Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Rail Occurrence Investigation
RO-2011-002
Final

Collision between suburban passenger trains G231 and 215A in Adelaide Yard, South Australia

24 February 2011

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Abstract

At 1209 on 24 February 2011 a suburban commuter train (215A) with 17 passengers on board was being routed from the Up South Main Line into platform 5 at the Adelaide Station. At about the same time a second commuter train (G231) with 22 passengers on board that was departing the Adelaide Station passed signal 141 located at the end of platform 3 at low speed. Shortly thereafter both drivers realised that their trains would come into conflict and applied their train brakes but it was too late to avoid a collision. There were no injuries as a result of the collision; however, both trains sustained minor damage.

The ATSB established that the driver of train G231 received a 'yellow' Right of Way flag from the Platform Coordinator, indicating that platform work was complete and that the train could advance up to signal 141 which was displaying a stop (red) indication.

It was concluded that as the train approached signal 141 the driver diverted his attention onto a lesser task of checking train notices and did not concentrate on the more important task of observing the status of signal 141. Subsequently he perceived that signal 141 had changed to a 'proceed' aspect, although the investigation subsequently established that it did not clear at any stage prior the SPAD event and continuously displayed a stop (red) indication for the passage of train G231.

In the interests of enhancing future rail safety the ATSB identified a number of safety issues which included the dispatching of trains towards starting signals, the level of protection afforded by the train's dead man's control and Automatic Warning System and a range of opportunities to reduce the risk of human performance error. The ATSB is satisfied that the actions proposed in response by Public Transport Services adequately address each of the safety issues.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

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

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

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

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

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

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

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, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, 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 in the interests of improved transport safety.

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.

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

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

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

EXECUTIVE SUMMARY

At 1209[1] on 24 February 2011 a suburban commuter train (215A) with 17 passengers on board was being routed from the Up South Main Line into platform 5 at the Adelaide Station. At about the same time a second commuter train (G231) with 22 passengers on board was departing the Adelaide Station and passed signal 141 located at the end of platform 3 at low speed. Shortly thereafter both drivers realised that their trains would come into conflict and applied their train brakes but it was too late to avoid a collision. There were no injuries as a result of the collision; however, both trains sustained minor damage.

While the collision was not on the Defined Interstate Rail Network (DIRN) the South Australian 'Office of the Rail Safety Regulator' considered the event to be significant and requiring independent scrutiny and requested that the Australian Transport Safety Bureau (ATSB) investigate and identify factors that may have contributed to collision.

The ATSB established that the driver of train G231 received a 'yellow' Right of Way flag from the Platform Coordinator, indicating that platform work was complete and that the train could advance up to signal 141 which was displaying a stop (red) indication.

The ATSB concluded that as the train approached signal 141 the driver diverted his attention onto a lesser task of checking train notices and did not concentrate on the more important task of observing the status of signal 141. Subsequently he perceived that signal 141 had changed to a 'proceed' aspect although the investigation subsequently established that the signal did not clear at any stage prior the SPAD event and continuously displayed a stop (red) indication for the passage of train G231.

In the interest of enhancing future rail safety the ATSB has identified a number of safety issues which include the dispatching of trains towards starting signals, the level of protection afforded by the dead man's control and Automatic Warning System and a range of opportunities to reduce the risk of human performance error. The ATSB is satisfied that the actions proposed in response by Public Transport Services adequately address each of the safety issues.

The ATSB has noted that the South Australian State Government has recently announced that an 'automated train protection system' will be provided across the metropolitan rail network to protect against driver error as part of its 'Rail Revitalisation Project'.

1 FACTUAL INFORMATION

1.1 Overview

At 1209[1] on 24 February 2011 a suburban commuter train (215A) with 17 passengers on board was being routed from the Up South Main Line (Figure 4) into number 5 platform at the Adelaide Station. At about the same time a second commuter train (G231) with 22 passengers on board was departing number 3 platform. Shortly thereafter both drivers realised that their trains would come into conflict and applied their train brakes but it was too late to avoid a collision.

There were no injuries as a result of the collision; however, both trains sustained minor damage.

1.2 Location

The Adelaide metropolitan passenger railway system is operated by 'Public Transport Services' (PTS), the trading name for the Office of the Rail Commissioner, which is the legal entity that operates and maintains Adelaide's suburban train system.

Figure 1: Adelaide Railway Station and Convention Centre

[1] The 24-hour clock is used in this report. Australian Central Daylight-saving Time (CDT), UTC + 10.5 hours. Unless shown otherwise, all times are CDT.

