Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Rail Occurrence Investigation 2006/003
Final

Signal 161 Passed at Danger
TransAdelaide Passenger Train H307

Adelaide, South Australia

28 March 2006

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office location: 15 Mort Street, Canberra City, Australian Capital Territory
Telephone: 1800 621 372; from overseas + 61 2 6274 6590
Accident and serious incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6274 6474; from overseas + 61 2 6274 6474
E-mail: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

ISBN and formal report title: see 'Document retrieval information' on page v.

CONTENTS

DOCUMENT RETRIEVAL INFORMATION

Report No.	Publication date	No. of pages	ISBN
2006/003	20 December 2007	56	978-1-921165-60-3

Publication title

Signal 161 Passed at Danger, TransAdelaide Passenger Train H307, Adelaide, South Australia, 28 March 2006

Prepared by

Australian Transport Safety Bureau
PO Box 967, Civic Square ACT 2608 Australia
www.atsb.gov.au

Reference No.

Dec2007/Infrastructure 50420

Acknowledgements

The map section identified in this publication is reproduced by permission of Geoscience Australia, Canberra. Crown Copyright ©. All rights reserved. www.ga.gov.au

The aerial photograph in this publication is reproduced by permission of the South Australian Department for Environment & Heritage, Environmental & Geographic Information. Level 1, 100 Pirie Street, Adelaide, South Australia, 5000. Copyright ©.

Abstract

At 0701 on 28 March 2006, TransAdelaide passenger train H307 passed signal 161 at Adelaide Railway Station while it was displaying a red stop aspect. Train H307 then travelled the wrong direction along the Up track for approximately two minutes before stopping about 600 m past signal 161.

At the same time, Great Southern Railway's *Indian Pacific* passenger train (1PA8) was approaching Torrens Junction where TransAdelaide's broad gauge line crosses the standard gauge Defined Interstate Rail Network (DIRN). The investigation found that the signalling system could not provide an appropriate indication to both trains and thus neither train driver was aware of the potential for a collision. Had train H307 continued on for a further 1000 m the two trains may have collided.

The investigation also concluded that driver distraction, conflicting signal indications (hand and fixed), and inexperience contributed to the occurrence.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external bodies.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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 proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, risk controls and organisational influences.

Contributing safety factor: a safety factor that, if it had not occurred or existed at the relevant time, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (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 operational environment at a specific point in time.

Safety issues can broadly be classified in terms of their level of risk as follows:

- **Critical safety issue**: associated with an intolerable level of risk.
- **Significant safety issue**: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable.
- **Minor safety issue**: associated with a broadly acceptable level of risk.

EXECUTIVE SUMMARY

At 0701[1] on 28 March 2006, TransAdelaide passenger train H307 departed from Adelaide station and passed signal 161 which was displaying a red stop aspect, an event commonly referred to as a 'Signal Passed at Danger' (SPAD). Train H307 continued travelling through Adelaide Yard where it was routed the wrong direction along the Up[2] track towards Outer Harbor.

At the same time, Great Southern Railway's *Indian Pacific* passenger train 1PA8 was travelling south on the Defined Interstate Rail Network (DIRN), and approaching Torrens Junction where TransAdelaide's broad gauge line crosses the standard gauge DIRN. The signalling system controlling rail traffic in the area would normally provide protection for conflicting train movements through the junction. However, as train H307 was travelling on the wrong track in the wrong running direction, the system could not provide appropriate signal indications to both trains, increasing the potential for a collision.

When TransAdelaide train controllers became aware that train H307 was travelling on the wrong line in the wrong running direction, and that the potential for a collision existed if both trains continued on their existing paths, they attempted to contact the drivers of both train H307 and train 1PA8. Train H307 was brought to a stop approximately 610 m past signal 161, which is slightly more than one kilometre before the point of potential collision at Torrens Junction. Train 1PA8 was brought to a stop with the lead locomotive across Torrens Junction.

The ATSB investigated the occurrence to identify factors that may have contributed to train H307 passing signal 161 while it was displaying a red stop aspect and then continuing on the wrong line for approximately two minutes before it stopped.

The initial SPAD at signal 161 was typical of SPADs categorised as 'Starting Against Signal'. This type of SPAD typically occurs at railway stations where signals are positioned at the departure end of station platforms and the train starts to move away from the platform before the signal displays a proceed indication.

The investigation found that a conversation with the Adelaide Station platform coordinator probably distracted the driver of train H307 from completing his normal train preparation procedure. At the scheduled departure time, the steady green light directed at the driver by the platform coordinator to provide 'Right of Way' was a 'cue' which was in direct conflict with the red light displayed by signal 161. It is possible that the driver responded to the cue to proceed represented by the green signal from the platform coordinator and completed some minor tasks shortly after starting the journey but did not check the indication displayed by signal 161.

At the time of the incident, TransAdelaide's train control system did not provide a clear SPAD alarm. It is likely that an inexperienced area controller, a period of high

1 The 24-hour clock is used in this report to describe the local time of day, Central Standard Time (CST), as particular events occurred.

2 The term 'Up Track' is used to identify the track upon which train movements would normally travel towards Adelaide Railway Station.

workload and the absence of a clear SPAD alarm contributed to a delay in train control personnel identifying that a SPAD had occurred.

It is likely that the driver of train H307 believed that he had departed Adelaide station under the correct signal indication and had been deliberately routed onto the Outer Harbor 'Up' track. The driver's limited experience, his level of uncertainty regarding the unusual route, and the absence of any information from the train controller to the contrary, probably contributed to his delayed decision to take the appropriate action which was to stop and seek verification of the train's route.

In addition, the investigation identified a number of other safety factors that may have increased TransAdelaide's safety risk. These safety factors are documented in the interests of improving railway safety and relate to:

- Inconsistencies in procedures and work practices when giving 'Right of Way' to trains departing Adelaide station.
- An investigation process which was unlikely to have provided a clear understanding of factors that may have contributed to past SPADs or a sound basis for identification of safety actions to prevent similar occurrences.
- The potential for departure procedures at Adelaide station to increase the risk of 'Starting against Signal' SPADS due to 'expectation' error.
- Possible deficiencies in emergency communications between TransAdelaide and ARTC railway operations.
- A failure to categorise or analyse SPAD trends with reference to 'Starting against Signal' SPADs or include them in risk assessment workshops.

The investigation noted that a new train control system was commissioned not long after the occurrence. The new system has audible and visual alarms to ensure that a similar SPAD should very quickly be recognised by train controllers. The ATSB also acknowledged TransAdelaide's pro-active response to addressing safety issues identified during the course of the investigation. TransAdelaide management also appear to be committed to developing a healthy safety culture and improving their approach to SPAD investigation and mitigation.

However, the investigation concluded that there were further opportunities for improvement. The ATSB recommended that TransAdelaide undertake further work to address safety issues relating to the SPAD investigation process and develop a clear understanding of SPAD causal factors such as potential underlying contributors to signal anticipation.

1 FACTUAL INFORMATION

1.1 Introduction

At 0701 on 28 March 2006, TransAdelaide[3] passenger train H307 passed signal 161 while it was displaying a red stop aspect. This type of event is commonly referred to as a 'Signal Passed at Danger' (SPAD), describing an incident when a train passes a stop signal without the authority to do so. Train H307 continued to travel the wrong direction along the Up track for approximately two minutes before stopping about 610 m past signal 161.

At the same time, Great Southern Railway's *Indian Pacific* passenger train 1PA8 was travelling south on the Defined Interstate Rail Network (DIRN), and approaching Torrens Junction where TransAdelaide's broad gauge line crosses the standard gauge DIRN. The signalling system controlling rail traffic in the area would normally provide protection for conflicting train movements through the junction. However, as train H307 was travelling on the wrong track in the wrong running direction, the system could not provide appropriate signal indications to both trains, increasing the potential for a collision.

While it was noted that train H307 would need to have travelled a further 1000 m before obstructing the junction, the incident demonstrated how an undetected SPAD at Adelaide station could present the potential for a collision between a TransAdelaide passenger train and a train travelling on the DIRN. Consequently, the Australian Transport Safety Bureau (ATSB) initiated an investigation under the *Transport Safety Investigation Act 2003* (TSI Act).

1.2 Location

The incident occurred at Adelaide Railway Station. Adelaide Railway Station comprises nine terminating platforms, such that trains both enter from and exit to the west. Commercial buildings are positioned above part of the station platforms with a canopy extending to cover all platforms.

Adelaide Yard extends for approximately 700 m west of the station platforms. The yard provides the ability to route trains between each platform and Adelaide's four main rail corridors. Access to and from TransAdelaide's railcar maintenance facility is also provided from the Adelaide Yard.

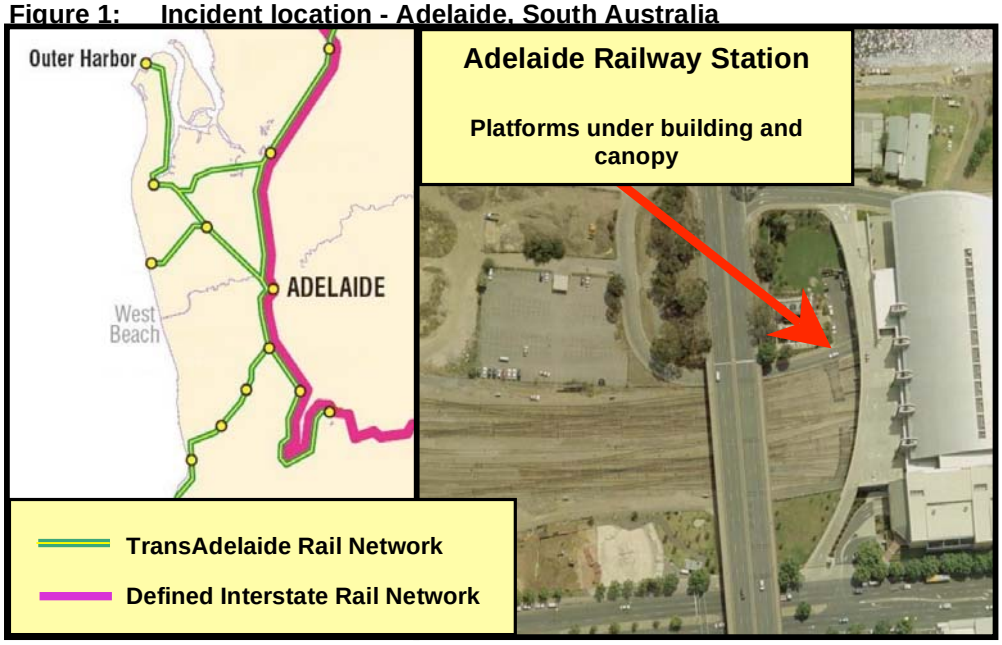
At the western end of the yard the tracks branch to the north and south. The northern tracks branch again at Torrens Junction, approximately one km north-west of Adelaide Yard. Torrens Junction is where TransAdelaide's broad gauge line to the Adelaide suburb of Outer Harbor crosses the standard gauge DIRN which is managed by the Australian Rail Track Corporation (ARTC)[4]. Management of train

3 TransAdelaide is an accredited rail organisation providing public rail transport services to Adelaide's metropolitan area. TransAdelaide operate a fleet of 94 railcars and is also responsible for access to, and maintenance of, Adelaide's broad gauge metropolitan passenger rail network.

4 ARTC is the accredited rail organisation responsible for access to, and maintenance of the DIRN, which in the Adelaide area largely runs parallel to TransAdelaide's rail network.

movements through Torrens Junction is generally the responsibility of TransAdelaide, although both TransAdelaide and ARTC work closely to ensure the safe and efficient operation of both networks. This includes the communication of unusual operating conditions to relevant train drivers and train controllers on each network.

Figure 1: Incident location - Adelaide, South Australia



Map - Geoscience Australia. Crown Copyright ©.
Aerial - Department for Environment & Heritage, SA Copyright ©

1.3 Vehicles and Personnel

Train H307

Passenger train H307 consisted of two 3100 class diesel/electric multiple units (DMU 3105 and 3106) which could be operated from either end of the train. The train length was 50 metres, weighed 92 tonnes and was crewed by one TransAdelaide railcar driver.

The driver was a 63 year old male who had been employed as a railcar driver for about six years. Most of this time, the driver was classified as a 'Class 3' driver under training before gaining competency as a 'Main Line' driver about 18 months before the incident. The driver had been medically examined about a month previously and assessed as 'fit for duty' as prescribed by the national standard[5] used by TransAdelaide.

Train Control Personnel

TransAdelaide train control is structured with two functional levels operating as a team to achieve safe rail operations. The train controller is responsible for the

5 National Transport Commission (NTC) *National Standard for Health Assessment of Rail Safety Workers, June 2004.*

authorisation and control of movements over TransAdelaide's rail network while the area controller is responsible for signal control and monitoring of train movements under the direction of the train controller. At the time of the SPAD at Signal 161, there were two train controllers on duty (managing the entire TransAdelaide network) and one area controller dedicated to the Adelaide Yard area control.

The two train controllers each had in excess of 10 years train control experience. The area controller had just completed training for the position and was working his first unsupervised day as an area controller since being assessed as 'competent' the week before.

Train 1PA8

Passenger train 1PA8 consisted of one NR class locomotive (NR17) hauling 15 passenger coaches and three motorail wagons. The train length was 448 metres, weighed about 970 tonnes and was crewed by two locomotive drivers.

1.4 The Occurrence

The rostered driver for passenger train H307 started work at 0415 on 28 March 2006. The driver prepared a train for service at the maintenance facility before driving it to Adelaide station for a scheduled service (G103) departing Platform number 3 at 0524. The return service (103G) arrived back in Adelaide at 0647 on Platform 6. The driver was then required to transfer to train H307, a scheduled service to Outer Harbor at 0701, located on Platform 7.

