



Office of Transport Safety Investigations

RAIL SAFETY INVESTIGATION REPORT

**SIGNAL PASSED AT DANGER BY CITYRAIL SERVICE 67-R
RESULTING IN AN OPPOSING MOVEMENT**

NORTH STRATHFIELD

2 SEPTEMBER 2006



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OTSI File Ref: 04315

21 September 2007

**Office of Transport Safety Investigations
Level 17, 201 Elizabeth Street
Sydney NSW 2000**

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EXECUTIVE SUMMARY

The Incident

At approximately 1:08am (Eastern Standard Time) on 2 September 2006, an empty CityRail service 67-R passed Signal ST 164 at stop without authority¹ on the 'Down Relief' line at North Strathfield and continued onto the single, bi-directional 'Goods' line between North Strathfield and Homebush, as the points were set for this route. At the same time, Pacific National's freight service 5YN2 was travelling on the same 'Goods' line between Flemington and Homebush, but in the opposite direction. 67-R and 5YN2 were proceeding towards each other on the same line.²

The Area Controller at Strathfield Signal Box witnessed the evolving opposing movement on his indication board and attempted to contact the Drivers of 67-R and 5YN2 by radio to direct them to stop their trains immediately. The Driver of 5YN2 responded by stopping his train as directed. However, the Area Controller was unable to establish radio contact with the Driver of 67-R because the Driver had entered the wrong train designation, or run number, when he logged into the radio network. In the meantime, a number of other Area Controllers stood on the balcony of the Strathfield Signal Box and tried to attract the attention of the Driver of 67-R in an attempt to warn him of the impending danger. The Driver was unaware of these attempts to contact him but eventually realised that he was on the wrong line and brought his train to a stand adjacent to the Strathfield Signal Box and some 194 metres from the stationary 5YN2.

There was no injury or damage resulting from the incident.

Findings

The following findings have been made as a result of the lines of inquiry that have been followed to address the Terms of Reference for this investigation:

¹ A train passing a signal at stop without authority is commonly referred to in the rail industry as a 'SPAD', a Signal Passed at Danger.

² In the rail industry, this is referred to as an 'opposing movement'.

a. Causation

- i. The opposing movement was a consequence of an error by the Driver of 67-R who either did not see, or did not respond to, Signal ST 164 and passed the signal when it was at stop. As a result, 67-R deviated from the intended route and proceeded onto on the same track as, and travelling towards, 5YN2.

b. Contributory Factors

- i. Signal ST 164 is sited in a manner and location that meets the required technical parameters; as such it should have been readily apparent. However, as a 'ground dwarf signal', it is lower than other signals in the immediate area and may have been overlooked by the Driver in favour of two Main Line signals in advance of it which were showing proceed indications.
- ii. The Driver of 67-R and the Area Controller had worked for nine and eight consecutive days respectively and were due to proceed on rest days at the end of their shifts. While these rosters and the hours shown therein were within industry and RailCorp's scheduling parameters, research³ indicates that both members were operating in a 'zone' where there was an increased likelihood of them making an error.

c. Anticipation and Management of Risk

- i. There was no record within RailCorp of Signal ST 164 having previously been passed at danger. Even so, Signal ST 164 is not fitted with any form of mechanical protection, such as a train stop or catch points, to mitigate the consequences of a SPAD.

d. Conduct of Train Movements

- i. While the route for 67-R was set properly, other Area Controllers stated that they would have set the route in such a way that would have required the Driver to have waited longer at Signal ST 168R but then given him a clear run through Signal ST 164 and on to

³ Rail Safety & Standards Board (2004), *Human Factors of Fatigue and Shift Work* Railtrack PLC (S&SD)

Strathfield. Such a setting would also have provided an increased safety margin.

e. Adequacy of Driver's Route Knowledge and Competency

- i. The Driver was a fully trained and qualified driver; his route knowledge for the 67-R timetabled run was adequate.

f. Effectiveness of Communications Equipment and Protocols

- i. The communications equipment and the protocols in place at the time of the incident were functional and adequate.
- ii. Management of the situation which brought 67-R and 5YN2 onto a collision course was made more difficult because of an error made by the Driver of 67-R at the start of his leg from Hornsby, when he logged into the radio network and identified his train with an incorrect designation. Effectively, this error prevented the Area Controller from making direct contact with the driver of 67-R through the MetroNet communications system.
- iii. At the onset of the incident, the Area Controller did not broadcast an emergency message to all trains in the area to stop.

g. Effectiveness of Emergency Response

- i. In the face of what was an imminent and significant emergency, other members in the Strathfield Signal Box reacted quickly by making radio calls to support the Area Controller and attempting to warn the Driver of 67-R by using flags and hand lamps.
- ii. RailCorp's immediate actions to establish that its signals system was not defective, and that other operations on the same line were not in jeopardy, were timely and appropriate.

Recommendations

In order to prevent a recurrence of this type of incident, the following remedial safety actions are recommended for implementation by the organisations specified below:

a. RailCorp

- i. ensure that Signal ST 164 is upgraded to an LED-type signal;
- ii. issue instructions to Strathfield Area Controllers to reinforce the implementation of Local Instruction NOS02/2006, which requires Area Controllers to hold trains at Signal ST 168R that is protected by catch points, before setting Signal ST 164 to clear;
- iii. install a train stop at Signal ST 164;
- iv. identify any locations where a similar SPAD could occur and implement remedial safety action to eliminate the potential for collision as a result of opposing or following movement;
- v. alarm its control panels and indication boards, where it has not already done so, so that Area Controllers are automatically alerted to situations where signals have been passed at stop and/or to opposing movements;
- vi. issue instructions to drivers to reinforce the importance of correct MetroNet log in procedure;
- vii. conduct a review of the train radio log in process to ascertain if the risk can be engineered out of the system;
- viii. issue instructions to area controllers to raise the awareness of emergency broadcast functions of MetroNet radio and monitor compliance with such instructions; and
- ix. monitor the recommendations contained in its own internal investigation report to ensure that the safety actions are implemented in a timely manner.

b. The Independent Transport Safety and Reliability Regulator

- i. satisfy itself as to the efficacy of any reviews or re-assessments undertaken by RailCorp in response to this occurrence.

PART 1 INTRODUCTION

Notification and Response

- 1.1 At 7:30am on Monday 4 September 2006, RailCorp notified the OTSI Duty Officer by email that an empty rail cleaning service had passed Signal ST 164 at North Strathfield at stop without authority (SPAD) at approximately 1:08am on 2 September 2006 and continued onto the 'Goods' line towards Homebush on the same line as an oncoming freight train.
- 1.2 Based on the information provided by the reporter, the Chief Investigator directed an OTSI Investigator seek additional and detailed information from RailCorp. The information was received by OTSI on 14 September 2006 whereupon the report was assessed.

Initiation of Investigation

- 1.3 As a result of the assessment conducted by the OTSI Investigator, the Chief Investigator determined that the incident warranted formal investigation by OTSI and initiated a Rail Safety Investigation in accordance with s67 of the *Rail Safety Act 2002*.

Interim Factual Statement

- 1.4 On 28 September 2006, the Chief Investigator notified all Directly Involved Parties (DIP) that OTSI was investigating the SPAD and opposing movement and requested that each organisation nominate an officer to act as the point of contact for all inquiries made by the appointed OTSI Investigator in Charge. The Terms of Reference for the Investigation were provided to the DIPs with this notification.
- 1.5 An Interim Factual Statement notifying OTSI's investigation and describing the incident in terms of what had happened was published on the OTSI website on 29 September 2006.