The Office of the Rail Commissioner took responsibility for Adelaide's passenger railway system on 1 September 2010 when it was announced that TransAdelaide[2] (the existing operator) would be abolished and its staff and functions transferred to the Office of the Rail Commissioner.

The Adelaide Railway Station (Figure 1) is the central terminus for Adelaide's suburban passenger train network. The station is located on the north side of North Terrace and to the east of the Morphett Street road bridge. It is a 'dead end' station with nine platforms all of which are located beneath the Adelaide Convention Centre.

The collision occurred on the southern side of the railway yard, just west of the Adelaide Station, beneath the Morphett Street Bridge.

1.3 Train information

Train 215A

Train 215A was a regular passenger service that comprised a single 3000 class diesel/electric multiple unit (DMU 3027). The train was 26 m in length and weighed 46 t.

The driver of train 215A had over 20 years' industry experience of which 12 years included main line driving duties on the Adelaide passenger rail network. He was qualified as a 'Class 5' driver and therefore allowed to drive unsupervised on the Adelaide passenger network. He had not been involved in any previous operational safety related incident or SPAD[3] event.

An examination of PTS records established that the driver was qualified in all necessary safe working procedures, medically in date and fit as prescribed by the *National Standard for Health Assessment of Rail Safety Workers*.

Train G231

Train G231 was a regular passenger service that consisted of two 3100 class diesel/electric multiple units (DMU 3133 leading and 3134 trailing). The train was 52 m in length and weighed 92 t.

The driver of train G231 had about 2 years experience in the rail industry having commenced employment with TransAdelaide in July 2009. After completing pre-requisite training he became a 'Class 3' driver and was allowed to perform shunting duties at the Adelaide Railcar Depot. He commenced main line driver training (under supervision) in March 2010. By late May 2010 he had qualified as a 'Class 5' driver and therefore was allowed to drive unsupervised on Adelaide's passenger main line network. He had been driving for about 8 months, as a 'Class 5' driver, when the incident occurred. He had not been involved in any previous operational safety related incident or SPAD event.

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[2] Within this report, the operator PTS is used where events occurred after 6 September 2010 and the operator TransAdelaide is used where events occurred prior to 1 September 2010.

[3] SPAD - Acronym for 'Signal Past at Danger', the unauthorised passing of a signal displaying a stop indication.

An examination of PTS records established that the driver was qualified in all necessary safe working procedures, medically in date and fit as prescribed by the *National Standard for Health Assessment of Rail Safety Workers*.

1.4 Train control and Adelaide station personnel

All trains are signalled into and out of the Adelaide railway station using colour light signals that are controlled by a computerised safety system and remotely operated from the Adelaide Operations Control Centre (OCC).

The OCC is structured with two levels of direct management to achieve safe rail operations. Train controllers are responsible for the authorisation and control of movements throughout the metropolitan rail network while area controllers are responsible for signal control and monitoring of train movements under the direction of the train controllers. At the time of the incident there were three train controllers on duty (north, south and relief) and two area controllers who were dedicated to the Adelaide and Metro boards/area of control respectively. Voice communication between train drivers and train controllers was over the South Australian Government Radio Network[4] (SAGRN).

The three train controllers on duty at the time of the collision were qualified and all very experienced; the area controllers were qualified but with about 12 months experience.

Platform coordinator

When trains depart the Adelaide Railway Station the driver is given a Right of Way[5] (RoW) hand signal by a platform coordinator (PC) or a passenger service assistant (PSA), depending on train size and configuration[6]. The PC who provided the RoW signal to the driver of train G231 had over 30 years experience in the rail industry of which 25 years included the duties of station supervisor and platform coordinator at the Adelaide Station. At the time of the incident he was qualified in all necessary safe working procedures including RoW procedures.

The only known operational incident involving the PC was an earlier SPAD event. The internal PTS investigation determined that the PC had correctly followed procedures and he did not contribute to the event.

An examination of PTS records established that the PC was medically in date and fit as prescribed by the *National Standard for Health Assessment of Rail Safety Workers*.

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4 The South Australian Government Radio Network (SAGRN) is the term used to refer to a state-wide trunked radio communication system shared by government and public services agencies such as the police, ambulance, fire and PTS, etc.

5 The RoW signal given to a driver indicates that passengers are either onboard or clear of the train at the scheduled departure time and the status of the 'Starter Signal' located at the end of the platform. RoW does not give authority to pass a signal.