At 0701, the platform coordinator gave the driver of H307 a hand signal to depart Adelaide station. At that time, the route through Adelaide Yard had not been set for train H307's journey to Outer Harbor. Consequently, signal 161 positioned at the end of Platform 7, was displaying a red stop aspect. However, train H307 passed signal 161 and continued on through Adelaide Yard. Approximately 160 m past signal 161, points AD49 directed train H307 the wrong direction down the Up track towards Outer Harbor. A short distance later, train H307 trailed[6] and damaged points AD54 before continuing through Adelaide Yard towards Torrens Junction.

As train H307 passed signal 161, passenger train 1PA8 was travelling on the DIRN and also approaching Torrens Junction. The TransAdelaide train controller's original intention was for train 1PA8 to traverse Torrens Junction before train H307. When TransAdelaide train controllers became aware that train H307 was travelling on the wrong line and that the potential for a collision existed if both trains continued on their existing paths, they attempted to contact the drivers of both train H307 and train 1PA8.

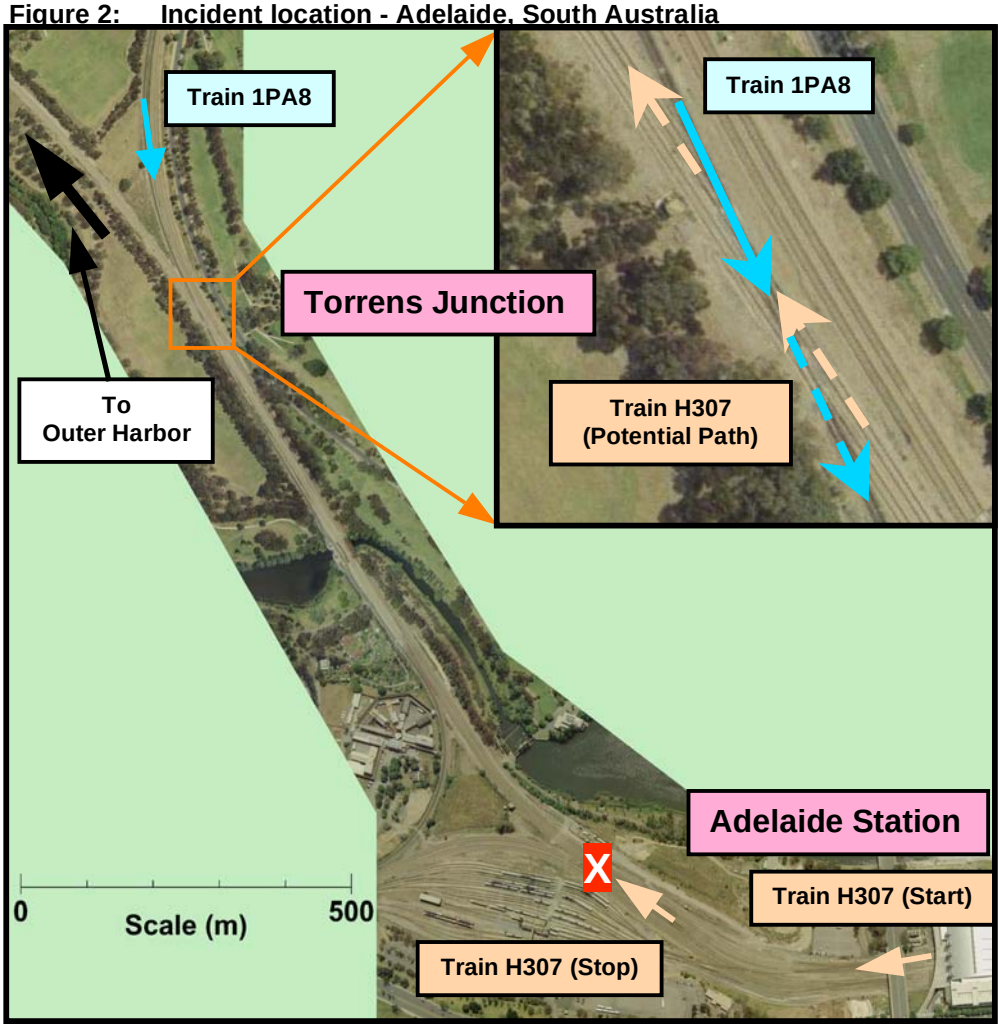
Train H307 was brought to a stop approximately 610 m past signal 161, which is slightly more than one kilometre before it would have crossed Torrens Junction. The driver was just bringing train H307 to a halt when he received the directive from TransAdelaide train control to stop.

---

6 The term 'trailed' refers to traversing points at diverging tracks that have not been set appropriately to allow the passage of the train.

TransAdelaide train control attempted to contact train 1PA8 using a UHF radio programmed with the ARTC's 'South Control' frequency. However, the radio onboard train 1PA8 was tuned to the 'Metro Control' channel. Consequently, the drivers of train 1PA8 did not receive TransAdelaide's radio call, but received a relayed message from the ARTC train controller. Train 1PA8 was brought to a stop but the lead locomotive was obstructing Torrens Junction. There were no injuries. Once train controllers were satisfied that there was no further risk to rail safety, train 1PA8 was permitted to continue its journey. TransAdelaide personnel then initiated procedures to recover train H307 and restore passenger services over the TransAdelaide passenger rail network.

Figure 2: Incident location - Adelaide, South Australia



In compliance with normal TransAdelaide procedures, the driver of train H307 was requested to undertake screening for drugs and alcohol following the incident. The tests, administered by Worksafe SA, returned a negative result.

1.5 Environmental Conditions

Information on the weather conditions at Adelaide was obtained from the Bureau of Meteorology (BoM)[7]. The temperature at 0700 was 15.8°C. There was approximately three eighths cloud cover, a light south easterly breeze and no recent rain. At the time of the incident the sun was approximately six degrees below the eastern horizon. The almost new moon was at an altitude of 15°, also to the east, and provided negligible ambient light. Discounting artificial lighting, any significant moonlight, and the sun's position below the horizon the level of ambient light was such that large objects could be seen but with no discernible detail.

7 Measurements taken at Kent Town, approximately 2.5 km east of Adelaide Railway Station.

2 ANALYSIS

TransAdelaide's *Common General Operating Rules* defines the meaning of indications and documents procedures for safe railway operations. In relation to signal indications, the rules state:

> Red light indicates 'Stop'
>
> Yellow light indicates 'caution' – proceed cautiously
>
> Green light indicates 'clear' – proceed

and:

> A driver must:
>
> (s) Not move towards the entrance of a section ahead before the starting signal (if any) is cleared …
>
> (v) Before starting a train the driver must be satisfied that the line ahead is clear, that all applicable signals are at 'proceed', and be in possession of the appropriate authority to enter the section.

In this case, the driver passed signal 161 displaying a red light and consequently train H307 entered a section without authority and before the signal was cleared.

The investigation found no evidence of any mechanical defect or deficiency in train H307 that may have contributed to the initial SPAD at signal 161. Consequently, the analysis focuses on verifying the signal indication displayed to the driver and the factors which may have influenced the driver's actions when approaching the signal. The analysis also considers the actions of train control personnel and the effectiveness of any SPAD alarm systems.

In addition, the investigation examined how TransAdelaide manages SPAD events with respect to analysis of the contributing factors, and the identification and implementation of systems to prevent similar occurrences.

2.1 Recorded Evidence

Recorded data was critical in establishing a sequence of events, thereby identifying when and where individual actions occurred, and allowing investigation as to why these actions may have occurred. Recorded data was available from a variety of sources:

- Signalling system data logging

  Both the TransAdelaide and the ARTC rail networks incorporate line-side signalling controlled remotely from their respective Centralised Train Control (CTC) centres located in Adelaide. Both systems incorporate data logging that records changes to the status of field equipment such as signals, points and track circuits. TransAdelaide's system also records fault conditions and commands entered by train and area controllers.

- Train H307 and Train 1PA8 data logging

  Both trains had electronic data recorders that captured a variety of information including train speed and distance in relation to time.

- Voice communication recording

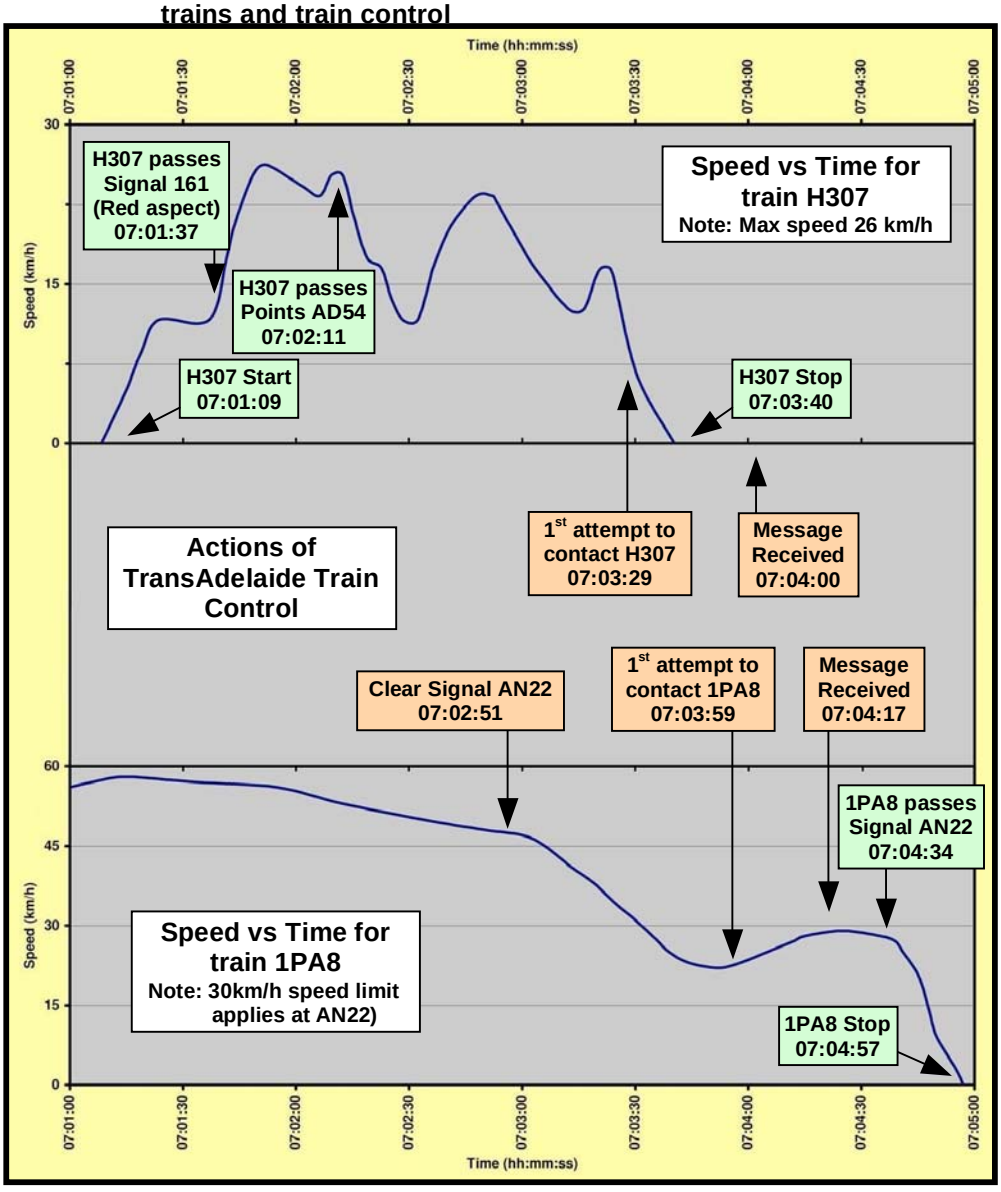
  TransAdelaide and the ARTC record all voice communications (telephone and radio) with train controllers at their respective CTC centres.

- Video recording

  TransAdelaide records video images at the Adelaide Railway Station and on the majority of their passenger trains. Video images were available showing train H307 departing from Platform 7 at Adelaide station. Images were also available from video cameras onboard train H307.

Examination of all recorded data allowed reconstruction of the sequence of events leading up to, including and following this incident (illustrated in Figure 3)[8].

Figure 3: Sequence of events based on recorded information from both trains and train control



8 TransAdelaide's signalling system was used as a common time reference.

The examination of recorded data established that:

- Train H307 had started its journey from Platform 7 and had passed signal 161 at 07:01:37.
- Signal 161 had been displaying a red light and no command to clear the signal had been issued from TransAdelaide Train Control.
- The route through Adelaide Yard had not been correctly set for the scheduled movement.
- A point failure indication was recorded as the train traversed points AD54 at 07:02:11.
- Forty seconds after traversing points AD54, a command was issued from TransAdelaide Train Control to clear signal AN22, thereby authorising train 1PA8 to proceed through Torrens Junction.
- A further 38 seconds passed before TransAdelaide Train Control attempted to contact the driver of train H307, by which time the driver had almost brought the train to a stop.
- Train H307 stopped at 07:03:40, about 610 m past signal 161.
- Train 1PA8 had stopped at 07:04:57 and was obstructing the TransAdelaide tracks at Torrens Junction.

2.2 Signal 161 Passed At Danger (SPAD)

The ability to sight a signal is critical to applying the appropriate action required by the signal's indication (stop or proceed). At the time of the SPAD at Signal 161, there was negligible ambient light beyond the signal. Against the darkened background and assuming no physical obstruction, the indication lights of signal 161 should have been clearly visible to the driver of train H307.