Terms of Reference

- 1.6 The Chief Investigator established the following Terms of Reference to determine why the incident had occurred and what to do to prevent the recurrence of such incidents:
- a. identify the factors, both primary and contributory, which caused the incident;
 - b. identify whether the incident might have been anticipated and assess the effectiveness of any strategies (engineering or procedural) that were in place to manage the related risk/s;
 - c. identify whether train movements at the time were being conducted in accordance with procedures established by RailCorp for such work;
 - d. identify whether the driver's competency and route knowledge for the intended movement were adequate and in accordance with established procedures;
 - e. identify any deficiencies with the effectiveness of the communications equipment and protocols involved in the incident;
 - f. assess the effectiveness of emergency actions in response to the incident, and
 - g. advise on any matters arising from the investigation that would enhance the safety of rail operations.

Methodology

- a. OTSI utilises the ICAM (Incident Cause Analysis Method) approach in the conduct of its investigations and applies the Reason Model of Active Failures and Latent Conditions to its analysis of causative and contributory factors.
- b. The underlying feature of the methodology is the Just Culture principle with its focus on safety outcomes rather than the attribution of blame or liability.

Consultation

- a. On 29 August 2007, a copy of the Draft Investigation Report was forwarded to Pacific National, RailCorp and ITSRR. The purpose was to provide DIPs with the opportunity to contribute to the compilation of this Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and providing any commentary that would enhance the structure, substance, integrity and utility of the Investigation Report. DIPs were requested to submit their comments by 14 September 2006. Submissions were received from Pacific National, RailCorp and ITSRR.
- b. The Chief Investigator considered all representations made by DIPs and where appropriate, reflected their advice in this Final Report. On 11 and 20 September 2007, the Chief Investigator informed DIPs which matters from their submissions had been incorporated in this Final Report and where any proposal was not included, the reasons for not doing so.

Investigation Report

- a. This report describes the SPAD and opposing movement incident which occurred between North Strathfield and Homebush on 2 September 2006 and explains why it occurred. The recommendations that are made are designed to contribute to the safety of rail operations.

PART 2 FACTUAL INFORMATION

Incident Synopsis

- 2.1 At approximately 1:08am (Eastern Standard Time) on 2 September 2006, an empty CityRail service 67-R passed Signal ST 164 at stop without authority on the 'Down Relief' line at North Strathfield and continued onto the single, bi-directional 'Goods' line between North Strathfield and Homebush. Pacific National's freight service 5YN2 was travelling on the same 'Goods' line at the same time, but in the opposite direction, between Flemington and Homebush. This meant that 67-R and 5YN2 were travelling towards each other on the same line.
- 2.2 The Area Controller at the Strathfield Signal Box was alerted to the evolving opposing movement by a colleague who was watching the indication board and noticed two trains occupying the same section. He immediately attempted to contact the Drivers of 67-R and 5YN2 by radio to direct them to stop their trains immediately. The Driver of 5YN2 responded by stopping his train as directed. However, because the Driver of 67-R had entered the wrong run number when he logged into the radio network he could not be contacted by radio. In the meantime, a number of other Area Controllers waved emergency hand lights as they stood on the balcony of the signal box and tried to attract the attention of the Driver of 67-R in an attempt to warn him of the impending danger. These actions failed to attract the attention of the Driver of 67-R. However, he subsequently realised that he was on the wrong line and brought his train to a stand before Signal ST 253, adjacent to Strathfield Signal Box. When the Driver brought 67-R to a stand it was 194 metres from the stationary 5YN2.

Site Location and Information

- 2.3 North Strathfield is a suburb located 13km by rail West of Sydney's CBD (see *Figure 1*). The configuration of the tracks and signals at North Strathfield, together with the actual and intended route of 67-R, is shown in *Figure 2*.

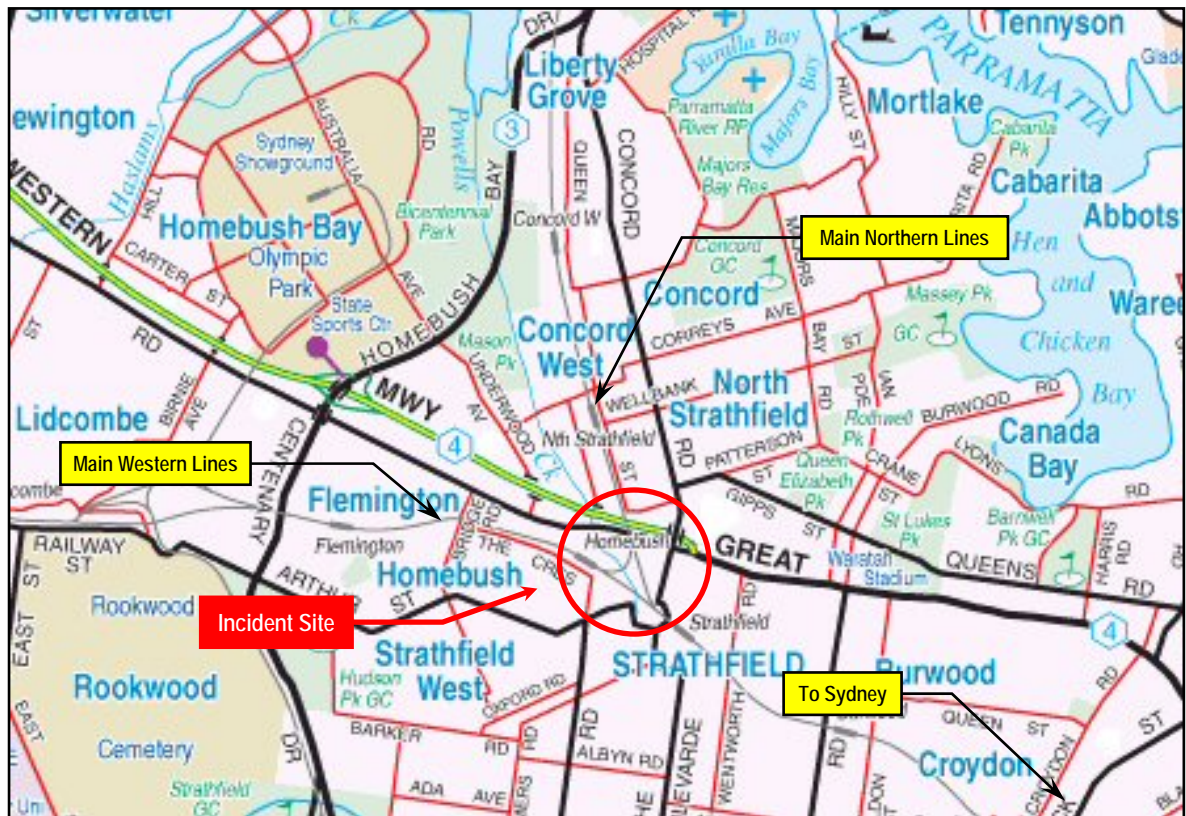


Figure 1: Incident location

- 2.4 The North Strathfield 'Down Relief' and 'Goods' lines are part of RailCorp's Sydney suburban rail network and connect Sydney's Main Western and Southern lines to the Main Northern Line. The 'Goods' line is an electrified single line track, and forms part of a triangle configuration between North Strathfield, Strathfield and Homebush stations. Rail traffic along the 'Goods' line generally consists of freight trains travelling to and from Sydney's freight terminals and Northern regions.
- 2.5 Train operation on the 'Goods' line is bi-directional with signalling and points controlled under the Rail Vehicle Detection System from RailCorp's Strathfield Signal Box. Posted track speeds on the 'Down Relief' line and the 'Goods' line for the section between North Strathfield and Flemington vary from 35km/h to 80km/h. The maximum speed for the 'Down Relief' line is 80km/h, although it reduces to 55km/h and then 50km/h nearer to the location of the incident. The maximum speed for the 'Goods' line from Homebush is 35km/h.