6 PSAs are required to work all trains after 1900 and whenever the configuration of a train exceeds two x 2000/2100 class railcars or three x 3000/3100 class railcars. Where a PSA works a train they provide RoW and in that circumstance a PC does not dispatch the train from the Adelaide Station.

1.5 Signalling system

Signalling – field equipment

The Adelaide metropolitan railway signalling system substantially comprises signals, points and track circuits interlocked by a comprehensive safety control system. In railway systems employing colour light signals, a 'proceed authority' given to a train driver is provided by a group of coloured lights. The correct display and interpretation of these lights is essential for a train to be safely routed through a defined section of track, in this case the Adelaide Yard.

Signal 141, located at the end of platform 3 (Adelaide Station), was classified as a platform starter signal. It can display a red 'stop' aspect or a medium speed 'proceed' aspect (yellow/caution or green/clear) in conjunction with a 'multilamp route indicator' dependent on the status of the main line ahead. The multilamp route indicator displays alpha/numeric characters designating the route set for a train, for example 'SS' designates the South Suburban Main Line (Figure 2).

Figure 2: Signal 141 at end of platform 3 Adelaide Station

Signalling – interlocking equipment

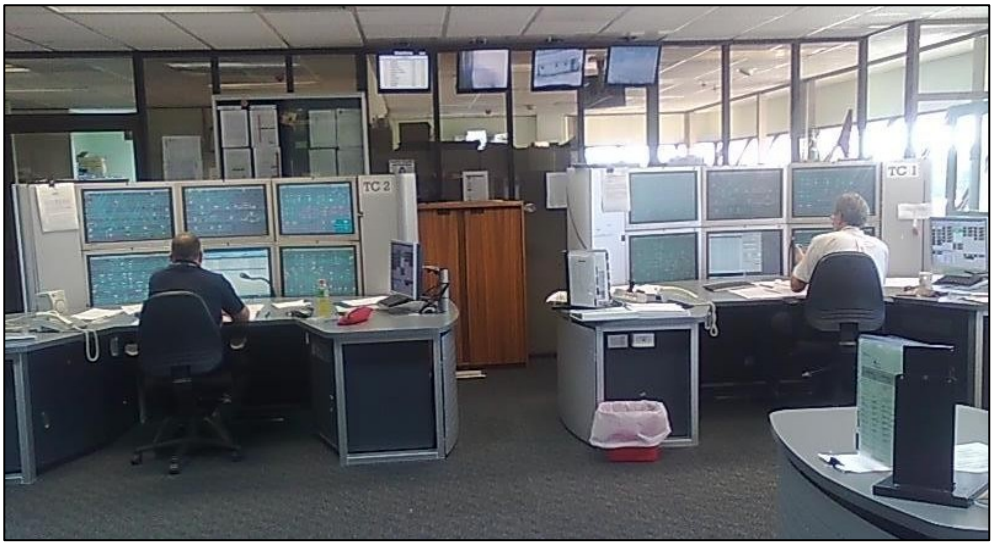
Interlocking equipment manages the safety relationship between points, signals and conflicting train routes. The system installed at Adelaide to provide this function is a proprietary Solid State Interlocking (SSI) system specifically designed for railway fail-safe applications.

The SSI system processes all the various field inputs and drives the outputs interfacing with designated field equipment while simultaneously maintaining a log of the various commands and the states of the input/output field equipment on an event logger. This data can be reviewed to assist with the examination of incidents and accidents.

Remote control of signalling equipment

The Adelaide signalling system provides for the real time monitoring and control of signals, points and track circuits using a non-vital supervisory control and data acquisition (SCADA) control system, hereinafter referred to as a CTC[7] system.

Figure 3: PTS Adelaide Rail Operations Control Centre



This system provides for the graphical representation and control of field equipment from a train controller's workstation (Figure 3) plus the facility to capture data on an event logger. This data can be viewed at a later date to assist with the replay of events and the examination of incidents/accidents.

1.6 The occurrence

At about 0505 on the morning of the incident, the driver of train G231 signed on for duty at the Dry Creek railcar depot. The depot is located about 10.600 track kilometres north of Adelaide Station on the Gawler railway line. After signing on, he went out into the yard and prepared two train sets for traffic. He then departed with one of the sets for Adelaide. The first revenue service that he worked was to Oaklands followed by the 0809 service to Belair and return. He then had a rostered break of about two and a half hours before working train G231.