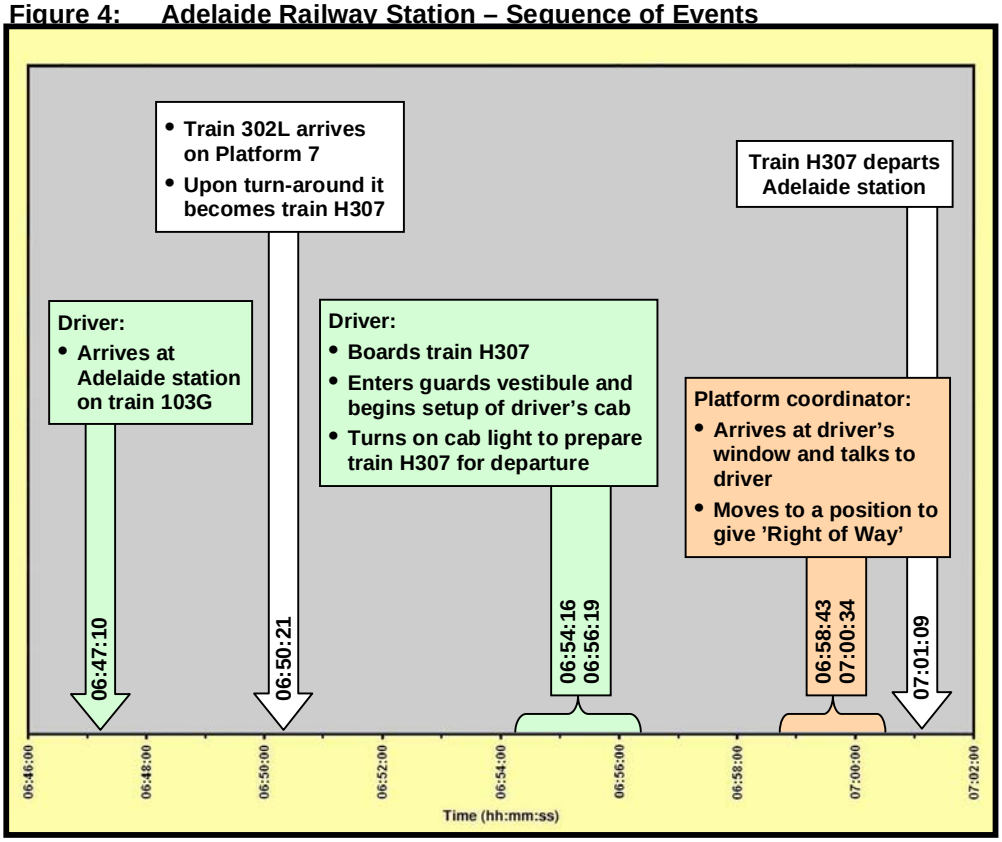
The SPAD at signal 161 was typical of SPADs categorised as 'Starting Against Signal'. This type of SPAD typically occurs at railway stations where signals are positioned at the departure end of station platforms and the stationary train starts to move away from the platform before the signal displays a proceed indication. The investigation identified a number of possible factors that could have contributed to the SPAD at Signal 161. These were associated with train departure procedures and driver issues including, distraction, fatigue and/or expectation. In order to identify which factor, or combination of factors, contributed to the SPAD it is important to have a broad understanding of TransAdelaide's rail operations at Adelaide Railway Station.

TransAdelaide's rail network consists of four main rail corridors with the longest return journey taking approximately two hours. Each driver's work schedule is configured to allow sufficient time between driving commitments for meal and toilet breaks, usually at Adelaide Railway Station. Consequently, TransAdelaide drivers are likely to operate a variety of scheduled services over the course of a working day.

Recorded information, both data and video[9], was examined to allow the actions of the driver of train H307 and supporting staff to be reconstructed in the time leading up to the SPAD. The driver had arrived back in Adelaide at approximately 0647 after driving train 103G. Train 103G terminated on Platform 6 and the driver was required to transfer to train H307, scheduled to depart from Platform 7 at 0701. The train that was to operate as service H307 was scheduled to arrive at Platform 7 at 0645, however, signalling data indicates that it did not arrive until 0650.

There was about a seven minute period between the arrival of train 103G (06:47:10) and the time that the driver was observed boarding train H307 (06:54:16). The driver advised that upon arrival at Adelaide, he isolated the cabin of train 103G before going for a toilet break. Considering a number of factors, it would appear consistent that seven minutes would be a reasonable time to isolate the cabin, pack and collect his kit bag, go to the toilet then to board train H307.

Figure 4: Adelaide Railway Station – Sequence of Events



At the time the driver boarded train H307, there was still approximately six minutes before the scheduled departure time. This would normally be sufficient time to prepare a train for departure. Indeed, video evidence from the platform camera indicated that the driver did not appear to be in a rush. The video shows the driver entering the guard's vestibule and driver's cab, securing the doors, turning on the cab light and beginning the preparations for departure. Approximately two minutes passed during these actions.

The driver indicated that it was his usual routine in the minutes before departure to organise the driver's cab, store his kit bag and read train running documentation.

9 TransAdelaide's signalling system was used for a common time reference.

Train running documentation advises the driver of details relevant to the scheduled service and highlights any known safety hazards, work gangs, or speed limits that may be encountered during the journey. The driver's exact actions could not be verified by the video evidence. However, after approximately two minutes, the platform coordinator was observed approaching the driver's cab and a conversation began.

The video evidence indicated that this conversation continued until approximately 30 seconds before departure. At this point, the platform coordinator moved to a position approximately five metres from the train's cab before turning and giving 'Right of Way' (RoW)[10]. At 07:01:09, train H307 began to move and 28 seconds later was detected passing signal 161 while it was displaying a red stop aspect.

Departure Procedures

A characteristic common to many 'Starting Against Signal' SPADs is other personnel providing information to the driver which conflicts with that provided by the signal. Similarly, the actions of personnel may not always be in accordance with documented procedures, may obscure sighting of the signal, and/or the procedures may contain ambiguous or conflicting information.

The departure procedure for train H307 required a platform coordinator to give RoW. Examination of video evidence and post incident discussions with TransAdelaide personnel showed that the platform coordinator adopted a slightly modified version of the 'All clear or proceed' signal to provide RoW to the driver of train H307. This involved using a steady green light held in front of the body, directed at the driver from a position approximately five metres in front of train H307, shown in Figure 5.

At the time when the platform coordinator provided RoW, signal 161 was displaying a red light. The steady green light directed at the driver by the platform coordinator was a 'cue' which was in direct conflict with the red light displayed by the signal. It is possible that the driver responded to the cue to proceed represented by the green signal from the platform coordinator and had failed to check that there was a similar indication showing on signal 161.

The investigation examined the possibility that the platform coordinator may have partially obscured the driver's view of signal 161 while giving RoW. Given the curvature of some platforms in Adelaide Station whether or not this occurs will depend on the position of a railcar and the platform coordinator in relation to the signal. Analysis concluded it was unlikely in this case that the signal 161 was obscured by the platform coordinator while giving RoW to the driver of train H307.

10 'Right of Way' is a signal to the driver that passengers are either onboard or clear of the train at the scheduled time of departure.

Figure 5: Platform coordinator giving 'Right of Way' to train H307

Note: Video time information not synchronised with reference time

The investigation identified a number of issues relating to the process of giving 'Right of Way' at Adelaide railway station. (Refer to Section 2.8 and Appendix A for further discussion regarding these.)

Driver Distraction

Driver distraction has been defined by the American Automobile Association Foundation as occurring

> 'when a driver is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object or person within or outside the vehicle compelled or tended to induce the driver's shifting attention away from the driving task'.[11]

Driver distraction can include a range of factors either inside or outside a vehicle that draw on a person's limited physical, visual and cognitive resources, resulting in a degradation of the driving performance. Eating, drinking, operating a mobile telephone, operating other devices integral or brought into the vehicle, smoking, and conversing with another occupant are all interior factors that can distract from the driving task. Exterior factors such as a person, object or event can also distract a driver. It has been estimated that driver inattention contributes to 25 per cent of road accidents and that distraction is a contributing factor to over half of these

11 Young, K., Regan, M., & Hammer, M. (2003). *Driver distraction: A review of the literature.* Monash University Accident Research Centre. Report No. 206.

inattention accidents.[12] Similarly, distraction can be a significant issue relating to the train driving task.

The train driver's recollection of the sequence of events was generally consistent with the video records, although it varied slightly with respect to their timing. He said that he felt rushed throughout the departure process; however, video evidence does not show him running or walking quickly to board train H307. While the video evidence may not directly support the driver's recollection of feeling rushed, the video and other statements by the driver provide some indication as to what may have given rise to this feeling. He stated that he had observed a green proceed signal prior to departing the platform, albeit the hand signal provided by the platform coordinator, and then when he had started the train, he placed the train running documentation in the cab mounted holder. Having been distracted at the critical time required to observe signal 161, it is likely that the driver did not see or consciously notice the red 'stop' indication.

The video evidence provides a level of support to this scenario. Having been involved in a discussion with the platform coordinator for approximately two minutes, the driver was distracted from his normal train preparation procedure. There was only 30 seconds between the end of this conversation and the platform coordinator giving RoW. During this time, it would be normal for the driver to be focused on the actions of the platform coordinator, checking rear vision mirrors, closing the automatic doors and starting the train. Consequently, if the driver had not completed some of his cab procedures such as storing the train running documentation, it is likely that he would do this shortly after starting his journey.

Distraction of safety critical workers

Both the driver and the train controllers advised of an operational procedure that has the potential to cause distraction and potentially affect safety. The potential source of distraction relates to a requirement for train drivers to report any late running in excess of two minutes to the train controller (in August 2006, this was extended to late running in excess of three minutes).

The impression given to investigators was that this requirement could introduce a source of distraction to the driver, possibly at the critical time required to observe a signal indication. If the signal was located in close proximity to a departing train, it would be possible that this communication could distract the driver from observing the signal and result in a 'Starting against Signal' SPAD. However, TransAdelaide procedures state that late running communication should be conducted on arrival at a terminus station, not on departure. TransAdelaide also instruct their drivers to only conduct radio communication at a time that will not distract from the driving task.

Excessive radio communication can also introduce a source of distraction to the train controller, possibly during periods of high workload such as times of high density traffic (peak periods). It is essential during these times that train controllers are not distracted from their safety critical role. However, unnecessary radio communication will potentially expose controllers to distraction.

12 Young et al. (2003).

There was no evidence to suggest that unnecessary radio communication distracted either the driver of train H307 or the train controllers, however, the potential risk to TransAdelaide remains. It should be noted that a new CTC system was commissioned not long after this incident. The new system has the functionality to monitor, record operational statistics (including late running) and provide assistance to the train controller to manage routing of late trains. TransAdelaide advised that it continually reviews non-safety related processes so as to minimise the use of radio communication and other potential sources of distraction.

Fatigue & Rostering

Fatigue can have a very significant effect on human performance. It can reduce attention, increase reaction times and affect memory. When fatigued, it can take longer for a person to perceive and interpret information and longer for them to decide on, and carry out, an appropriate course of action. Fatigue can also affect a person's ability to judge distance, speed and time. Typically, individuals will be unaware of the effects of moderate levels of fatigue on their performance.

Fatigue can arise from a number of sources, including the nature and duration of work, insufficient rest or sleep, and the time of day (with performance generally most affected during the period 0300 to 0500, and a smaller decrement occurring in the period 1500 to 1700). Systems for managing fatigue are common in the rail industry where workers are frequently asked to work rotating shifts which require early morning starts and/or late night endings depending on the work roster. Rail organisations generally manage fatigue of rail safety workers under their safety management systems. TransAdelaide use FAID[13] to assist with fatigue management of its railcar drivers and predict the level of fatigue based on rostered hours. However like many companies, TransAdelaide does not actively adjust the model to account for actual hours worked as opposed to rostered hours on duty.

When questioned, the driver stated that he did not feel tired or fatigued. Examination of his rostered and actual hours worked for the previous seven days did not indicate that fatigue was a likely factor in the incident. However, the driver also indicated that some family issues had led to a level of anxiety though he considered that this had not affected his work performance. It is possible that the quality of his rest and/or sleep may have been affected as a result of this anxiety but it cannot be concluded to what extent, if any, this may have influenced his actions on the morning of the incident.

Expectation

A person's perception of the probability of a given event is strongly influenced by past experience[14]. Similarly, the frequency with which a person encounters a specific event will influence their expectation that the same event will occur again.

For example, a train driver's perception that red signal will clear to yellow or green before they get to it is reinforced every time that driver approaches the signal and

---

13 FAID - Fatigue Audit InterDyne is a commercially available computer program that derives a fatigue score based on hours worked or rostered.

14 National Transportation Safety Board (1998). Safety at passive grade crossing. Volume 1: Analysis. Safety study NTSB/SS-98/02. Washington DC.

observes it change to a ‘clear’ indication. Under these conditions, route familiarity combined with the expectation that a signal will ‘clear’ has the potential to lull a driver into becoming complacent or developing poor driving habits. Conversely, if a driver regularly encounters a signal that does not ‘clear’ as the train approaches, it is more likely that the driver will develop an expectation of a red signal and be more prepared to stop.

Signals at the end of station platforms, such as Adelaide, are susceptible to expectation error, which in turn increases the risk of ‘Starting Against Signal’ SPADs. Adelaide yard can be relatively busy at times. When trains are running in accordance to the timetable, it would be expected that signals would clear at the scheduled departure time. At times when there are minor train delays it is possible that delays in clearing the platform departure signal could occur if the planned train route was unavailable. However, platform coordinators give RoW at the scheduled departure time regardless of any delay to clearing the departure signal.

A random sample of scheduled train departures from Adelaide station was examined. Based on recorded signal data, about 20 per cent clearly demonstrated that trains had moved off and approached the departure signal before it had been cleared to green. Under these conditions, it is likely the drivers would expect the signal to change to a proceed indication as they approach it, or at the least, experience only a short delay before the signal cleared.