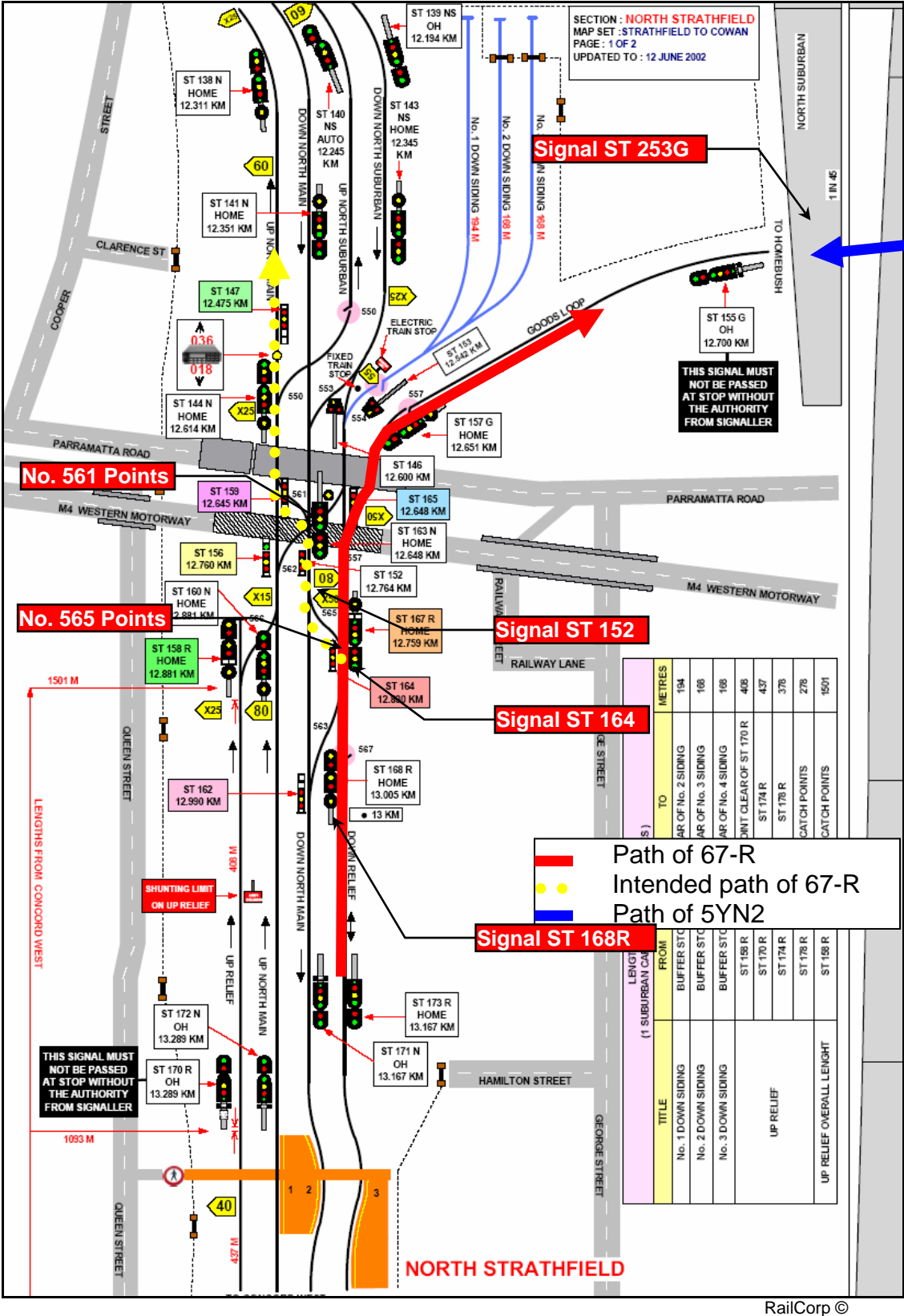


Figure 2: Track and Signal configuration at North Strathfield showing Actual and Intended Routes of 67-R

Incident Narrative

Before the Incident

- 2.6 67-R, an empty CityRail service departed Hornsby at 12:56am for the Sydney Terminal. During this journey, 67-R was required to travel on the 'Down Relief' line between Concord West and North Strathfield (see *Figure 2*). 67-R crossed from the 'Up Main' line at Concord West to the 'Down Relief' line at 1:05am and then proceeded along the 'Down Relief' line towards Signal ST 168R at North Strathfield which was at stop. 67-R came to a stand at Signal ST 168R at approximately 1:08am.⁴ 67-R's route to this point and its actual route thereafter are indicated by the Red arrow in *Figure 2*. The route it should have followed is shown in Yellow.
- 2.7 After 67-R came to a stand at the Signal ST 168R, the Area Controller at Strathfield Signal Box then set the route for 67-R to proceed to Signal ST 164. Signal ST 168R is a subsidiary shunting signal fitted with a train stop; the train stop's purpose is to automatically trigger the application of a train's brakes by discharging the supply of air pressure that holds the train's brakes 'off' (see *Figure 3*) if the train fails to respond to the stop signal.

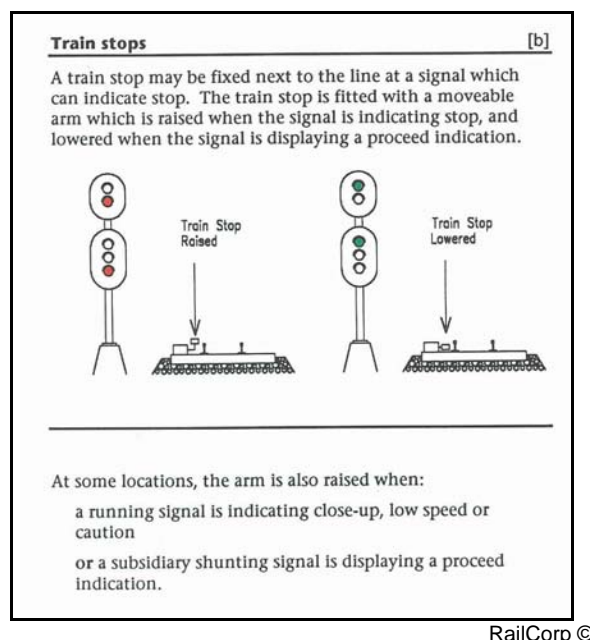


Figure 3: Train Stop Information

⁴ 67-R was travelling on this route as part of RailCorp's rail cleaning program. RailCorp's Network Rules (NGE 220) state that track-circuits must be treated as unreliable if they have not been travelled over by rail traffic for 72 hours or more.

- 2.8 The operational arrangements on this signal include a 60-second time release for the operation of No. 565 crossover (see No 565 Points on *Figure 2*). Having 'tripped' past the train stop, 67-R was brought to a stand after which its air supply commenced to recharge. This occurred, as designed, while the No. 565 crossover was being released. Once these two functions were completed, 67-R moved towards Signal ST 164, which was at stop.

The Incident

- 2.9 Signal ST 164 was displaying a two-red-light indication and 67-R was obliged to stop at the signal. Instead, it continued on and in the absence of a train stop and with the points set towards the 'Goods' line, 67-R deviated from its intended route and continued along the line towards Homebush (the intended and actual routes are depicted in *Figure 2*).
- 2.10 The Area Controller for the Homebush Panel did not notice that 67-R was proceeding along the 'Down Goods' line. However, a second controller who was reviewing the indication board, observed that 67-R had continued past Signal ST 164 without stopping and was travelling along the 'Goods' line. He also observed that Pacific National's freight service 5YN2 was on the same track, between Flemington and Homebush, and was moving towards 67-R. He immediately alerted the Area Controller for the Homebush Panel to this predicament. The Homebush Area Controller then attempted to contact the Driver of 67-R, by radio, without success. He then asked another Area Controller to contact the Driver of 5YN2 and to direct him to stop his train immediately while he continued to attempt to contact the Driver of 67-R. The Driver of 5YN2 responded to the direction he was given but the Driver of 67-R did not respond to the continuing radio calls. A number of other Area Controllers in the signal box then relocated to the balcony of the signal box and attempted to alert the Driver of 67-R using flags and hand lamps. However, the Driver of 67-R realised that he was on the wrong track before reaching the signal box and, having done so, brought his train to a stand adjacent to the Strathfield Signal Box.