On that day the Adelaide metropolitan rail system experienced a major service disruption caused by the breakdown of a 2000 class railcar at about 0814. This event caused significant delays throughout the morning.

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[7] Centralised Traffic Control (CTC) – A safe working system of remotely controlling points and signals at a number of locations from a centralised control room. (Source: Glossary for the National Codes of Practice and Dictionary of Railway Terminology).

The PC on duty at the time of the incident commenced work at 1030.

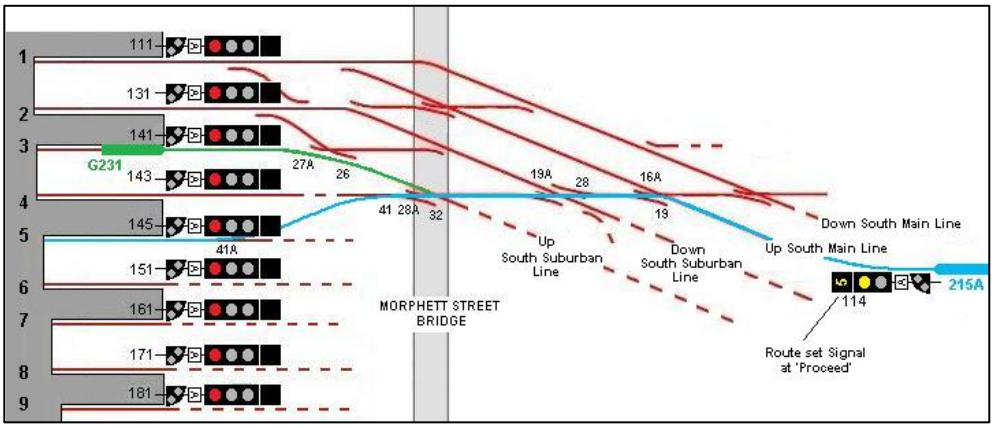
The driver of train 215A (involved in the collision) signed on for duty at 1100 at the Belair depot, which is located about 21.500 track kilometres south of Adelaide Station. Train 215A departed Belair at 1131. At 1200 the train was approaching Goodwood Loop, approximately 5.400 track kilometres south of Adelaide.

At about this time the driver of train G231 had just finished lunch and left the crib room to make his way to platform 3 to join train G231. As he walked along platform 3 he noticed a stationary two car train close to the buffer stop. Being unsure if this was his train he conferred with the PC who advised that his train was running late and would be alongside shortly[8].

Train G231 arrived into platform 3 about three minutes before its scheduled departure time of 1208. The driver involved in the incident had a brief conversation with the driver he was relieving to ascertain whether there were any issues with the train; there were none. He then spoke with the PC, joined the train, completed pre-departure checks and passenger announcements. Shortly after 1208 the PC gave the driver of train G231 a yellow RoW flag indicating that passengers were clear of the train and the signal ahead (141) was at stop. The driver acknowledged the PC and also observed that signal 141 was at stop. He then made a final passenger announcement, closed the railcar doors, and accelerated slowly (green train as illustrated in Figure 4) towards the end of the platform.

The driver's recollection thereafter was that when he next looked at signal 141 it was displaying an '*SS and a green light*', that is, he thought the route ahead was set and clear for the Down South Suburban Main Line.

Figure 4: Adelaide Yard (part) showing path of trains 215A and G231



At this time train 215A, travelling on the Up South Main Line, had just entered a network of points leading into platform 5 and would therefore cross directly in front of platform 3 (blue train as illustrated in Figure 4).

In the meantime, the driver of train G231 continued with departure checks as his train moved along platform 3, including a review of train notices[9], and shortly

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[8] The operating rules and signalling system permitted multiple trains to marshal in the Adelaide Station platforms and was a normal operating practice.

[9] Train Notice – Train notices contain daily operational information about track conditions critical to the safety of train operations and employees working on or near the track.

thereafter the train passed signal 141. It was about this time that the driver noticed a railcar (215A) travelling on the South Main Line, and that it appeared to be coming towards his train.

Initially the two drivers were not concerned with the proximity of their respective trains as there are many movements occurring throughout the Adelaide Yard which appear to converge. However, the two trains were now on a collision course and it was only in the last moment that both drivers realised the pathing of their trains would result in a collision. Both drivers applied their train brakes but the two trains collided, with the off-side front of train G231 clipping the off-side of train 215A.

Both trains came to a stand within a short distance.