While the examination of the evidence did not indicate that ‘expectation error’ contributed to the SPAD this instance, the method of operation at Adelaide station does increase the risk of ‘Starting Against Signal’ SPADS due to expectation error.

2.2.1 Summary of Signal 161 Passed at Danger (SPAD)

The SPAD at signal 161 was typical of SPADs categorised as ‘Starting Against Signal’ SPADs. This typically occurs at railway stations where a stationary train starts to move away from the platform before the signal displays a proceed indication.

At the time when the platform coordinator provided RoW to the driver of train H307, signal 161 was displaying a red light. The steady green light directed at the driver by the platform coordinator was a ‘cue’ which was in direct conflict with the red light displayed by the signal. It is possible that the driver responded to the cue to proceed represented by the green signal from the platform coordinator and had failed to check that there was a similar indication showing on signal 161.

It is likely that a conversation with the platform coordinator prevented the driver of train H307 from completing his normal train preparation procedure. Consequently, some minor tasks may have been completed shortly after starting the journey, thereby distracting the driver at the critical time required to observe signal 161 and thus resulting in train H307 passing signal 161 while it was displaying a red light.

It was unlikely that the signal 161 was obscured by the platform coordinator while giving RoW to the driver of train H307. However, the departure procedures at Adelaide Station have the potential for platform coordinators to be positioned in such a way that they may obscure, or partially obscure, a main signal during the execution of their duties.

2.3 Passage of train H307 following the SPAD

A railway signalling system is designed to manage the routing of train movements while providing safe separation between other trains and track hazards. If a train passes a red signal (SPAD) and the driver is unaware of his/her actions, the risk of a collision, derailment or equipment damage increases greatly. Consequently, other control measures are usually put in place to limit the level of risk in the event of a SPAD. For example:

- A driver's ability to recognise unexpected driving conditions and apply the appropriate action.

  When a SPAD occurs in a location such as Adelaide Yard, it is likely that the train would travel along an unintended track if permitted to proceed for any significant distance. This was the case for train H307, when about 160 m past signal 161, the train was routed the wrong direction down the Up track towards Outer Harbor. Most drivers would become aware fairly quickly that they were on the wrong track and would contact train control for assistance. In this case the train continued for a further 440 m which suggests that the driver was relatively slow to respond to the unusual circumstances.

- Remote signal monitoring and alarm indications.

  TransAdelaide's rail network was controlled and monitored from a Centralised Train Control (CTC) centre located in Adelaide Yard. The status of field equipment, such as track occupancy, signal indication and point position, along with indications of fault conditions, were all displayed at text/graphic terminals. Recorded data confirms that the monitoring system identified and reported that train H307 had '… passed signal 161 at stop, onto track 161A'. The system also reported the failure of points AD54. No action was initiated until almost two minutes after train H307 had past signal 161 and these alarms had occurred.

Recorded data (Figure 3) and statements from TransAdelaide personnel were analysed in an attempt to understand why train H307 had been allowed to travel approximately 600 m past signal 161.

Driver of Train H307

The driver of train H307 said that all seemed normal as he departed Adelaide station. He indicated that he quickly became aware that the points had directed train H307 onto the wrong track. However, believing that signal 161 had been green, he assumed that the train controller had intentionally routed his train onto this track.

The driver said that he continued travelling at a reduced speed, thinking that the train controller would route train H307 back onto the correct track a little further through the yard. As train H307 approached the junction where the TransAdelaide tracks split to the north and south, the driver realised that there would be no opportunity to return to the normal track. Consequently, he stopped train H307 intending to contact the train controller to seek assistance. The driver advised that as he was drawing to a stop, the train controller began calling by radio and instructed him to stop train H307.

The speed profile recorded by train H307 is consistent with the driver's account of events. TransAdelaide requires trains to depart Adelaide station at no more than 15 km/h. After the train has cleared the platforms they may increase speed to no more than 35 km/h while travelling through Adelaide Yard. The recorded data exhibits

this speed profile as train H307 began its journey. However, when train H307 traversed the points that directed it onto the wrong track, the recorded data showed that train speed varied between 11 km/h and 23 km/h before decreasing to a stop. This speed profile was distinctly different from the 35 km/h speed that would normally be expected, indicating that the driver had recognised he was not travelling the expected route.

The level of ambient light through Adelaide Yard at the time of the incident was low. Under these conditions, it is likely that larger objects could be seen, but the finer details of objects would have been more difficult to see. While it was apparent that the driver recognised that the train was on the wrong track he apparently did not see that the lay/position of points AD54 was incorrect.

The driver of train H307 had approximately 18 months driving experience on TransAdelaide's metropolitan rail network. A driver with this level of experience is likely to gain considerable route knowledge of TransAdelaide's network under normal operating conditions. However, the driver's exposure to unusual operational situations is likely to have been limited. The driver's actions and statements indicate that he was unaware of, or at least unsure in the first instance that the train's path was unintended.

In most cases, the most appropriate action in times of confusion would be to stop and contact the train controller to verify the validity of the train's path. However, in this case, the driver's level of uncertainty, his belief that he had been deliberately routed on this path and the absence of any information from the train controller to the contrary probably contributed to his delayed decision to stop and seek verification.

Train Control Personnel

Train control personnel said they only became aware that train H307 had passed signal 161 when some unusual indications on the control centre's mimic panel[15] were noticed. A train controller was returning from a break and noticed a number of red indications on the mimic panel that appeared to imply a 'module failure'[16] in the vicinity of points AD54. Shortly after, train control personnel observed a change in status of track indications. These precluded a failed module and indicated that a train was travelling the wrong direction along the Up track towards Outer Harbor. Train control personnel said that they were also able to observe the train from the control room window. However, by that time they could only see the rear tail lights of train H307 and noted that it was travelling very slowly. Train control personnel said that they attempted to contact the driver of train H307 by radio to direct that the train should be stopped immediately. In addition, train control personnel also attempted to contact the driver of train 1PA8 with a similar direction to stop.

TransAdelaide's CTC system provides full control and monitoring capability of the signalling system throughout Adelaide Yard. There are a number of indicators that

15 The mimic panel was a large wall mounted panel that displayed TransAdelaide's rail network and included lamps to indicate the status of field devices such as signals, points and track circuits.

16 TransAdelaide's signalling system in Adelaide Yard used 'Solid State Interlocking' (SSI). SSI incorporates a number of electronic 'modules' that control and monitor field devices such as signals, points and track circuits.

should have drawn the attention of train control personnel that train H307 had passed signal 161 and was subsequently travelling on the wrong track through Adelaide Yard.

- SPAD Notification – At the time of the incident, TransAdelaide's CTC system had the ability to notify train control personnel if a train passed a signal that was displaying a red light. However, the notification was not an obvious alarm, only a message on a text display and an output to a system printer. The attention of train control personnel is usually focused towards mimic or graphic displays, reducing the likelihood that a small text message would be noticed (Figure 6).
- Mimic/Graphic Indications – At the time of the incident, TransAdelaide's CTC system provided visual indication of signal indications and train movements on both the mimic and graphics displays (Figure 6). If train control personnel happened to observe indications that represented a train moving past a red signal then it is likely that train control personnel would interpret it as a SPAD. However, during periods of high workload, the likelihood of a controller observing these particular indications at the critical moment is quite low.
- Rejected Command – At the time of the incident, a characteristic of TransAdelaide's CTC system was rejection of invalid commands. For example, the normal process for signalling train H307 from Platform 7 at Adelaide station would involve typing a command on a keyboard to clear signal 161 at 0701. If a train had already passed the signal, the command would be invalid since the route over which the signal reads would be occupied. Under these conditions the CTC system would return a text message advising that the command had been rejected. No reason for the rejection would be provided, however, it would have been normal for the controller to assess indications to identify why the command had been rejected.
- Points Failure Notification – TransAdelaide's CTC system also provided indication when points AD54 were damaged. Similar to SPAD notification, there was no obvious alarm. However, the system would display a point failure as a flashing indication on the controller's graphic display and the mimic panel.

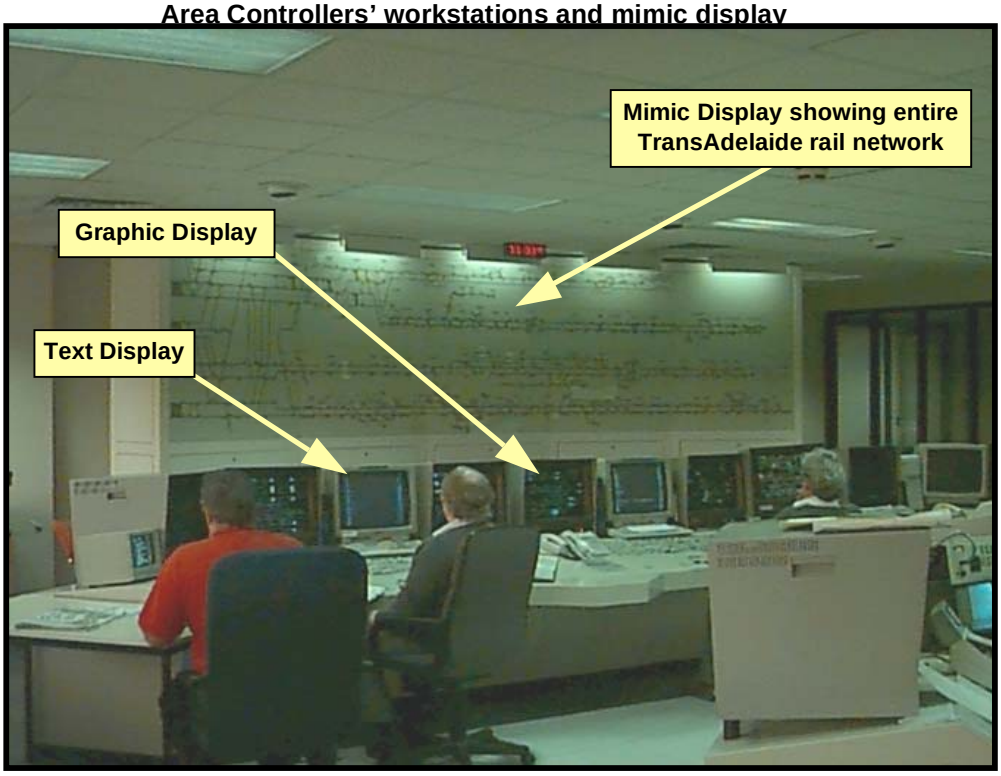
Train H307 passed signal 161 at 07:01:37. The SPAD notification, mimic and graphic indication at train control would have occurred within one or two seconds. At, or around this time, it would be normal for the controller to attempt a command to clear signal 161 for the scheduled service. The failure of points AD54 was approximately 34 seconds after H307 passed signal 161. By this time, all of the indications listed above had occurred. However, train H307 continued to travel undetected on the wrong track for a further 440 m.

It is important to note that at this point in time, signal AN22 had not been cleared to route train 1PA8 through Torrens Junction on the DIRN. Signal AN22 was still red and providing protection for TransAdelaide trains travelling through Torrens Junction on the broad gauge track. However, 74 seconds after train H307 passed signal 161, train control personnel cleared signal AN22, permitting train 1PA8 to cross the unprotected path of train H307. By this time, train H307 had travelled approximately 430 m past signal 161. The action of clearing signal AN22 was evidence that train control personnel were still unaware at that point that train H307 had passed signal 161.

Almost two minutes after train H307 passed signal 161, the radio communications records show that train control personnel were attempting to radio the driver and

direct train H307 to stop. By this time, the driver of H307 had almost brought train H307 to a stop of his own accord, approximately 610 m past signal 161.

Figure 6: TransAdelaide CTC – Area Controllers' workstations and mimic display



Analysis of Actions

The area controller, managing Adelaide station and yard at the time of this SPAD, was inexperienced and was working his first unsupervised day as an area controller since being assessed as 'competent' the week before. At the time that train H307 passed signal 161, the workload for the Adelaide area was relatively high. The area controller stated that a number of train movements were late arriving at Adelaide Station and advised that he did not attempt to clear signal 161 since the incoming train movements were considered the higher priority. It is likely that the indicators listed above were overlooked since the area controller was focused on other train movements. In addition, the area controller's inexperience was likely to have reduced his ability to scan the mimic, graphic and text displays for unexpected indications such as a SPAD. Commands controlling signals, recorded by the signalling system, verified that the area controller's focus was on the southern part of the yard (in and out of Platform 2) at the time that train H307 departed Platform 7 at the northern side of the yard.

Train 1PA8 was travelling on the DIRN and approaching Torrens Junction as train H307 passed signal 161. However, signal AN22 was cleared after the SPAD, placing train 1PA8 in direct conflict with the unauthorised movement of train H307. ARTC train movements through Torrens Junction are not scheduled movements and require TransAdelaide train controllers to plan how they are to pass through the junction without disrupting TransAdelaide train movements. It is likely that, at the time of the SPAD, the train controller was focused on the task of planning train 1PA8's movement through Torrens Junction and had not observed the unexpected

indications shortly after train H307 departed from Platform 7. As would be normal practice, the train controller requested that the area controller clear signal AN22, which considering the area controller's high workload at the time, was executed without an awareness of the SPAD at signal 161 (74 seconds earlier).

TransAdelaide commissioned a new CTC system not long after this incident. The new system incorporates two levels of alarm, each of which provides clearly audible and visual notifications to train control personnel. SPADs at controlled signals are classed as 'Critical Alarms' and SPADs at automatic signals are classed as 'Non-critical Alarms'. It would be unlikely that a SPAD, such as train H307 passing signal 161, would go unnoticed by train controllers using the new CTC system.

2.3.1 Summary of train H307 following the SPAD

It is likely that a combination of factors relating to the train driver contributed to the extent of travel past signal 161 by train H307:

- The driver believed that signal 161 was green and that train H307 had been intentionally routed in this direction.
- Low levels of ambient light in the time before dawn reduced the driver's ability to recognise track detail, specifically, the incorrect lay of points AD54 for the passage of his train.
- The train driver's relative inexperience at managing unusual operational situations.