After the Incident

- 2.11 Having stopped 67-R, the Driver communicated with the Guard using the train intercom about what had happened. Two Area Controllers then entered the track area adjacent to the signal box and spoke to the Driver and Guard of 67-R. The Driver of 67-R was then directed to await further instructions.
- 2.12 With both trains now safely stopped, the Train Controller at RailCorp's Rail Management Centre at Central deployed a number of staff including a Relief Driver to the area. A RailCorp Signal Engineer and a Network Operations Superintendent also later deployed to the scene.
- 2.13 Before travelling back to Sydney Terminal, the relief Driver along with the original Driver, the Signal Engineer and the Network Operations Superintendent, took 67-R to North Strathfield then recreated the incident and checked that the signals were functional.

Train Information

- 2.14 CityRail rail cleaning service 67-R consisted of an eight-car Tangara Electric Multiple Unit Train. It consisted of two 4-car units with a total train length of 162m and a total weight of 370t (see *Photo 1*).



Photo 1: Tangara Electric Multiple Unit Train

- 2.15 67-R is a scheduled rail cleaning service that operates from Hornsby to Central Railway Station every day except Sundays and Mondays. It travels from Hornsby via Strathfield before heading East to Central

Station. It does not carry passengers and ordinarily makes no scheduled stops during its journey.

- 2.16 Pacific National's freight service 5YN2 consisted of three NR class locomotives and a mixture of 24 loaded and empty container wagons (see *Photo 2*). 5YN2 measured 807m in length and had a total weight of 4197t. It commenced this leg of its journey from Sydney Freight Terminal at Chullora at 12:55am and was bound for Morandoo in Newcastle.



Photo 2: Pacific National NR Class Locomotive

Employee Information

- 2.17 67-R was crewed by a driver and a guard who operated in the front driver's compartment and the guard's compartment, in the 5th car, respectively. The Driver of 67-R had been a RailCorp train driver for eight years. He was based out of Central Depot and was qualified for the route. The Guard had 10 years rail experience, two of which had been spent as a Guard. Both crew members were within their respective medical and competency assessment periods.
- 2.18 5YN2 was crewed by a driver and a driver's assistant. This crew had operated together for approximately four months during which time they had operated over the route from Chullora to Morandoo at least once each week. They had been driving trains for 30 years and 17 years respectfully. They too were familiar with, and qualified for, the route and

were within their respective medical and competency assessment periods.

- 2.19 The Area Controller for the Homebush Panel had been a railway employee for 35 years. He had been working at the Strathfield Signal Box as an Area Controller for two years.

Communication Equipment

- 2.20 The Driver and Guard of 67-R communicated using the train intercom and bell signals. The Driver also had access to the following communication equipment to enable contact with Train Control and Signallers:
- a. the Metronet train radio system, as installed in all CityRail trains;
 - b. mobile telephones; and
 - c. trackside phones co-located at signals.

Meteorological Information

- 2.21 The train crews described the weather conditions at the time of the incident (1:08am) as dark and dry. The Bureau of Meteorology recorded a minimum temperature of 13.1°C on the night of the incident. There had been no precipitation in the previous 24 hours.

Injuries and Damage

- 2.22 There was no injury or damage resulting from the incident.

Medical and Toxicological Information

- 2.23 The Driver of 67-R was tested for the presence of drugs and alcohol and returned negative results. RailCorp did not require any other person involved to undergo similar testing.

PART 3 ANALYSIS

Exclusions

- 3.1 The following matters were excluded as either causal or contributory factors after testing/and or examination:
- a. that the driver of 67-R was affected alcohol and/or drugs;
 - b. that Signal ST 164 and the preceding Signal ST 168R or any of the related track circuitry malfunctioned, and
 - c. cabin design and lighting within 67-R.

Causation

- 3.2 At interview, the Driver of 67-R acknowledged that he did not observe that Signal ST 164 was at stop as he approached it, and not having seen it, he passed the signal at danger. Accordingly, OTSI's investigation focussed on matters that may have affected the Driver's decision-making and actions.

Contributory Factors

Driver's Expectations

- 3.3 Just as he had done on Friday 25 August 2007, the Driver of 67-R commenced his service run at 12:56am and was scheduled to travel through North Strathfield Junction at 1:16am and Strathfield at 1:19am before arriving at Sydney Terminal at 1:32am. The route and the related timings on 2 September 2006 were identical to those of the previous week. The route between North Strathfield to Strathfield is indicated in *Figure 2* and required the Driver to:
- a. travel South along the 'Up North Main' line then cross from the 'Up North Main' line to the 'Down Relief' line at Concord West via No. 581 Points (these Points do not appear in *Figure 2* as they are located further North before North Strathfield station),
 - b. travel along the 'Down Relief' line to Signal ST 168R,

- c. wait at Signal ST 168R until the subsidiary signal was cleared permitting 67-R to 'trip' past the train stop,
- d. proceed to Signal ST 164, then cross from the 'Down Relief' line to the 'Down North Main' line via No. 565 points, and
- e. proceed past Signal ST 152 and cross from the 'Down North Main' line to the 'Up North Main' via No. 561 points and on to Strathfield.

3.4 Signal ST 168R is a 'double light / colour light' signal; the signal lights are aligned vertically and each head is fitted with two lights. Below the double lights is a single 'calling-on' subsidiary shunt signal (see *Photo 3*).

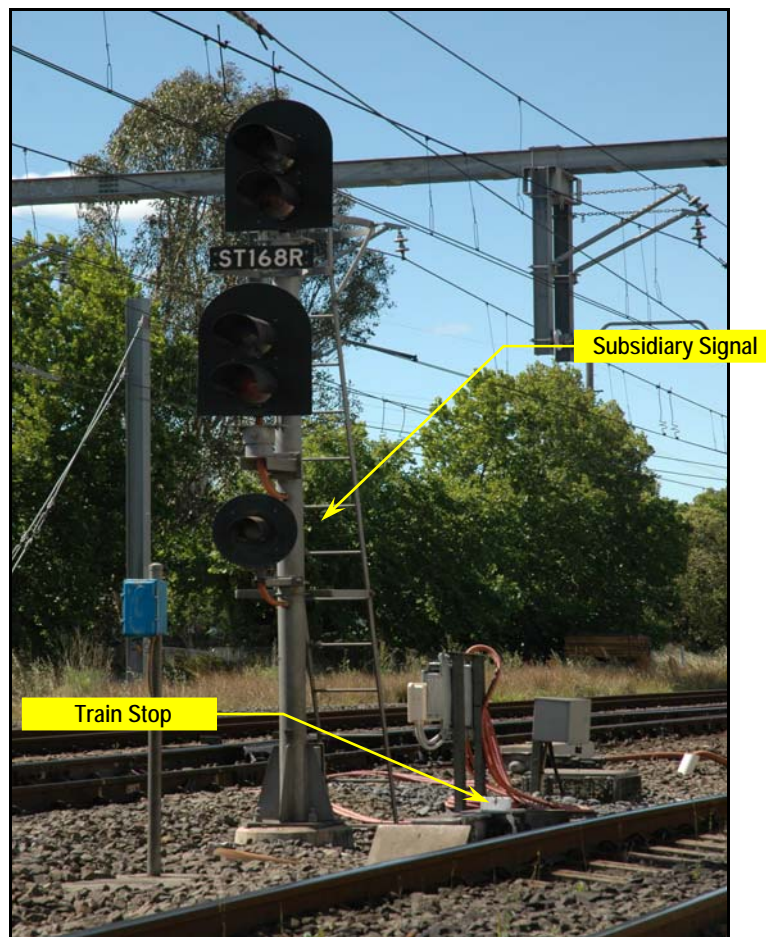


Photo 3: Signal ST 168R

3.5 The purpose of the subsidiary signal is to authorise the train to proceed into the next section⁵. This signal is fitted with a train stop. The Driver

⁵ A section is a length of running line of defined limits, the entry to which is usually defined by stop signals. RailCorp's Glossary of Signal Terms 2005.

indicated that on approaching this signal on the previous Friday, he had been 'called-on' on by the subsidiary signal and had moved forward to 'trip' past the signal. However, the next signal, ST 164, had not been at stop and the route had been set for him to travel through the crossovers from the 'Down Relief' to the 'Down North Main' and then on to the 'Up North Main'. The Driver indicated that he was anticipating being able to do the same thing as he approached Signal ST 164 on 2 September 2006, however he did not observe the indication of Signal ST 164 or the position of the associated points, and continued on.