1.6.1 Post occurrence

Immediately following the incident the driver of train G231 contacted the Operations Control Centre, over the radio system, stating that he had received a proceed indication on signal 141 but had collided with train 215A (Figure 5).

Figure 5: Evidence of collision damage on railcar 3133 and 3027

When the train controller had confirmed that both trains had come to a stand he arranged for signals staff to examine the CTC and SSI signal replay files which showed that train G231 had passed signal 141 while displaying a stop (red) aspect.

The train controller arranged for the two drivers and the PC to be drug and alcohol tested; all three returned zero readings.

The South Australian 'Office of the Rail Safety Regulator' was advised of the collision at 1220 and subsequently contacted the ATSB with a request to investigate.

2 ANALYSIS

On 24 February 2011 the Australian Transport Safety Bureau (ATSB) received notification from the South Australian 'Office of the Rail Safety Regulator' of a collision involving two suburban commuter trains, 215A and G231, in the Adelaide Yard with a request to investigate.

As part of the investigation process the ATSB sourced all perishable evidence including CTC data files, SSI data files, CCTV video files, voice logs and train data logs. This information was supplemented with driver and platform coordinator (PC) interviews and with data comprising train graphs, train running information, timetables, site plans, safety policies/procedures and work instructions.

Based on the initial examination of the evidence it was determined that:

- There were no deficiencies in the track that required further investigation.
- There was no indication of any mechanical deficiencies with either train that required further investigation.

Consequently, the analysis focuses on:

- The verification of the indication displayed by signal 141.
- The actions of the railcar drivers and the factors that may have influenced those actions.
- The actions of the platform coordinator and whether his actions contributed to the SPAD event.
- The management of SPAD events with respect to analysis, identification and implementation of strategies to prevent similar occurrences.

2.1 Sequence of events analysis

The following reconstruction of events on the 24 February 2011 is based on the statements given by the two drivers and PC involved in the incident and a review of SSI and CTC replay files, the train data loggers, and voice logs. At the time of the incident, the Adelaide signalling system was automatically synchronised to a national time server (CDT) and is the time base used throughout this report[10].

Train G231 (coming in as 310E) arrived at the head of platform 3 at 1204:10; it then travelled along the length of platform coming to a stand before disembarking passengers at 1204:51.

At 1206:27 CCTV footage (Figure 6) shows the incident driver about to board train G231 about 1 minute and 33 seconds before the scheduled departure time of 1208.

At 1206:50 CCTV footage (Figure 7) shows the driver as having just entered the driver's cab and then switching on the train headlights 1 minute and 10 seconds before the scheduled departure time of 1208. He then commences pre-departure checks.

[10] CCTV images have been corrected by adding 2 minutes within images to show the actual (CDT) time.

At 1208:29 CCTV footage (Figure 8) shows that the platform coordinator (PC) has just given the driver of train G231 a RoW flag. The driver in his interview stated that he observed the RoW flag to be yellow in colour which indicated to him that signal 141 was at stop (red). He acknowledged the PC and also recalled observing that signal 141 was at stop. The driver made some final passenger announcements, closed the railcar doors, and began to accelerate slowly towards the end of the platform. When the train had passed the PC, he walked away to continue with his other duties.

The CTC replay file showed that from 1208:20 through to 1209:11 (when train G231 passed signal 141) there was no manual or computer request to clear signal 141 and that at no stage did recorded data show that it cleared to a 'proceed' aspect.

An examination of the SSI data confirmed that the safety interlocking system did not at any stage issue a command to clear signal 141 and that signal 141 did not give a proceed indication while train G231 approached it.

Examination of the CTC replay file (Figure 9[11] at 1208:30) also showed that train 215A travelling on the Up South Main Line had received a proceed aspect on signal 114. This indicated that the route was correctly set and signal 114 was clear for train 215A to proceed into platform 5.

CCTV footage (Excerpt - Figure 10) showed that from about 1208:43 through until 1208:52[12] the driver of train G231 appears to have become distracted and/or preoccupied with his head and body turned to the right and at times bent downwards. The driver indicated at interview that he was undertaking additional departure checks and reviewing timetable and train notice information.

At 1209:11 the CTC data replay file (Figure 11 and Figure 12) shows that train G231 had just passed signal 141 while displaying a stop (red) indication.

At about this time, train 215A travelling on the South Main Line had just entered onto a network of points providing access into platform 5. This network of points crossed directly in front of platform 3 and although both drivers applied their train brakes when they became aware of the risk of a conflict, the two trains collided at 1209:31.