From the perspective of train control, it is likely that a combination of factors contributed to the extent of travel past signal 161 by train H307:

- TransAdelaide's CTC system at the time did not provide an audible SPAD alarm or clear visual SPAD alarm.
- The workload for the train controllers was relatively high at the time and the controller responsible for the Adelaide area was inexperienced.

2.4 SPAD Investigation

Australian Standard AS4292.7-2006 *Railway Safety Management Part 7: Railway safety investigation* describes the intent of a safety investigation as the enhancement of safety through the discovery of any systemic problems and deficiencies which may have led to the occurrence or any latent safety issues the investigation might reveal. The key components of the investigation are the collection of evidence, analysis of evidence, development of conclusions (findings) and identification of safety actions (recommendations)[17].

The ATSB examined TransAdelaide's investigation process and investigation reports for a number of previous SPADs (summarised in section 2.4.1). TransAdelaide's pre-1999 SPAD investigation process was predominantly aimed at sanctioning the responsible train drivers. Each SPAD was addressed individually

17 The standard also makes reference to the *Australian Code of Practice – Rail Safety Investigation* which provides further information and guidance for compliance to the standard.

and disciplinary action taken. In 1999, TransAdelaide changed its approach to SPAD management and developed a standard form for investigation. TransAdelaide also developed a SPAD database which permitted ongoing comparison and trend analysis with the intent of identifying strategies to avoid future incidents.

The form developed by TransAdelaide's for SPAD investigation is titled a 'Preliminary Report'. The form is predominantly a checklist for the collection of evidence. The form provides the opportunity for recording the driver's opinion, both for cause and possible treatment, and also provides a section for the Instructor Driver (assessing the SPAD) to comment and suggest a recommendation. However, the comments or opinions are not based on any documented analysis and in some of the past reports provided to the ATSB these fields were not completed. In short, the preliminary report only records the factual evidence and verifies that the SPAD occurred. It does not provide a framework for detailed analysis, findings or recommended safety actions based on the findings.

Irrespective of any supporting technical systems, train driving is essentially a human activity. The failure of TransAdelaide's preliminary report system is that it does not encourage the identification and analysis of potential underlying causes, and 'human error' is often implied to be the primary and only cause of an incident. It is important to ask why, and analyse how, a human error occurred to understand how it can be prevented in the future. For example, when considering the SPAD at signal 161 on 28 March 2006, the factual evidence indicates that the train passed the signal was it was displaying a red indication. In the absence of any further analysis, it may be easy to conclude that the cause was driver error. However, when asking why the driver made an error, other factors become evident such as distraction and conflicting signal indications due to platform departure procedures. This now adds possible organisational factors to the causal list.

It is also important to analyse the consequence of the risk and the factors that may contribute to the consequence. For example, a SPAD can result in a short overrun if the driver saw the red indication but failed to stop in time, or it can result in a long overrun if the driver believed he/she had passed a yellow or green indication and continued on the journey. The SPAD at signal 161 is typical of the latter. If these issues are also investigated, it may be possible to identify safety actions aimed at reducing the consequence if a SPAD occurs.

TransAdelaide's SPAD investigation system at the time of this occurrence was not thorough enough to provide a clear understanding of factors that may have contributed to the SPAD or be a sound basis for identification of safety actions to prevent similar occurrences.

2.4.1 Examination of SPAD Investigation Reports

Previous SPADs by the driver of H307

The driver of train H307 had one previous SPAD recorded on his driving record. This occurred at signal 1233, Oaklands Park on 10 November 2004. Based on the information in the preliminary report, the SPAD occurred about five weeks after qualifying as a mainline railcar driver. The report indicated that the driver was distracted by a pedestrian crossing the track and failed to apply the brakes in time to stop at the red signal.

The report provides no record of any recommendations. However, the ATSB discussed the incident with the driver and found that he had been provided with re-training and continued driving without further incident until 28 March 2006.

Previous Starting Against Signal SPADs at Adelaide Station

There are nine platforms at Adelaide station, each with a signal positioned at the departure end of the station platform. Seven SPADs, not including signal 161 on 28 March 2006, had been recorded[18] at these signals from 1997 until the time of this incident. From a SPAD analysis point of view, these can be considered as multiple SPADs at an Adelaide station departure signal. Based on the information provided to the ATSB, two of these SPADs were attributed to a green or yellow signal changing to red as the train approached the signal, giving insufficient time for the train to brake to a stop before passing the signal. The remaining five implied some level of driver error as a cause, and could be categorised as 'Starting Against Signal' SPADs.

TransAdelaide was only able to provide the ATSB with three preliminary reports and a driver's statement for the five possible 'Starting Against Signal' SPADs at Adelaide station. From the limited information available, it appeared that distraction or lack of attention may have been contributing factors to the each of these SPADs. However, of particular interest are comments recorded in the preliminary reports by railcar drivers in two of the SPAD events at Adelaide station departure signals:

- One report recorded the driver's opinion as to how similar incidents could be prevented in the future. The driver suggested that the platform coordinator should wait until the departure signal was clear before giving RoW to the railcar driver.
- Another report recorded the driver's belief that the signal was clear and that he only became aware that something was unusual when he noticed the incorrect lay of the switches. The driver also stated that the overrun may not have been as extensive had the train controller provided prompt notification that a SPAD had occurred.

These two points obtained from the preliminary reports of previous SPAD events at Adelaide station departure signals indicate possible control strategies that, if implemented, may have prevented or reduced the consequence of the SPAD at signal 161 on 28 March 2006. This is not to say that TransAdelaide should have implemented these specific strategies, only that precursors to a SPAD with similar contributory factors had occurred and possible control strategies had been suggested. Section 2.5 provides further discussion on SPAD mitigation processes.

Previous Starting Against Signal SPADs at Other Stations

Many other stations in TransAdelaide's rail network have signals positioned at the departure end of the station platform. The ATSB examined five SPADs at platform departure signals that had occurred in the 12 months prior to this incident. One was attributed to a green or yellow signal changing to red as the train approached the signal, giving insufficient time for the train to brake to a stop before passing the

18 Data obtained from TransAdelaide's SPAD database and the database of reported occurrences maintained by Transport SA.

signal. Two involved express trains that had not stopped at the station and therefore could not be categorised as 'Starting Against Signal' SPADs.

From the limited information provided in the preliminary reports for the remaining two SPADs, it appeared that both could be categorised as 'Starting Against Signal' SPADs and both drivers believed they had been given a clear signal to proceed. However, there was insufficient information in the preliminary reports to determine any contributing factors.

2.5 SPAD Mitigation

Controlling the risk of a SPAD event is generally achieved through a risk management process. Risk management is the culture, process and structure aimed at effectively managing and controlling risks, and is an integral part of an organisation's Safety Management System. Many rail organisations use the Australian Standard AS/NZS 4360:2004 *Risk Management* as a generic guide for managing risk. Specific guidance on the implementation of the standard can also be found in the accompanying handbook HB 436:2004 *Risk Management Guidelines – Companion to AS/NZS 4360:2004*. A risk management system usually includes components such as hazard identification, analysis and treatment, with the step of 'monitor and review' closing the risk management 'loop'.

TransAdelaide's approach to SPAD mitigation was examined both in general and in the context of the incident on 28 March 2006. The following discussion relates to the information submitted to the ATSB after TransAdelaide's review of the draft safety investigation report (refer to section 2.9 for further discussion regarding the draft review process).

SPAD - Risk Identification

The aim of risk identification is to develop a comprehensive list of risk sources and events that might have an impact on an organisation. Putting this into context, it means not only recognising that SPADs are a safety risk but identifying the many ways that a SPAD can occur.

In March 2004, TransAdelaide commissioned consultants to facilitate a series of risk assessment workshops and to prepare a SPAD risk management plan. The workshop identified 48 potential causes of SPADs based on a process of brain-storming and the examination of historical data.

As previously discussed, the SPAD at signal 161 was typical of SPADs categorised as 'Starting Against Signal'. Typical causes of 'Starting Against Signal' SPADs are associated with train departure procedures such as the driver receiving conflicting signal indication and/or the departure signal being obstructed by station personnel or other people standing on the platform. Similarly, driver related issues such as distraction, fatigue or expectation can also contribute to 'Starting against Signal' SPADs. While some of these factors were addressed in the risk assessment workshops, it would appear that many factors do not appear when considered in the context of 'Starting Against Signal' SPADs. It is likely that this omission partly occurred due to the structure and accuracy of the historical data considered in the workshops.

For national consistency, the State and Territory Rail Safety Regulators have agreed on a set of definitions and categories[19] by which rail safety related incidents should be reported under their respective legislation. One of these categories is 'Starting Against Signal' SPADs which is recognised by rail organisations worldwide as contributing to a large proportion of total SPADs. However, at the time that the workshops were conducted and up to the time of the SPAD at signal 161, TransAdelaide did not categorise or analyse SPAD trends with reference to 'Starting Against Signal' SPADs. Consequently, 'Starting Against Signal' SPADs could not be analysed for trends nor identified for consideration in the risk assessment workshops.

It should also be noted that the accuracy and usefulness of historical data is very reliant on identifying the root cause of previous SPADs through thorough investigation. TransAdelaide's past approach to SPAD investigation, with its limited focus on the underlying causes of 'human errors', did not lend itself to an effective analysis of historical data.

SPAD - Risk Analysis and Evaluation

The aim of analysis and evaluation is to develop a complete understanding of the risk and determine if controls should be put in place to mitigate that risk. The SPAD risk assessment workshops examined the identified risks and graded them with consideration of severity, likelihood and their ability to be detected.

However, as mentioned above, factors associated with 'Starting Against Signal' SPADs had not been clearly identified and as a consequence could not be effectively analysed and evaluated. Similarly, the limited information available from previous SPAD investigations is unlikely to have permitted a clear understanding of the identified SPAD risks and their causal factors.

SPAD - Risk Treatment

Risk treatment aims to identify and implement controls to modify the risk such that its severity can be reduced or the likelihood that it could occur is reduced or eliminated completely. TransAdelaide's SPAD risk management plan documented 32 recommended actions to treat the 48 identified risks. These treatments incorporated both engineering and administrative controls, many of which have now been implemented or have progressed significantly.

Considering that the SPAD investigation process was incomplete and invariably identified human error as the sole cause, it was not surprising that the primary recommended actions to control these risks were related to training programs and rigorous application of performance management systems. TransAdelaide advised that since 2000, 85 per cent of SPADs resulted in some form of disciplinary action due to violation of rules or procedures. In conjunction with disciplinary action, 57 per cent of employees were provided with retraining.

TransAdelaide advised that only a small percentage of employees experienced a subsequent SPAD. However, since the SPAD investigation did not examine why the driver made an error, it is unlikely that any underlying causes could have been identified and appropriately managed. In this scenario, it is likely that the

---

19 Standard ON-S1 *Occurrence Categories and Definitions.*

underlying risk would remain such that a different employee could experience a similar SPAD some time in the future.

It should be emphasised that this observation only indicates that the process was considered incomplete and does not indicate that the outcome was incorrect in every case. TransAdelaide may be able to create a more error tolerant environment by considering other treatments that may reduce the SPAD risk even if a human error occurs.

SPAD - Risk Monitor and Review

Monitoring and review is an essential risk control element that is often neglected. This step closes the risk management loop by verifying the effectiveness of a risk treatment and re-assessing it if required to further reduce the potential risk. The risk management process should be ongoing since risks very rarely remain static. For example, it's not uncommon to see the number of recorded SPADs reduce following a concerted training and awareness campaign, only to see the number of incidents increase some time later. A pattern such as this could also indicate that an unidentified causal factor may exist that training could not fully address.

TransAdelaide has established a SPAD committee to monitor and review SPAD risks. While the meetings have not been as regular as originally intended, the concept is a positive step in the SPAD risk management process. An examination of the SPAD committee minutes indicated that significant emphasis had been placed on statistical analysis of historical data.

It was noted that the statistical analysis mostly considered performance type trends (the number of SPADs by year, month, day, time etc.) as opposed to causal type trends (distraction, sighting, braking issues etc.). Performance based analysis may provide an indication of an organisations overall SPAD performance or improvement, but is unlikely to be effective at identifying any key causes of SPADs for targeting further improvement opportunities. For example, an overall reduction in the number of SPADs may be evident following the installation of electromagnetic track brakes[20] (recognised as a positive initiative by TransAdelaide). However, the improvement may be due to improved train braking performance and unlikely to address any possible underlying cause such as late braking issues due to distraction or poor signal sighting.

The ATSB noted that a recommended action in the SPAD risk management plan was the establishment of a SPAD investigation group to investigate individual SPADs, compile data, conduct analysis, determine trends, make recommendations, report and oversee implementation. Based on the information provided by TransAdelaide, it is not evident that this recommendation has been implemented. It is possible that incorporating the intent of this recommendation into the work structure of the SPAD committee may provide TransAdelaide with the opportunity to further improve management of SPAD risk.

---

20 An electromagnetic track brake is a supplementary brake that applies a brake shoe directly onto the track thereby providing greater braking effort than could be achieved by the wheels alone.