- 3.6 Once past Signal ST 168's 'calling-on' indication, RailCorp's Network Rule *NSG 606* requires drivers to proceed at no greater than 25km/h, but to expect the next signal to be at stop. Data taken from the 67-R's event recorder showed that it was operated at approximately 30km/hr as it passed Signal ST 164. OTSI further noted that catch points are positioned immediately past Signal ST 168R which meant that any train failing to stop at this signal, when an opposing route had been set, would be derailed.



Photo 4: Signal ST 164

- 3.7 Signal ST 164 is a dwarf shunt signal or 'ground dolly' located 1.2m to the left of the 'Down Relief' track (see *Photo 4*). This is in contrast to the previous Signal, ST 168R, which was positioned at a level comparable with a driver's eyes in the train's cab. Notwithstanding this difference, the positioning of Signal ST 164 complied with RailCorp's Signalling Design Principles, ESG 100.1. Clause 1.12.2.4 of these principles specifies that subsidiary and shunt signals should be clearly visible from a distance of at least 50m. This Signal was clearly visible at a distance of 80m. RailCorp's testing also confirmed that this signal was fully operational.
- 3.8 The Driver of 67-R considered that his ability to see Signal ST 164 might also have been adversely affected by the excessive brightness of the previous signal (Signal ST 168R). While the signal is brightly lit, OTSI observed that it was not excessively bright and discounted the possibility that it might have affected the Driver's night vision. It was established, through testing, that Signal ST 164 was fully operational at the time of the incident. While the signal is not currently an LED-type signal, RailCorp has indicated that this signal and others surrounding it will be upgraded to LED-type signals in the 2007/2008 Major Planned Maintenance Schedule.
- 3.9 As the Driver approached Signal ST 164, he would have seen a number of signals beyond it including Signal ST 152. Signal ST 152, like Signal ST 164, is a 'dwarf shunt signal'. It is located in the six-foot⁶ between the Up North and Down North lines in the direction that the Driver had travelled the previous week on the 25 August 2007, and was expecting to travel on the night of 2 September 2006. However, on the night of 2 September 2006, the Homebush Area Controller cleared Signal ST 152 in anticipation of setting the route for 67-R but then cancelled the signal to allow another train, 66-U, to travel through from Strathfield. It is possible that the Driver of 67-R may have considered that the route he was travelling over was clear because he was focussing on Signal ST 152 which had previously cleared but had been placed back to stop as he approached.

⁶ The "six-foot" is a term used to describe the area **between** two sets of tracks. The area **within** a set of rails is termed the "four-foot".

Route Setting

3.10 The routes over which 67-R and 5YN2 were travelling immediately prior to the incident were being controlled from the Strathfield Signal Box. This facility is located on the Northern side of the main line between Strathfield and Homebush railway stations and adjacent to the 'Goods' line where the incident occurred. It is one of the largest signalling complexes in the Sydney Metropolitan area and train movements incorporating the triangle between Strathfield, Homebush and North Strathfield, are controlled from within it. Specific sections of track are allocated to Area Controllers who are responsible for setting the route into, through and out of their area of operation. There is a control panel for each track section and the Area Controller can manipulate signals and track settings via the control panel. There is also a large indication board on view to all Area Controllers which shows the position of trains covered by the Strathfield Signal Box. Trains are represented by a series of lights on the indication board which show which section of track the train is occupying (see *Photo 5*).

