models: The Fatigue Audit InterDyne Tool.* http://www.fra.dot.gov/rpd/downloads/TR_Procedures_or_Validation_and_Calibration_final.pdf

Folkard, S., Lombardi, D.A., & Tucker, P.T. (2005). Shiftwork: Safety, Sleepiness and Sleep. Industrial Health, 43, 20−23.

Independent Transport Safety Regulator (2013). *ITSR Rail Industry Safety Report 2011−2012.*

Independent Transport Safety Regulator (2010). Transport Safety Alert 34 − *Use of bio-mathematical models in managing risks of human fatigue in the workplace*.

Independent Transport Safety Regulator (2011). *Managing signals passed at danger.* http://www.transportregulator.nsw.gov.au/rail/publications/presentations_papers/Managing_spads.pdf.

Interdynamics (2012). *FAID v2.1 User Guide.*

Kahneman, D. (2011). *Thinking Fast and Slow.* Farrar, Straus & Giroux: New York.

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

NSW Transport Safety Bureau, *Independent Inquiry Report, Coal Train Collision, Beresfield NSW, 23 October 1997*.

Rail Industry Safety and Standards Board (Dec 2010). *Glossary of Rail Terminology – Guideline.*

Rail Industry Safety and Standards Board (2012). *RISSB Guideline on Fatigue Risk Management Version 3(Draft).*

RailCorp (2007). *Infrastructure Engineering Manual − Track Fundamentals* TMC 202 Version 2.

RailCorp General Rules NGE 200 − August 2005.

RailCorp Engineering Standard − *NSW Signalling SGS 01 Infrastructure Engineering Manual – Glossary of Signalling Terms.*

RailCorp Infrastructure Engineering Standard – Signalling, *Signalling Systems – Basic Principles and Configuration Standard*, March 2006.

Rail Safety National Law National Regulations (2012) − Made under the *Rail Safety National Law (NSW).*

Rail Safety and Standards Board (2004).McGuffog, A., Spencer, M., Turner, C. & Stone, B. (2004). *T059 Human factors study of fatigue and shift work, Appendix 1: Working patterns of train drivers – Implications for fatigue and safety.*

Rail Safety & Standards Board (2008). Understanding Human Factors. A guide for the railway industry. http://www.rssb.co.uk/SiteCollectionDocuments/pdf/understanding_human_factors_a_guide_for_the_railway_industry.pdf

Rail Safety and Standards Board (2010). Robertson, K., Spencer, M., McGuffog, A. & Stone, B. (2010). *Fatigue and shiftwork for freight locomotive drivers and contract trackworkers. Appendix F: Analysis of data from signals passed at danger.*

Roach, G.D., Fletcher, A. & Dawson, D. (2004). A model to predict work -related fatigue based on hours of work. *Aviation, Space, and Environmental Medicine, 75(3),* 61−69.

Swinburne University of Technology Astronomy Online Encyclopaedia.

Tassi, P & Muzet, A. (2000). Sleep Inertia. *Sleep Medicine Reviews, 4 (4),* 341−353.

Tucker, P., Folkard, S. & Macdonald, I. (2003). Rest breaks and accident risk. *The Lancet, 361,* 680.

Turner, C & Stone, B.M. (2004). *T059 Human factors study of fatigue and shift work, Appendix 2: Review of coping strategies to mitigate fatigue of train drivers.*

Williamson, A., Lombardi, D.A., Folkard, S., Stutts, J., Courtney, T.K. & Connor, J.L. (2011). The link between fatigue and safety. *Accident Analysis and Prevention, 43,* 498−515.

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:

- Pacific National Bulk Rail (a division of Asciano Limited)
- RailCorp
- Swetha International Pty Ltd
- The Office of the National Rail Safety Regulator

- The RailCorp area controller
- The train crew of 9837
- Submissions were received from Pacific National Bulk Rail, Sydney Trains (formerly RailCorp), the Office of the National Rail Safety Regulator and a train crew member of 9837

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 fare-paying passenger operations.

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

24 Hours 1800 020 616
Web www.atsb.gov.au
Twitter @ATSBinfo
Email atsbinfo@atsb.gov.au

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
Multiple SPAD by freight train 9837, Hurlstone Park, NSW
30 January 2013

RO-2013-003
Final – 15 November 2013