2.5.1 Summary of SPAD Mitigation

Examination of TransAdelaide's SPAD mitigation process identified the following:

- In general, TransAdelaide has actively sought to reduce SPADs by implementing a detailed risk assessment process.
- TransAdelaide's SPAD risk management plan documented 32 recommended actions to treat the 48 identified risks. These treatments incorporated both engineering and administrative controls, many of which have now been implemented or have progressed significantly.
- While TransAdelaide's risk assessment process was considered a positive initiative and the process itself appeared sound, it is likely that the resultant risk management plan may have been limited due to the incomplete historical data used as one of the primary sources of information.
- Factors associated with 'Starting Against Signal' SPADs had not been clearly identified and as a consequence could not be effectively analysed and evaluated.
- TransAdelaide's approach to using performance based trend analysis may provide an indication of the organisation's overall SPAD performance or improvement, but is unlikely to be effective at identifying some of the key causes of SPADs for targeting further improvement opportunities.
- A recommended action in TransAdelaide's SPAD risk management plan was the establishment of a SPAD investigation group to investigate individual SPADs, compile data, conduct analysis, determine trends, make recommendations, report and oversee implementation. It is possible that incorporating the intent of this recommendation into the work structure of the SPAD committee may provide TransAdelaide with the opportunity to further improve management of SPAD risk.

It should be emphasised that these observations only indicate that the process was considered incomplete and does not indicate that the outcome was incorrect in every case. TransAdelaide may be able to create a more error tolerant environment by considering other treatments that may reduce the SPAD risk even if a human error occurs. It also illustrates why, if historical data is to be used for risk assessment, it is critical that previous SPADs are thoroughly investigated to achieve a clear understanding of the underlying causes.

2.6 Training

Most training of TransAdelaide personnel is conducted in-house. Some elements of training are common between disciplines (train drivers, platform coordinators, passenger service assistants and train control personnel) while other elements are tailored and unique to the specific job requirements. However, the basic philosophy of training for each discipline is relatively consistent.

Common elements usually involve safety related training such as 'safe-working' procedures on or around the railway track. Once candidates have achieved competencies in these elements, the training becomes more job specific. Qualified trainers conduct a combination of classroom and practical training followed by competency based assessments before operational training starts. Under operational training, candidates are observed and mentored by a combination of qualified

trainers and other experienced personnel until candidates have been assessed as competent to work unsupervised. Ongoing periodic reassessment is generally conducted by qualified trainers observing personnel in the work environment.

The investigation identified several areas where appropriate training may help to avoid a similar incident in the future or at least reduce its potential consequence.

Platform coordinator

TransAdelaide's training documentation clearly defines the procedure and execution of hand signals intended to provide a railcar driver with 'Right of Way' (RoW). TransAdelaide's qualified trainers advised that training and assessment was consistent with the documented procedures. However, there were a number of inconsistencies identified during the investigation in the execution of hand signals intended to provide a railcar driver with RoW. (Refer to Section 2.8 and Appendix A for further discussion.)

It was evident that undesirable work practices related to providing RoW had been permitted to evolve in the work place over time.

Driver and Train Control Personnel

Normally training courses are based on documented rules and procedures. TransAdelaide's training is consistent with this philosophy where candidates are instructed on the 'Do's and Don'ts' associated with common operational scenarios. The expectation is that responses to more unexpected or unusual operational conditions will be learned on-the-job, either through direct experience or through the observation of other worker's actions.

In this incident, the driver of train H307 was relatively inexperienced (about 18 months on main line). Consequently it is unlikely that he had ever been exposed, either directly or indirectly, to a sequence of events resulting in a train unintentionally travelling the wrong direction down a track. It is likely that this lack of experience, accompanied by the belief that signal 161 had been green, resulted in a delayed response once he became aware that the train was on the wrong track.

The next level of defence to prevent the extended travel of a train after passing a red signal, are the actions of the train control personnel. However, the area controller managing Adelaide Station and yard was also inexperienced as it was his first unsupervised day on the job after passing his competency assessments. Again, it is likely that inexperience contributed to the delay in recognising that train H307 had passed signal 161 while it was displaying a red indication.

Training improvement

While it is recognised that training in all operational scenarios cannot always be provided, it is crucial that training should provide general rules or strategies to be followed in the event of unusual operational conditions. TransAdelaide should consider how initial training and periodic re-training could decrease operational risk, particularly for unusual conditions. The assessment could also consider utilising internal auditing to identify and control undesirable work practices.

2.7 Communication

Both TransAdelaide and the ARTC use UHF radio for voice communication between train controllers and trains operating on their respective rail networks. The two radio systems have been allocated different frequencies and consequently it is not possible for trains operating on each system to communicate directly to users on the other network. The investigation determined that TransAdelaide's and ARTC's communication system operated correctly and did not contribute either directly or indirectly to train H307 passing signal 161 while displaying a red light. However, attempted communication between TransAdelaide train control and the driver of train 1PA8 highlighted a communication deficiency between the two railway operations.

When TransAdelaide train control identified that train H307 was travelling on the wrong track towards Torrens Junction, they also identified a risk of collision with train 1PA8 travelling on the ARTC network. The TransAdelaide controller's first response was to attempt to contact the drivers of train 1PA8 directly using a UHF radio tuned to the ARTC's 'South Control' frequency. However, trains approaching Torrens Junction on the ARTC network, such as 1PA8, are usually tuned to ARTC's 'Metro Control' channel. Consequently, the drivers of train 1PA8 did not receive TransAdelaide's radio call.

TransAdelaide's procedure for emergency communication, relating to trains on the ARTC network, is to contact ARTC controllers using a dedicated emergency channel on the South Australian Government Radio Network (SAGRN). This facility was not used when TransAdelaide Train Control attempted to stop train 1PA8. Fortunately, TransAdelaide's radio call to the drivers of 1PA8 was also heard by an ARTC train controller who relayed the instruction to stop on the correct radio frequency to train 1PA8.

The issue of communication between the ARTC and TransAdelaide has been the subject of discussion between the respective organisations for some time. Both rail networks share a common rail corridor to the north and south of Adelaide. Each rail network interfaces at Goodwood Junction (to the south) and Torrens Junction (to the north) where the ARTC line crosses the TransAdelaide line. Consequently, both organisations can be exposed to risk in the event of a rail safety accident or incident, either by way of intersecting tracks or by proximity to parallel tracks.

TransAdelaide is committed to adopting the SAGRN for its voice communication requirements. The ARTC uses UHF radios programmed with frequencies specific to the controlled areas. Unfortunately, the SAGRN radios do not use the same frequency band as the ARTC radios, making it impossible to include a common channel for communication.

To address the issue of communication in an emergency situation, a SAGRN radio console, programmed with a dedicated emergency channel, was installed at the ARTC train control centre. This emergency facility, through activation by either the ARTC or TransAdelaide, triggers an audible alert and allows normal voice conversation between respective train control staff. If necessary, either TransAdelaide or the ARTC operational channels may be 'patched' together to enable either user to monitor communications directly.

TransAdelaide also have a UHF radio, located in their train control centre, programmed with the ARTC's 'South Control' frequency only. This radio is an operational requirement due to the complexity of handling large freight trains down

steep descending grades south of Adelaide. It is desirable that TransAdelaide controllers have direct communication with a train approaching on the ARTC network to allow the effective planning of the interface between passenger services at Goodwood.

In this particular case, communication of the request to stop train 1PA8 was successful, albeit not through the intended communication channel. It is also unlikely that using the SAGRN emergency facility would have achieved the desired result any quicker in this case. However, it highlights that TransAdelaide's first response was not to use the system specifically designed for use in an emergency situation. In a different incident scenario, it is possible that failure to use the appropriate emergency communication facility may contribute to a delay in achieving the desired communication.

2.8 Interim recommendation

The interim recommendation issued on 13 April 2006 (shown on page 33) was based on early interviews and direct observations of operating procedures as used by platform coordinators at the Adelaide Railway Station. The investigation team continued to examine available evidence including TransAdelaide rules, operating procedures and other available information. The findings have served to reinforce the intent of the interim recommendation for the following reasons:

- A basic principle of railway operations is that a steady green lamp/light is intended to convey to a train driver that the track/line ahead is safe and clear for his/her train movement. To use a steady green lamp/light to indicate any other meaning exposes the system to risk.
- The ATSB considers that TransAdelaide's interpretation of rules when applied to the process of giving 'Right of Way' is inconsistent with the intent of the 'Common General Operating Rules' and should be reviewed.
- The ATSB also considers there is a real potential that a platform coordinator may obscure, or partially obscure, a main signal during the execution of their duties at Adelaide Station. This, coupled with giving a steady green signal to a railcar driver, presents a safety risk to TransAdelaide.

Appendix A 'Procedure for giving Right of Way (RoW)' provides detailed explanation of the ATSB's findings regarding TransAdelaide's procedures for giving RoW.

2.9 TransAdelaide Submission to Draft Report

ATSB safety investigations rely on the provision and accuracy of information provided by individuals and organisations. The *Transport Safety Investigation Act 2003* (TSI Act) allows the ATSB to provide a draft report to Directly Involved Parties for the purpose of providing comment and to submit further evidence that may not have been previously provided. It also allows an organisation to advise where safety actions have been taken in response to the incident investigated.

Following its review of the ATSB draft report, TransAdelaide expressed concerns regarding the findings, especially those related to SPAD management. TransAdelaide provided comment on the draft recommendations and accepted the

opportunity to submit significantly more information to the investigation to allow the ATSB to develop a clearer understanding of TransAdelaide's SPAD mitigation process. Previous sections of this report discuss TransAdelaide's SPAD investigation (Section 2.4) and SPAD mitigation (Section 2.5) processes based on the additional information provided by TransAdelaide.

Safety culture

In January 2006, TransAdelaide engaged a consultant to undertake a review of its safety performance and recommend actions to help achieve an improved safety culture. The review identified a number of barriers, explained the foundations for improvement and recommended initial steps for implementation of an effective safety culture program. TransAdelaide has set itself an objective aimed towards recognised industry best practice within five years.

Put in the context of SPAD mitigation, TransAdelaide's commitment towards a healthy organisation-wide safety culture is evident in its business plans. In 2004/05, TransAdelaide's business plan stated that SPADs would be '…addressed with consultation, retraining, counselling and disciplinary methods'. This statement tends to focus on human error and does not demonstrate a desirable safety culture in relation to SPAD management. However, TransAdelaide's focus on an improved safety culture is reflected in its 'Rail Systems Business Plan 2006/07' where the business initiative relating to SPADs refers to '…research and analysis of best practice SPADs management …'

The strategic actions documented in the 'Rail Systems Business Plan 2007/08' places further emphasis on an improved safety culture. The plan also highlighted TransAdelaide's commitment to a SPAD management system that encourages identification and treatment of SPAD causal factors by stating a strategic action as:

> Implement more rigorous investigation of all safety incidents including SPADs. Provide tools and training for rigorous cause analysis & problem solving. Outcomes to be shared.

In general, TransAdelaide appears to be committed to developing a healthy safety culture and an improved approach to SPAD investigation and mitigation.

3 FINDINGS

3.1 Context

At 0701 on 28 March 2006, TransAdelaide passenger train H307 passed signal 161 at Adelaide Railway Station while it was displaying a red stop aspect. Train H307 then travelled the wrong direction along the Up track for approximately two minutes before stopping approximately 600 m past signal 161.

From the evidence available, the following findings are made with respect to the SPAD at signal 161 and should not be read as apportioning blame or liability to any particular organisation or individual.

3.2 Contributing factors

- It is likely that a conversation with the Adelaide Station platform coordinator in the minutes before the train departed from the platform distracted the driver of train H307 from completing his normal train preparation procedure. Consequently, some minor tasks may have been completed shortly after starting the journey, providing a level of distraction at the critical time required to observe signal 161, resulting in train H307 passing signal 161 while it was displaying a red light. *[Safety Issue]*
- At the time when the platform coordinator provided Right of Way, signal 161 was displaying a red light. The steady green light directed at the driver by the platform coordinator was a 'cue' which was in direct conflict with the red light displayed by signal 161. It is possible that the driver responded to the cue to proceed represented by the green signal from the platform coordinator and had failed to check that there was a similar indication showing on signal 161. *[Safety Issue]*
- It is likely that the driver of train H307 believed that he had departed from Adelaide station under the correct signal indication and had been deliberately routed onto the Outer Harbor 'Up' track. The driver's limited experience is unlikely to have provided him with much exposure to unusual operating situations. Consequently, his level of uncertainty and the absence of any information from the train controller to the contrary, probably contributed to his delayed decision to take the appropriate action, which was to stop and seek verification of the train's route. *[Safety Issue]*
- It is likely that reduced levels of illumination due to early stages of civil twilight contributed to the driver's inability to recognise that points AD54 had been incorrectly set for the train path.
- At the time of the incident, TransAdelaide's train control system did not provide a clear SPAD alarm. It is likely that the inexperienced area controller, a period of high workload in the train control centre and the absence of a clear SPAD alarm contributed to a delay in train control personnel identifying that a SPAD had occurred. *[Safety Issue]*

3.3 Other Safety Factors

- There were inconsistencies observed in the execution of hand signals intended to provide 'Right of Way' to the train driver by the platform coordinators. In many cases, the hand signal applied was not consistent with the 'All clear or proceed' hand signal advised as applicable at the time of the incident. *[Safety Issue]*
- TransAdelaide's first response for emergency communication was an attempt to contact the drivers of train 1PA8 directly using a UHF radio programmed with the ARTC's 'South Control' frequency. This action is not consistent with TransAdelaide's procedure for emergency communication relating to trains on the ARTC network. While unlikely to have increased the safety risk in this case, it is possible that failure to use the appropriate emergency communication facility in a different scenario may contribute to a delay in achieving the desired communication. *[Safety Issue]*
- TransAdelaide's SPAD investigation process was unlikely to have provided a clear understanding of factors that may have contributed to past SPADs or a sound basis for identification of safety actions to prevent similar occurrences. A recommended action in TransAdelaide's SPAD risk management plan was the establishment of a SPAD investigation group to investigate individual SPADs, compile data, conduct analysis, determine trends, make recommendations, report and oversee implementation. It was not evident that this recommendation had been fully implemented at the time of the incident. *[Safety Issue]*
- TransAdelaide did not categorise or analyse SPAD trends with reference to 'Starting Against Signal' SPADs. Consequently, 'Starting Against Signal' SPADs were not identified for consideration in risk assessment workshops. *[Safety Issue]*
- It is possible that departure procedures at Adelaide station could increase the risk of 'Starting Against Signal' SPADS due to expectation error. Platform coordinators give RoW at the scheduled departure time regardless of any delay to clearing the departure signal. Under these conditions, it is possible that drivers would move off and slowly approach the signal with an expectation that it would clear as they approached, increasing the risk of an error if the signal remained red. *[Safety Issue]*
- It is possible that excessive radio communication due to non-safety related procedures could introduce a source of distraction to the train controller, particularly during periods of high workload such as times of high density traffic (peak periods). *[Safety Issue]*

3.4 Other key findings

- Signal 161 was displaying a red light and no command had been issued from train control to clear it prior to the departure of train H307 from the platform.
- Against a darkened background and assuming no physical obstruction, signal 161 should have been clearly visible to the driver of train H307.
- Train H307 passed signal 161 while it was displaying a red light.
- TransAdelaide Train Control cleared signal AN22, placing train 1PA8 in conflict with the path of train H307.
- TransAdelaide Train Control did not actively respond to the SPAD for almost two minutes after train H307 passed signal 161.