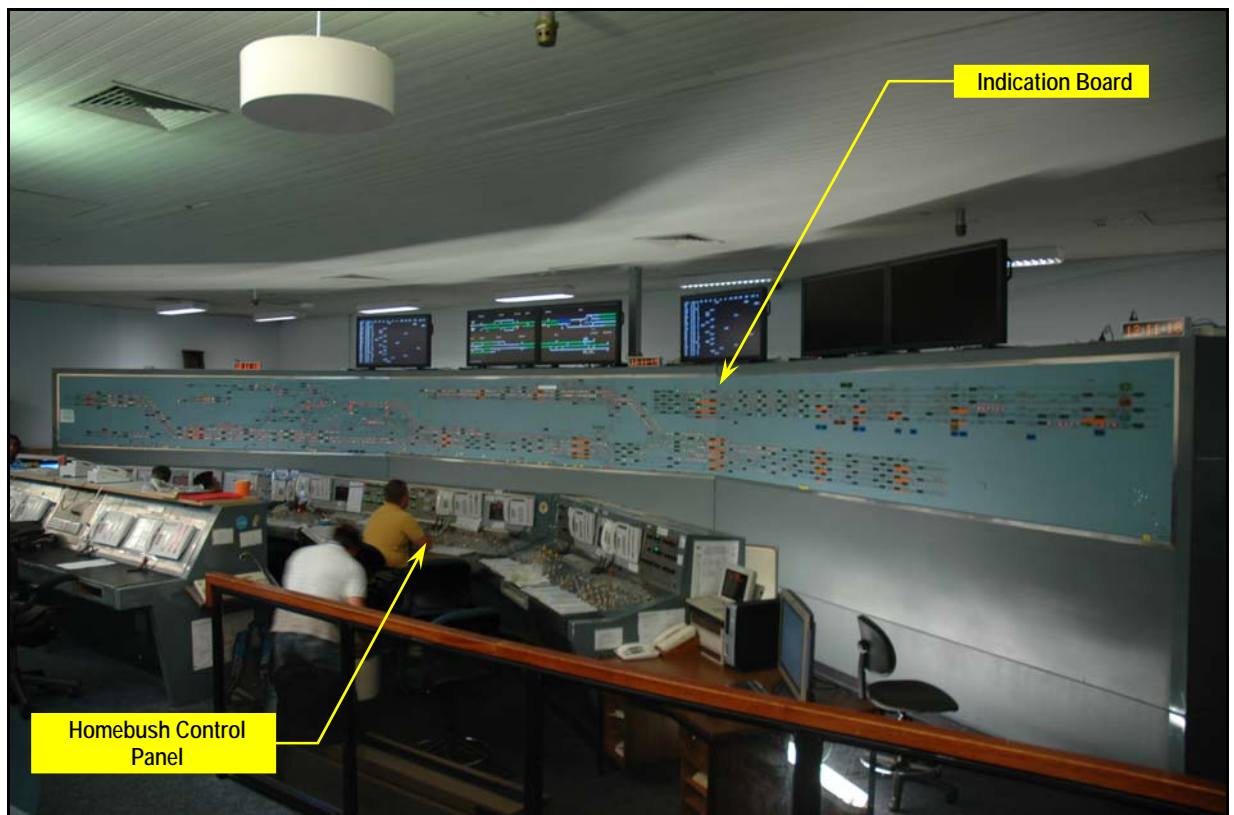


Photo 5: Control Panels Strathfield Signal Box

- 3.11 However, there are no alarms to indicate that a SPAD or an opposing movement has occurred in the section. On the night of the incident, there were seven Area Controllers in the Strathfield Signal Box; six were operating the various control panels and one person was on office duties.
- 3.12 The Area Controller operating the Homebush Panel set the route for 67-R to proceed along the 'Down Relief' road towards No. 565 points. He then considered clearing Signal ST 164 to facilitate the movement of 67-R from the 'Down Relief' line back across and onto the 'Up North Main' line. However, he was also aware of the movement of 66-U, a passenger service running from Strathfield to Hornsby via the 'Down North Main' line. He therefore decided to maintain Signal ST 164 at stop and not reverse No. 565 points for the movement of 67-R until the interlocking allowed the points to be moved after 66-U had cleared the track circuits. This meant that 67-R was to wait at Signal ST 164 until the points were reversed and the signal cleared. However, the Driver of 67-R was anticipating being able to proceed past Signal ST 164 through to Strathfield, as he done the previous week, and either did not see the signal or did not respond to it. Having passed Signal ST 164, which was indicating stop, 67-R continued through No. 565 points which were set in the normal position, thus directing 67-R along the 'Goods' line towards the oncoming 5YN2.
- 3.13 Although the Area Controller was entitled to set the route as he did, a number of other area controllers described an alternative setting that would have held the Driver at Signal 168R (see *Photo 6*) until it was possible to have provided him with a clear path across all signals from the 'Down Relief' line to the 'Up North Main' line, instead of requiring the Driver of 67-R to stop and then calling him forward to again stop at Signal ST 164.

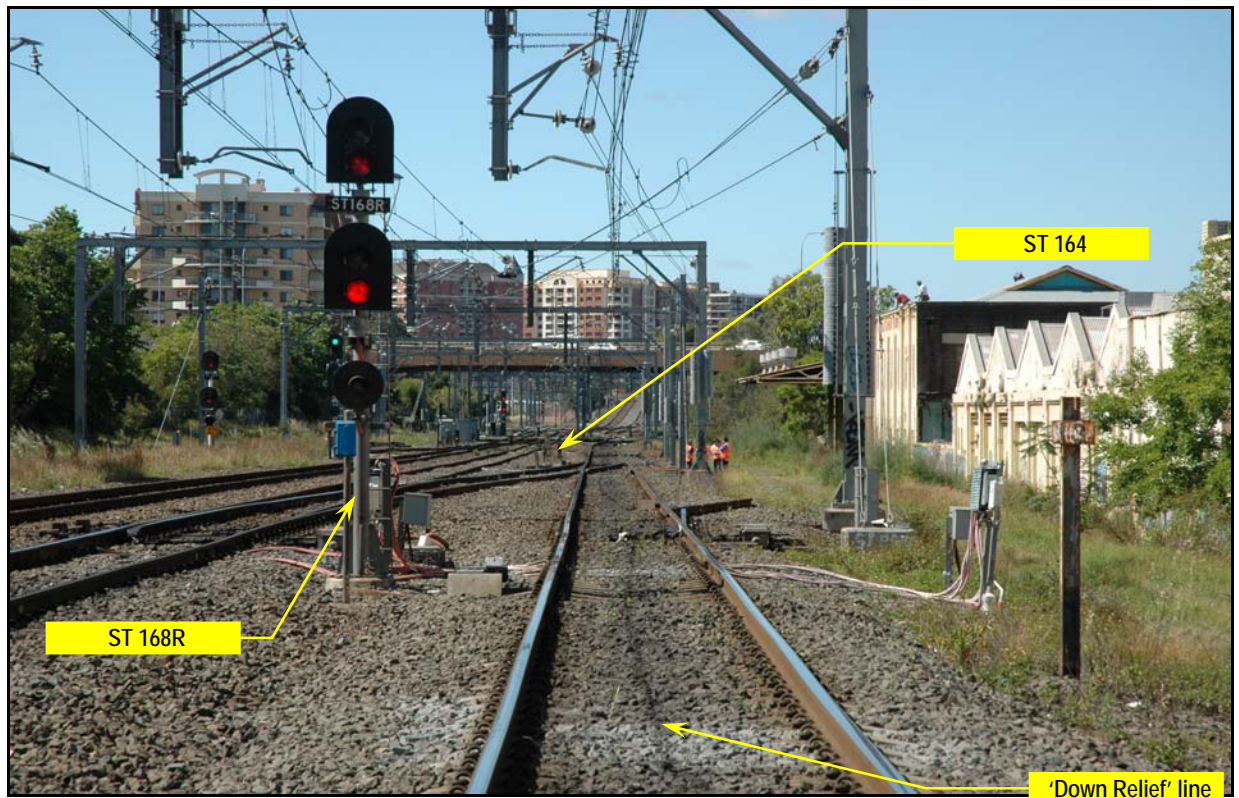


Photo 6: Signal ST 168R and 'Down Relief' line looking South

Fatigue

- 3.14 The Driver was questioned about his work roster and matters that might have affected his concentration. The Driver stated that he was feeling well on the day of the incident and he could recall no issues that might have affected his concentration; that he had only been involved in one previous SPAD during his eight years of service as a RailCorp train driver and that he did not have any form of secondary employment. He also stated that he was not committed to any other form of regular endeavour, such as voluntary work, that impacted on the opportunity for respite. He advised that his rosters were based on late afternoon or night shifts.
- 3.15 The Driver of 67-R started his shift at 5:56pm and 67-R passed Signal ST164 at danger at 1.08am. The Driver admitted being tired at the time of the incident but was certain that he had not fallen asleep. Rosters record the fact that he worked either a late afternoon or an evening shift on the preceding eight days. The Driver was therefore in the final stages of the last of nine consecutive shifts and was proceeding on a two-day break at the end of the shift.

- 3.16 Research in the *Journal of Accident Analysis and Prevention*⁷ identifies that daytime sleep is typically less in duration and poorer in quality than nocturnal sleep. It was also found that there is an increased chance of fatigue-related accidents during the period between midnight and 6:00am. Britain's Rail Safety and Standards Board considers, based on its research, that the risk of a SPAD is increased during the early hours of the morning.⁸ It also cites that the time on a task and the number of consecutive shifts worked as being highly significant in the incidents of SPADs. The Board believes that the risk increases further after six consecutive shifts and more than doubles after ten shifts, compared with the initial value. It also notes that "*Shiftwork contributes to fatigue in train drivers and other operators because it limits the amount of sleep that workers are able to obtain to ensure that they are able to maintain sufficient alertness when at work.*"⁹
- 3.17 The Area Controller responsible for the Homebush Panel was watching the movement of 5YN2 on the indication board and was alerted to the presence of another train, which was later established to be 67-R, and hence the opposing movement, by a fellow Area Controller who happened to notice the indication on the panel almost immediately it appeared. The roster of the Area Controller on the Homebush Panel revealed that that he had worked the previous eight days. On each day he had worked an 8-hour shift. The first six shifts commenced at 6:00am and the next two at 10:00pm. On the night of the incident, he commenced his shift at 10:00pm and was rostered to finish at 6:00am the following morning, after which he was scheduled to have a rest day. It was also noted that the Area Controller was travelling for approximately two hours a day to and from work.
- 3.18 Both the Driver's and Area Controller's work and rest routine was analysed using the Fatigue Audit InterDyne (FAID) software program.

⁷ In research on road vehicle crashes it has been found that the odds of fatigue being related to a crash increase by six-times if the crash occurs between midnight and 6:00am (see Sagberg, F. (1999) *Road Accidents caused by drivers falling asleep* Accident Analysis and Prevention Vol. 31 pp 639-649.)

⁸ Rail Safety & Standards Board (2004), *Human Factors of Fatigue and Shift Work* Railtrack PLC (S&SD).

⁹ Rail Safety & Standards Board (2004) *Prioritisation of SPAD risk factors- further analysis of May/Summer peak in SPAD occurrence.*

This program is a Human Factors tool developed in conjunction with the Centre for Sleep Research at the University of South Australia. It is designed to give an indicative score of fatigue levels by persons working various shifts. Research by the University suggests that a fatigue score of 40-80 indicates a moderate level of fatigue, 80-100 a high level of fatigue and 100-120 a very high level of fatigue. The research on performance impairment indicates that a score of 80 reflects a fatigue level of approximately 200% for that obtained for a standard working week. The FAID scores calculated by OTSI were as follows:

- a. The Driver of 67-R's fatigue score was 71 for the night of the incident and 72 for the previous night. While these scores are considered to be within the moderate range for fatigue, OTSI notes that they are at the upper end of the range.
- b. The Area Controller's fatigue score was 90 for the night of the incident and 85 for the previous shift. OTSI notes that these scores are in the high range for fatigue.

Adequacy of the Emergency Response

3.19 Having been alerted to the opposing movement, the Homebush Area Controller immediately tried to contact the unidentified train by the MetroNet train radio system. Despite repeated attempts he was unable to contact this train. It was subsequently established that this was because the Driver of 67-R had erroneously logged into the Metronet system as Run 67- - at Hornsby. While these calls were being made, another Area Controller contacted the Driver of 5YN2 using the WB radio and directed him to come to an immediate stand. This call was logged at 1:08:40am, 19 seconds after the SPAD at Signal ST 164. This Controller then advised the Homebush Controller that 5YN2 had acknowledged his message and was bringing his train to an immediate stand. The Homebush Area Controller then called on his colleagues to try to attract the attention of the Driver of 67-R as he approached Strathfield Signal Box. This resulted in two Controllers re-locating to the balcony of the Signal Box, equipped with flags and hand lamps to try to stop 67-R.

However, this action was delayed somewhat while a search was undertaken to find the hand lamps required for such an action. While this search was being conducted, the Homebush Area Controller notified the Rail Management Centre at Sydney Terminal of the developing situation.

- 3.20 The Driver of 67-R was unaware of the fact that he had exceeded his authority and, while the foregoing actions were underway, brought his train to a stop adjacent to the Strathfield Signal Box some 80 seconds after passing Signal ST 164 at stop when he realised that he was on the wrong track. Two Controllers inside the Signal Box advised the Homebush Area Controller that both trains were now at a stand and then moved onto the track to talk to the Driver of 67-R and the Guard respectively. The Driver of 67-R was directed that his train was not be moved until instructed.
- 3.21 At 2.10am, a Condition Affecting the Network (CAN) notice was issued. This notice directed the Driver of 5YN2 to remain in situ until instructed otherwise. At 2:18am, a relieving driver was authorised to operate 67-R through the same section to re-enact the sequence of events leading up to the opposing movement. This activity was supervised by the Network Operations Superintendent and a Signal Engineer and the 67-R's original driver remained in the cabin to provide his perspective. He was adamant at this time that Signal ST 164 had been clear as he approached it. During the re-enactment, all of the related signals were found to have been functional, and using a playback facility, it was subsequently confirmed that Signal ST 164 had been at stop when 67-R approached it. Following the re-enactment, 67-R was authorised to depart for Sydney Terminal and the CAN notice was lifted at 2:36am, allowing 5YN2 to resume its journey.
- 3.22 The Driver of 67-R was relieved in location and travelled to the Sydney Terminal where he was subjected to drug and alcohol testing. The results of these tests were negative.
- 3.23 In the course of the investigation, voice recordings focusing on the communications following the SPAD were reviewed. These showed that the Area Controller did not initiate an emergency 'All Trains Stop' call which would have sent an audible warning 'beep' and text message to all

trains in the area including the Driver of 67-R, despite the Driver being logged into the MetroNet system with the incorrect designator.

- 3.24 Another method to assist in bringing the train to a halt that may have been considered by the Area Controller would have been for him to contact the Electrical Operations Centre in order for them to isolate the power to the section of line occupied by 67-R. Cutting the power would have the effect of slowing the train and perhaps alerting the Driver of 67-R to a potential problem.

Anticipation and Management of Risk

- 3.25 SPADs occur for a variety of reasons. A SPAD may be the consequence of a driver error, as was the case in this instance, and can also be caused by signalling errors. Such signalling errors can result in changes to signal indications without sufficient notice to the train driver to permit the train to be stopped in sufficient time, or in the available distance, to avoid the SPAD. SPADs can also be initiated by a failure to follow prescribed procedures when repairing or servicing track/trackside equipment; faulty signal components; faulty track circuitry or signal-related computing equipment; electrical surges and defective brakes.
- 3.26 The degree of risk associated with a SPAD varies greatly depending on where the SPAD occurs and the measures that are in place to manage the consequences of such an occurrence. SPADs that occur within a freight siding or yard will generally be of lesser consequence because they will occur at lower speeds. SPADs that occur on a main line may occur at greater speeds and are potentially of greater consequence. SPADs that occur at the junction of a freight yard or siding and a main line, or at some form of crossover on main lines, can have very serious consequences because they may result in collisions between trains at speed.
- 3.27 The primary defence against SPADs is the integrity of the signalling system itself. Like many rail signalling systems throughout the world, the NSW signalling system is a mixture of old and new technologies. Modern signalling systems/track circuitry incorporate alarms which alert Area

Controllers when a SPAD occurs. In this instance, there was no such automated alarm.

- 3.28 The second line of defence against SPADs is that provided by route knowledge. Typically, train drivers agree that route knowledge is a critical requirement to operate a train safely. Drivers need a working knowledge of the types and locations of signals they will pass on a route and need to be anticipating the various indications that they will receive well before they arrive at an actual signal. Drivers need to be able to cope with multiple signals in varying configurations and in varying placements and recognise very quickly which signal is intended for them and comprehend the significance of its indication regarding the route and signal settings that lie ahead. Such knowledge is gained through the study of route diagrams like those depicted in *Figure 2*; supervised route transit and experience gained through driving the same route on a regular basis. Drivers are required to be supervised and assessed before they qualify to operate over a particular route. They must also requalify on a route on a twelve-monthly basis.
- 3.29 The final 'lines' of defence are those measures which are taken to mitigate the consequences of SPADs when they do occur. These generally take the form of a mechanism to divert or derail a train in such a way as to avoid the prospect of a collision with another train. Such mechanisms are generally only installed at those locations where the prospects and consequences of a collision following a SPAD are considered to be significant, since there are obvious risks associated with deliberately derailing a train even when it is done to prevent more serious consequences. Another method used to mitigate against the effects of a SPAD is through the use of mechanisms such as train stops. Their purpose, as explained earlier, is to automatically initiate train braking in certain circumstances. In 2004, the Independent Transport Safety and Reliability Regulator (ITSRR) issued RailCorp with a Notification of Emerging Safety Concern relating to the provision of train stops at running signals. In this notice, ITSRR observed that *"there appears to be substantial risks associated with the fact that many automatic signals in*

the electrified area are still not equipped with train stops.” While Signal ST 164 is not an automatic signal the provision of a train stop would mitigate the consequences of a SPAD at this signal.