4 SAFETY ACTION

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

All of the responsible organisations for the safety issues identified during this investigation were given 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.

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.

TransAdelaide

Interim Recommendation (RIR20060009)

During the course of an ATSB investigation, an interim safety recommendation is issued if a critical ongoing safety risk is considered to exist to an organisation. The ATSB issued an interim recommendation on 13 April 2006 regarding train departure procedures at Adelaide Railway Station.

Safety Issue

There were inconsistencies in the procedures for the provision of 'Right of Way' to the train driver by the platform coordinator. At the time when the platform coordinator provided RoW, signal 161 was displaying a red light. The steady green light directed at the driver by the platform coordinator was a 'cue' which was in direct conflict with the red light displayed by the signal 161. It is possible that the driver responded to the cue to proceed represented by the green signal from the platform coordinator and had failed to check that there was a similar indication showing on signal 161.

ATSB Interim Safety Recommendation RIR20060009

The ATSB recommends that TransAdelaide:

- Review the departure procedures for Adelaide Station to ensure that platform coordinators provide railcar drivers with clear, unambiguous 'Starting' signals, consistent with TransAdelaide's *Common General Operating Rules*.
- Ensure that hand signals do not obscure a driver's view of line side signals.

Response from TransAdelaide

TransAdelaide agreed to this recommendation and has undertaken review of its departure procedures at Adelaide Railway Station. TransAdelaide also intends to trial flashing light wands to supplement the hand signals given by the platform coordinators.

Driver distraction when departing Adelaide Station

Safety Issue

It is likely that a conversation with the Adelaide Station platform coordinator in the minutes before the train departed from the platform distracted the driver of train H307 from completing his normal train preparation procedure. Consequently, some minor tasks may have been completed shortly after starting the journey, providing a level of distraction at the critical time required to observe signal 161, resulting in train H307 passing signal 161 while it was displaying a red light.

Response by TransAdelaide

TransAdelaide agreed with this safety issue. TransAdelaide advised that it will put in place an audit process for station departure procedures in Adelaide Station and will undertake further education in relation to the risk associated with potential sources of distraction.

Driver experience with unusual operating conditions

Safety Issue

It is likely that the driver of train H307 believed that he had departed from Adelaide station under the correct signal indication and had been deliberately routed onto the Outer Harbor 'Up' track. The driver's limited experience is unlikely to have provided him with much exposure to unusual operating situations. The driver's level of uncertainty, his belief that he had been deliberately routed on this path and the absence of any information from the train controller to the contrary probably contributed to his delayed decision to stop and seek verification of the train's route.

Response by TransAdelaide

TransAdelaide agreed with this safety issue. TransAdelaide advised that a review will be undertaken of training and assessment material to ensure that actions required in unusual circumstances are clearly expressed.

SPAD alarms

Safety Issue

At the time of the incident, TransAdelaide's train control system did not provide a clear SPAD alarm. It is likely that the inexperienced area controller, a period of high workload in the train control centre and the absence of a clear SPAD alarm

contributed to a delay in train control personnel identifying that a SPAD had occurred.

Safety actions already taken

TransAdelaide commissioned a new CTC system not long after the SPAD at signal 161. The new system incorporates two levels of alarm, both of which provide clearly audible and visual notifications to train control personnel. SPADs at controlled signals are classed as 'Critical Alarms' and SPADs at automatic signals are classed as 'Non-critical Alarms'. It would be unlikely that a SPAD, such as H307 passing signal 161, would go unnoticed by train controllers using the new CTC system.

Work practice inconsistencies

Safety Issue

There were inconsistencies observed in the execution of hand signals intended to provide 'Right of Way' to the train driver by the platform coordinators. In many cases, the hand signal applied was not consistent with the 'All clear or proceed' hand signal advised as applicable at the time of the incident.

Response by TransAdelaide

TransAdelaide agreed with this safety issue. TransAdelaide advised that it was reviewing the effectiveness of their internal audit program and would increase internal auditing of safety critical functions.

Communication with the ARTC controllers

Safety Issue

TransAdelaide's first response for emergency communication was an attempt to contact the drivers of train 1PA8 directly using a UHF radio programmed with the ARTC's 'South Control' frequency. This action is not consistent with TransAdelaide's procedure for emergency communication relating to trains on the ARTC network. While unlikely to have increased the safety risk in this case, it is possible that failure to use the appropriate emergency communication facility in a different scenario may contribute to a delay in achieving the desired communication.

Response by TransAdelaide

TransAdelaide acknowledged that a review of the emergency communication procedures between their train control and the ARTC train control would be conducted.

SPAD investigation process

Safety Issue

TransAdelaide's SPAD investigation process was unlikely to have provided a clear understanding of factors that may have contributed to past SPADs or a sound basis for identification of safety actions to prevent similar occurrences. A recommended action in TransAdelaide's SPAD risk management plan was the establishment of a SPAD investigation group to investigate individual SPADs, compile data, conduct analysis, determine trends, make recommendations, report and oversee implementation. It was not evident that this recommendation had been fully implemented at the time of the incident.

Response by TransAdelaide

TransAdelaide acknowledged that there was room to improve its investigation of SPAD incidents.

ATSB assessment of response/action

The ATSB acknowledges TransAdelaide's recognition of the safety issue and notes that more rigorous investigation of SPADs has been included in the 'Rail Systems Business Plan 2007/08'. However, at the time of publishing this report, it was not clear as to how far this process may have progressed.

ATSB safety recommendation RR20070032

The Australian Transport Safety Bureau recommends that TransAdelaide undertake further work to address this safety issue.

'Starting Against Signal' SPADs

Safety Issue

TransAdelaide did not categorise or analyse SPAD trends with reference to 'Starting Against Signal' SPADs. Consequently, 'Starting Against Signal' SPADs were not identified for consideration in risk assessment workshops.

Response by TransAdelaide

TransAdelaide agreed with this safety issue. TransAdelaide advised that its database had been revised so that its categories are consistent with the reporting requirements of the State Rail Safety Regulator. TransAdelaide also agreed to analyse SPAD trends with reference to 'Starting Against Signal' SPADs and common contributing factors.

Expectation error

Safety Issue

It is possible that departure procedures at Adelaide station could increase the risk of 'Starting Against Signal' SPADs due to expectation error. Platform coordinators give RoW at the scheduled departure time regardless of any delay to clearing the departure signal. Under these conditions, it is possible that drivers would move off and slowly approach the signal with an expectation that it would clear as they approached increasing the risk of an error if the signal remained red.

Response by TransAdelaide

TransAdelaide acknowledged that signal anticipation is a potential cause of SPADs and have included the risk in their risk management plan. TransAdelaide has also initiated SPAD awareness programmes to educate drivers on the risks associated with signal anticipation.

ATSB assessment of response/action

The ATSB acknowledges TransAdelaide's pro-active approach to SPAD mitigation associated with signal anticipation. However, since TransAdelaide's investigation process was unlikely to have provided a clear understanding of factors that may have contributed to past SPADs, it is unlikely that the factors contributing to signal anticipation could have been identified for all scenarios.

This issue is reflected in TransAdelaide's risk management plan in which the recommended actions to control signal anticipation risk is related to training programs and rigorous application of performance management systems (treatments addressing human error factors). If TransAdelaide considers why drivers anticipate a signal clearing, further opportunities may be identified to control the risk.

As mentioned previously, this observation only indicates that the process was considered incomplete and does not indicate that the outcome was incorrect in every case. TransAdelaide may identify further opportunities to improve railway safety if it considers this safety issue further.

ATSB safety recommendation RR20070033

The Australian Transport Safety Bureau recommends that TransAdelaide undertake further work to address this safety issue.

Excessive radio communication

Safety Issue

It is possible that excessive radio communication due to non-safety related procedures could introduce a source of distraction to the train controller, particularly during periods of high workload such as times of high density traffic (peak periods).

Response by TransAdelaide

TransAdelaide agreed with this safety issue. TransAdelaide advised that it continually reviews non-safety related processes so as to minimise the use of radio communication for these purposes. In addition, TransAdelaide's new CTC system incorporates clear audible and visual notifications that are likely to attract a controller's attention in the event of any alarm conditions.

APPENDIX A : PROCEDURE FOR GIVING RIGHT OF WAY

When departing Adelaide station, the driver is given a 'Right of Way' (RoW) hand signal, indicating that passengers are either onboard or clear of the train at the scheduled time of departure. The RoW hand signal is provided by either a platform coordinator (PC) or a passenger service assistant (PSA) depending on the train configuration. These actions are documented in TransAdelaide's operating rules.

TransAdelaide's operating rules are detailed in two documents:

- *Common General Operating Rules*
- *General Instruction and Addenda to the Working Timetable.*

Examination of TransAdelaide's rules accompanied with observation and discussion with TransAdelaide personnel identified a number of inconsistencies relating interpretation and/or application of these rules.

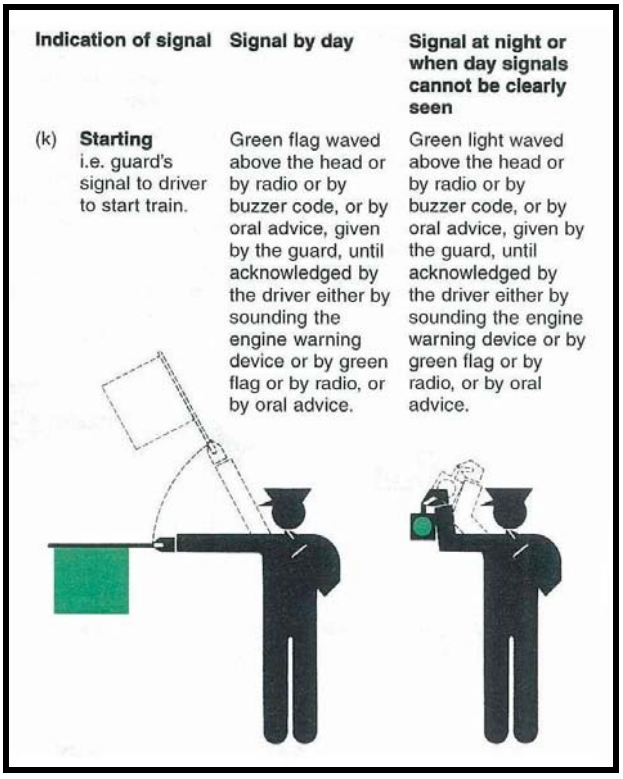
Common General Operating Rules

Neither the PC nor the PSA are defined terms in the *Common General Operating Rules*. Only the functional role of the PSA, effectively that of a Guard, is covered in the *Common General Operating Rules*. Rule 154(a) states:

> The signal for starting a train must be given by the guard (where provided) in accordance with General Rule 43(k). If necessary, the guard must blow his whistle to attract the attention of the driver.

Rule 43(k) defines the 'Starting' signal and is illustrated in Figure 7.

Figure 7: Rule 43(k) – 'Starting' hand signal



The functional role of the PC is effectively that of a station supervisor. However, a PC is only relevant when the train is a Driver Only Operated (DOO) train. The *Common General Operating Rules* does not address the requirements for DOO trains. These requirements are defined in the *General Instruction and Addenda to the Working Timetable*.

General Instruction and Addenda to the Working Timetable

The addenda are supplementary instructions to the *Common General Operating Rules*, developed by TransAdelaide to document processes not clearly addressed in the operating rules. TransAdelaide initially provided a document dated February 1999. However, upon examination it was found to have highlighted sections and comments inserted for amendment consideration. Upon further investigation it was found that this document was a draft version being circulated within TransAdelaide for comment. The latest approved version was the *General Instruction and Addenda to the Working Timetable* dated 9 June 1991. Both versions of the addenda were examined in relation to giving RoW to a train driver departing Adelaide station.

Hand Signals by a PSA

One of the functions performed by a PSA who is travelling on a TransAdelaide train is to provide RoW on departure from Adelaide Railway Station. This function is equivalent to the role of the Guard referenced in the addenda dated 9 June 1991. The hand signal specified in this document is the 'Starting' signal (Figure 7 on page 40).

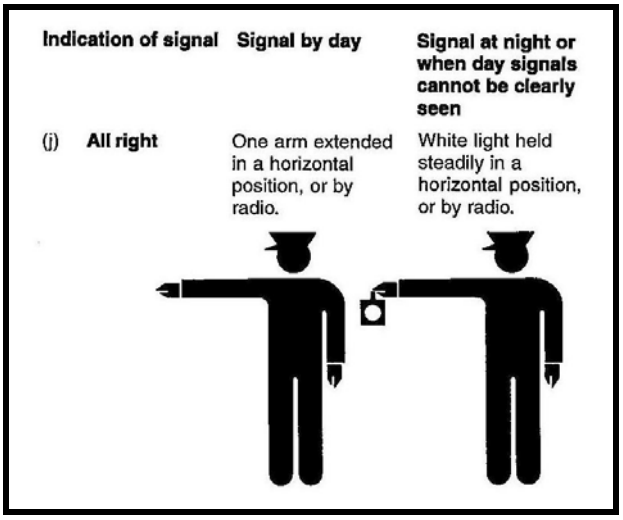
In the draft addenda dated February 1999, the function of the PSA is defined as that of a Qualified Worker on a non-driver only operated movement. Again, the hand signal specified is the Starting signal.

The process for a PSA to provide RoW, as documented in both versions of the *General Instruction and Addenda to the Working Timetable* is consistent with rule 154(a) defined in the *Common General Operating Rules*.

Hand Signals by a PC

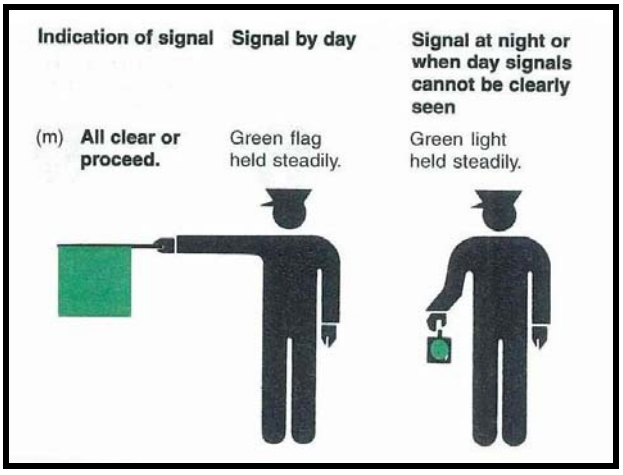
One function of a PC is to provide RoW to DOO trains departing from Adelaide Railway Station. This function is equivalent to the role of the Station Supervisor referenced in the addenda dated 9 June 1991. The hand signal specified in this document is the 'All Right' signal as defined in rule 43(j) (illustrated in Figure 8). This differs when referring to the draft addenda dated February 1999. Here the function of the PC is defined as that of a Qualified Worker on a DOO movement. The hand signal specified is the Starting signal (Figure 7 on page 40).

Figure 8: Rule 43(j) – 'All Right' hand signal



However, TransAdelaide advised that the current practice for the PC was to give the 'All clear or proceed' signal as defined in rule 43(m), to provide RoW to the driver. Rule 43(m) is illustrated in Figure 9 on page 42. This practice differs from the functions defined in both versions of TransAdelaide's *General Instruction and Addenda to the Working Timetable*. Only in the draft addenda dated February 1999, under the section documenting the roles of a Suburban Train Driver when operating a driver-only train, is there reference to a Qualified Worker giving "…the 'ALL CLEAR' signal…". (Noting that subsequent paragraphs continue to make inconsistent reference to the 'Start' signal.)

Figure 9: Rule 43(m) – 'All clear or proceed' hand signal



Train Notice No. 104A

Many months after the investigation started, a copy of TransAdelaide's *Train Notice No. 104A of 14 April 1993 (Standing)* was provided. This document authorises and details alterations to the *General Instruction and Addenda to the Working Timetable* dated 1991. Only in this document were the departure procedures consistent with statements made by TransAdelaide staff.

The train notice states that when departing Adelaide station, a qualified employee must give "*…the 'ALL CLEAR' signal…*" as defined in rule 43(m). The notice also clearly states that it is the driver's responsibility to check the line ahead and ensure that the correct signal indication is displayed.

On-site Observations

While examining the actual work practices of the PC, the investigation team observed inconsistencies in the execution of hand signals intended to provide the driver with RoW. In some cases RoW was provided using the 'All clear or proceed' signal (Figure 9). However, in many cases the investigation team observed the PC giving RoW using a steady green flag or light held in front of the body which is not a valid hand signal as defined in the operating rules. In other cases, RoW was observed using an outreached arm with no flag or light which is the 'All right' signal (Figure 8 on page 41).

Analysis of Operating Rules

Considering the variation in hand signals, both defined in rules and executed in practice, closer examination was conducted to clarify the intent or philosophy behind the operating rules.

It is an acknowledged principle of railway operations that a steady green lamp/light indicates to a train driver that the track/line ahead is safe and clear for his/her train movement. To use a steady green lamp/light to indicate any other meaning exposes the system to risk. The original Rule Book of the South Australian Railways (1947) recognises this risk as there is no valid hand signal defined that displays a steady green lamp/light. The *Common General Operating Rules* were derived from the original rule book; however, a hand signal in the form of a steady green lamp/light was included, most likely to reflect the operations of the Commonwealth Railways[21]. This hand signal was defined as 'All clear or proceed', illustrated in Figure 9 on page 42.

To understand the intent of the 'All clear or proceed' hand signal, the rules were examined to identify where this hand signal is referenced. The TransAdelaide operating rules refer to the 'All clear or proceed' signal in rule 161(b) which states:

> Goods trains and mixed trains must stop at places specified in the Working Time Tables, unless a hand signal in accordance with General Rule 43(m) is received from the signalman indicating that so far as he is concerned the train is not required to stop. If the hand signal is also received by the driver from the guard, the train may run through without stopping.

It is evident that a driver may only proceed if this hand signal is received by both the guard and the signalman, thereby ensuring that the track/line ahead is safe and clear, and the basic principle of railway operation preserved.

The *Australian Code of Practice* (ACOP) is not relevant to TransAdelaide rail operations; however, the ACOP also includes a hand signal in the form of a steady

21 The Commonwealth Railways operated in the northern part of South Australia where many areas had limited safety interlocking systems in place. It is likely that part of the guard's responsibility was to check the lie of points ahead before giving an 'All clear or proceed' signal to the driver.

green lamp/light. The ACOP rule was examined to establish if the intent of a hand signal in the form of a steady green lamp/light was consistent between railway operating rules. The steady green hand signal in the ACOP is used to '… admit or to dispatch trains from yards where there are no fixed signals for the purpose …'. Again, the basic principle of railway operation is preserved since the rule also states that the '… command shall not be given until the facing points for the intended movement have been examined and confirmed as correctly set and locked.'

Both TransAdelaide's operating rules and the ACOP only permit the issue of a hand signal such as 'All clear or proceed' if the track ahead has been verified as safe and clear. It is not the role of the PC or PSA to confirm that the track ahead is safe and clear, only that passengers are either onboard and/or clear of the train. Consequently, these rules alone would not permit either the PC or PSA to use a steady green 'All clear or proceed' hand signal to give RoW from a station platform.

However, it would appear that a shift in basic philosophy or interpretation of the *Common General Operating Rules* has occurred with the issue of *Train Notice No. 104A*. The train notice specifies the use of the 'All clear or proceed' hand signal, but places the responsibility on the driver to check the line ahead and ensure that the correct signal indication is displayed.

These requirements have carried over to TransAdelaide's draft version of the *General Instruction and Addenda to the Working Timetable*. However, the draft addenda February 1999 is inconsistent by making reference to both the 'Starting' signal (Figure 7 on page 40) and the 'All clear or proceed' signal (Figure 9 on page 42) when RoW is provided by the PC. When RoW is provided by the PSA, the 'Starting' signal (Figure 7) is specified as the required hand signal to give RoW to a driver.

Comparison with other railway operators

Procedures for giving RoW to passenger trains operating on other metropolitan rail networks were examined. In both New South Wales and Victoria, station personnel use a white flag or light to give RoW[22] to on-board personnel (driver or guard). In addition, station personnel are required to check fixed signals before giving RoW.

Using a white flag or light reduces the risk of driver confusion due to possible conflicting green against red information. As additional protection against error, checking the signal before giving RoW helps reduce the risk of 'Starting against Signal' SPADs.

Summary of procedure for giving Right of Way

TransAdelaide's approved documentation requires a PC to give RoW using the 'All clear or proceed' hand signal. TransAdelaide's draft documentation is inconsistent by making reference to both the 'Starting' signal and the 'All clear or proceed' when RoW is provided by the PC. In both documents, the steady green 'All clear or

22 The equivalent procedure in NSW is the 'Right Away procedure for Station Staff' and uses the 'Clear for right away' hand signal. The equivalent procedure in Victoria is the 'Right Time Departure of Trains' procedure and uses the 'All Right' hand signal.

proceed' hand signal is not intended to convey to a train driver that the line ahead is clear and that the correct signal indication is displayed. The documents place this responsibility onto the train driver.

A basic principle of railway operations is that a steady green lamp/light is intended to convey to a train driver that the track/line ahead is safe and clear for his/her train movement. Adopting TransAdelaide's steady green 'All clear or proceed' hand signal does not convey this message, exposing the system to risk.

TransAdelaide's 'Starting' hand signal also uses a green indication, all be it a moving signal. While the moving signal may reduce the risk of confusion, the green flag or light still exposes the procedure to conflicting indications under some operational conditions (ie. a red fixed signal). TransAdelaide's 'All Right' hand signal is more closely aligned with RoW practices in other States and is likely to reduce the risk of conflicting indications given to TransAdelaide train drivers departing Adelaide station. A requirement for the PC to also check the signal before giving RoW may also reduce the risk of 'Starting against Signal' SPADs.

When examining the actual work practices of the PC, the investigation team observed inconsistencies in the execution of hand signals intended to provide the driver with RoW. The inconsistencies, both in practice and documented, relating to the procedure for giving RoW at Adelaide station were identified early in the investigation. Consequently, an interim recommendation (refer to section 2.8) was released on 13 April 2006 to advise TransAdelaide of its exposure to a potential safety risk.

APPENDIX B : SOURCES AND SUBMISSIONS

Sources of information

Great Southern Railway Ltd

Pacific National Pty Ltd

TransAdelaide

References

Australian Code of Practice for the Defined Interstate Rail Network

Australian Standard AS/NZS 4360:2004 *Risk Management*

Australian Standard HB 436:2004 *Risk Management Guidelines – Companion to AS/NZS 4360:2004*

Australian Standard AS4292.7-2006 *Railway Safety Management Part 7: Railway safety investigation*

National Transportation Safety Board (1998). Safety at passive grade crossing. Volume 1: Analysis. Safety study NTSB/SS-98/02. Washington DC

National Transport Commission (NTC) *National Standard for Health Assessment of Rail Safety Workers, June 2004*.

State and Territory Rail Safety Regulators Panel *ON-S1, Occurrence Notification – Standard 1: Notification Standard, Occurrence Categories & Definitions*

TransAdelaide (2000), *Common General Operating Rules*

TransAdelaide (1991), *General Instruction and Addenda to the Working Timetable*

TransAdelaide (Draft, 1999), *General Instruction and Addenda to the Working Timetable*

TransAdelaide (1993), *Train Notice No. 104A of 14 April 1993 (Standing)*

Young, K., Regan, M., & Hammer, M. (2003). *Driver distraction: A review of the literature*. Monash University Accident Research Centre. Report No. 206

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the Executive Director may provide a draft report, on a confidential basis, to any person whom the Executive Director considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the Executive Director about the draft report.

A draft of this report was provided to:

- TransAdelaide
- Pacific National
- Australian Rail Track Corporation
- South Australian Railway Safety Regulator, and
- a small number of individuals.

Submissions were received from:

- TransAdelaide
- Australian Rail Track Corporation

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

APPENDIX C : MEDIA RELEASE

Investigation of TransAdelaide signal passed at danger incident

The ATSB has found that a TransAdelaide passenger train passed a red stop signal last year, which placed it on a collision course with an interstate passenger train because of a combination of human error and sub-optimal procedures.

The Australian Transport Safety Bureau has today released its final report into the investigation of the factors that contributed to TransAdelaide passenger train H307 passing signal 161, at the end of a platform at Adelaide Railway Station, while it was displaying a red stop aspect, (an event commonly referred to as 'Signal Passed at Danger' or SPAD), on 28 March 2006.

The initial SPAD at signal 161 was typical of SPADs categorised as 'Starting Against Signal'. This type of SPAD typically occurs at railway stations where signals are positioned at the departure end of station platforms and the stationary train starts to move away from the platform before the signal displays a proceed indication. In this case, it placed train H307 on a collision course with the *Indian Pacific* which was on a crossing line 1.6 km from Adelaide station.

The investigation found that a conversation with station staff probably distracted the train driver's departure preparation. When scheduled to depart, a steady green light used by station staff to signal 'Right of Way' was a 'cue' which was in direct conflict with the red light displayed by signal 161. The investigation concluded that it was possible that the driver responded to the cue to proceed represented by the green Right of Way light and completed some minor tasks shortly after starting the journey but did not check the indication displayed by signal 161.

At the time of the incident, TransAdelaide's train control system did not provide a clear SPAD alarm. It is likely that an inexperienced controller, a period of high workload and the absence of a clear SPAD alarm contributed to a delay in train control personnel identifying that a SPAD had occurred.

The driver of train H307 believed that he had departed from the platform at Adelaide station under the correct signal indication and had been deliberately routed onto another track. The train had continued for two minutes and 610 m before the driver stopped the train. The driver's limited experience, his level of uncertainty regarding the unusual route and the absence of any information from the train controller to the contrary probably contributed to a delayed decision to stop and seek verification of the train's route.

The investigation noted that a new train control system was commissioned not long after the occurrence. The new system has audible and visual alarms to ensure that a similar SPAD should very quickly be recognised by train controllers. The investigation concluded that there were further opportunities for improvement. The ATSB recommended that TransAdelaide undertake further work to address safety issues relating to the SPAD investigation process and develop a clear understanding of SPAD causal factors such as potential underlying contributors to signal anticipation.

Signal 161 Passed at Danger, TransAdelaide Passenger Train H307,
Adelaide, South Australia, 28 March 2006