- 3.30 More sophisticated technological solutions, such as the Automatic Train Protection system (ATP), are now available to guard against a range of circumstances such as driver incapacitation and speed, which might lead to a SPAD. This system automatically stops the train in the event that it passes a signal at stop. ATP is in limited use throughout Australia at this time but the system is to be trialled by RailCorp commencing on the Blue Mountains line between September 2007 and January 2008.
- 3.31 In order to manage the risks associated with SPADs, RailCorp maintains comprehensive data about where such occurrences are occurring and has a SPAD review committee. This committee, in conjunction with a Signal Sighting Committee, determines the priorities for upgrading Signals and the installation of measures intended to prevent or reduce the consequences of SPADs. RailCorp's records reveal no previous incidence of a SPAD at Signal ST 164.
- 3.32 In July 2006, ITSRR observed that *“although the annual numbers of SPADs have not yet begun decreasing, it seems some worthy initiatives have been undertaken by RailCorp on SPAD risk management. In summary they have established a 5-point program covering: enhanced performance measurement and evaluation, education and information, train management techniques, multi SPAD signal action plan and multi SPAD driver management.”*
- 3.33 Statistics compiled by ITSRR indicated that there were 456 SPADs reported in NSW in 2004/2005 and 443 in 2005/2006. These occurrences could be further categorised as follows:
 - a. 2004/2005.
 - i. 280 of the 456 SPADs recorded in NSW involved RailCorp trains and occurred in RailCorp-controlled territory ;
 - ii. 135 of these 280 SPADs in RailCorp territory were related to driver error, and

- iii. 145 of the 280 SPADs in RailCorp territory involved some sort of trackside problem, i.e., signaller error, technical malfunction.
- b. 2005/2006.
 - i. 263 of the 443 SPADs involved RailCorp trains and occurred in RailCorp-controlled territory;
 - ii. 129 of these 263 SPADs in RailCorp territory were related to driver error, and
 - iii. 134 of the 263 SPADs in RailCorp territory involved some sort of trackside problem, i.e., signaller error, technical malfunction.

Remedial Actions

- 3.34 As a result of this incident, RailCorp issued an instruction to Area Controllers at Strathfield Signal Box (Local Instruction NOS02/2006) requiring them to hold trains at Signal ST 168R, which is protected by catch points, before setting Signal ST 164 to clear.
- 3.35 RailCorp has also planned to replace Signal ST 164, and others nearby, with an LED type signal as part of a signals upgrade program in 2007/2008.

Summary

- 3.36 This very significant incident, which potentially brought two trains into head-on collision, was the consequence of human error. Although the Driver of 67-R was qualified for the route, he was expecting that the route would be set the same way it had been the week before and that he would cross onto the 'Up Main'. When he did not see, or did not respond to Signal ST 164 and passed it at danger, he ended up on the wrong track. Fortunately, his error was detected by an Area Controller who noticed two trains in the same section on the indication board at the Strathfield Signal Box.
- 3.37 The route set for 67-R by the Area Controller Homebush at the same signal box was not inappropriate but there was another option available to him that would have provided a greater safety margin.

- 3.38 This incident occurred at a time of night when research has shown there is an increased risk of human error through diminished attention. While the rosters of both the Driver of 67-R and the Area Controller Homebush fell within RailCorp's rostering parameters, they had worked nine and eight consecutive days respectively and were working mostly night shifts. Research has also shown that such a pattern of night work would have further increased the potential for them to make mistakes and errors of judgement.
- 3.39 The management of this emergency was made more difficult by an error made by the Driver of 67-R at the start of the leg at Hornsby when he entered an incorrect designation for his train whilst logging into the MetroNet radio network. This meant that when it was realised that there were two trains in the same section, he could only be contacted via MetroNet if the Area Controller had initiated an emergency 'All Trains Stop' or a broadcast call.
- 3.40 The potential collision was averted because of the alertness of the Area Controller reviewing the Strathfield panel; contact being quickly established with the Driver of the other train (5YN2) and the Driver of 67-R appreciating that he was on the wrong track and acting independently to bring his train to a stand.

PART 4 FINDINGS

3.41 In relation to those matters prescribed by the Terms of Reference as the principal lines of inquiry, OTSI finds as follows:

a. Causation

- i. The opposing movement was a consequence of an error by the Driver of 67-R who either did not see, or did not respond to, Signal ST 164 and passed the signal when it was at stop. As a result, 67-R deviated from the intended route and proceeded onto on the same track as, and travelling towards, 5YN2.

b. Contributory Factors

- i. Signal ST 164 is sited in a manner and location that meets the required technical parameters; as such it should have been readily apparent. However, as a 'ground dwarf signal', it is lower than other signals in the immediate area and may have been overlooked by the Driver in favour of two Main Line signals in advance of it, which were showing proceed indications.
- ii. The Driver of 67-R and the Area Controller had worked for nine and eight consecutive days respectively and were due to proceed on rest days at the end of their shifts. While these rosters and the hours shown therein were within industry and RailCorp's scheduling parameters, research¹⁰ indicates that both members were operating in a 'zone' where there was an increased likelihood of them making an error.

c. Anticipation and Management of Risk

- i. There was no record within RailCorp of Signal ST 164 having previously been passed at danger. Even so, Signal ST 164 is

¹⁰ Rail Safety & Standards Board (2004), *Human Factors of Fatigue and Shift Work* Railtrack PLC (S&SD)

not fitted with any form of mechanical protection, such as a train stop or catch points, to mitigate the consequences of a SPAD.

d. Conduct of Train Movements

- i. While the route for 67-R was set properly, other Area Controllers stated that they would have set the route in such a way that would have required the Driver to have waited longer at Signal ST 168R but then given him a clear run through Signal ST 164 and on to Strathfield. Such a setting would also have provided an increased safety margin.

e. Adequacy of Driver's Route Knowledge and Competency

- i. The Driver was a fully trained and qualified driver and his route knowledge for the 67-R timetabled run was adequate.

f. Effectiveness of Communications Equipment and Protocols

- i. The communication equipment and the protocols were functional and adequate.
- ii. Management of the situation which brought 67-R and 5YN2 onto a collision course was made more difficult because of an error made by the Driver of 67-R at the start of his leg from Hornsby, when he logged into the radio network and identified his train with an incorrect designation. Effectively, this error prevented the Area Controller from making direct contact with the driver of 67-R through the MetroNet communications system.
- iii. At the onset of the incident, the Area Controller did not broadcast an emergency message to all trains in the area to stop.

g. Effectiveness of Emergency Response

- i. In the face of what was an imminent and significant emergency, other members in the Strathfield Signal Box reacted quickly by making radio calls to support the Area Controller and attempting to warn the Driver of 67-R by using flags and hand lamps.
- ii. RailCorp's immediate actions to establish that its signals system was not defective, and that other operations on the same line were not in jeopardy, were timely and appropriate.

PART 5 RECOMMENDATIONS

5.1 In order to prevent a recurrence of this type of incident, the following remedial safety actions are recommended for implementation by the organisations specified below:

a. RailCorp

- i. ensure that Signal ST 164 is upgraded to an LED-type signal;
- ii. issue instructions to Strathfield Area Controllers to reinforce the implementation of Local Instruction NOS02/2006, which requires Area Controllers to hold trains at Signal ST 168R that is protected by catch points, before setting Signal ST 164 to clear;
- iii. install a train stop at Signal ST 164;
- iv. identify any locations where a similar SPAD could occur and implement remedial safety action to eliminate the potential for collision as a result of opposing or following movement;
- v. alarm its control panels and indication boards, where it has not already done so, so that Area Controllers are automatically alerted to situations where signals have been passed at stop and/or to opposing movements;
- vi. issue instructions to drivers to reinforce the importance of correct MetroNet log in procedure;
- vii. conduct a review of the train radio log in procedure to ascertain if the risk can be engineered out of the system;
- viii. issue instructions to area controllers to raise the awareness of emergency broadcast functions of MetroNet radio and monitor compliance with such instructions; and
- ix. monitor the recommendations contained in RailCorp's internal investigation report to ensure that the safety actions are implemented in a timely manner.

- b. The Independent Transport Safety and Reliability Regulator**
 - i. satisfy itself as to the efficacy of any reviews or re-assessments undertaken by RailCorp in response to this occurrence.