A subsequent review of available CCTV footage established that signal technicians were working in the vicinity of platform 9 at the time of the incident. However, the work undertaken was remote from and would not and did not affect the operation of signal 141. It was also concluded that the working position of the signal technicians near platform 9 was concealed from or outside of the viewing angle of the driver and therefore would not have contributed to the incident.

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[11] Figure 8 shows the status of signal 141 at 1208:30, one second after the PC had given the 'yellow' RoW flag to the driver of train G231indicating that 'platform work was complete' i.e. all passengers onboard but the starter signal 141 was at stop.

[12] After 1208:52 the driver's cab is no longer visible on CCTV footage.

Figure 6: CCTV replay 1206:27 - driver boarding train G231

Figure 7: CCTV replay 1206:50 - driver in cab turned on headlights

Figure 8: CCTV replay 1208:29 - PC has given RoW

Figure 9: CTC replay 1208:30 - signal 141 was at stop

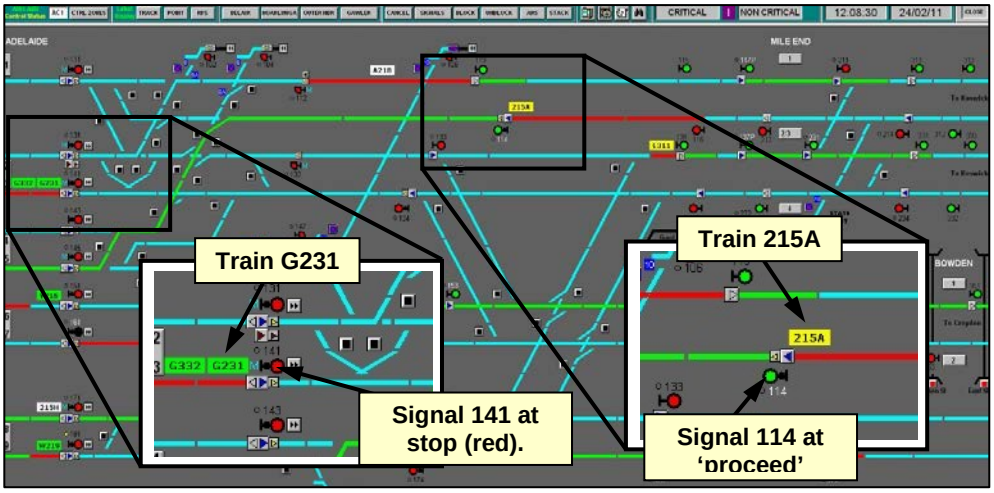


Figure 10: CCTV replay 1208:51 - driver turned sideways looking down

Figure 11: CTC replay 1209:11 - train G231 passing signal 141 at stop

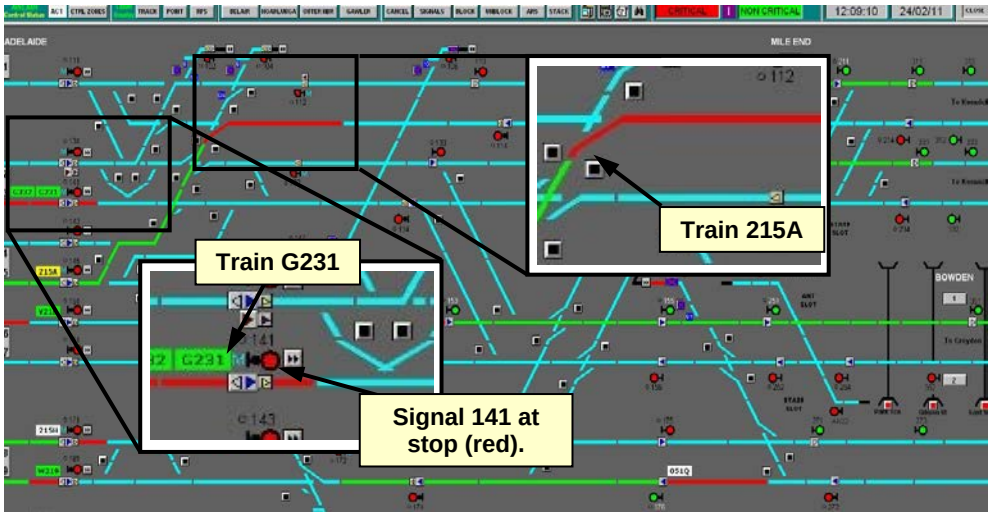
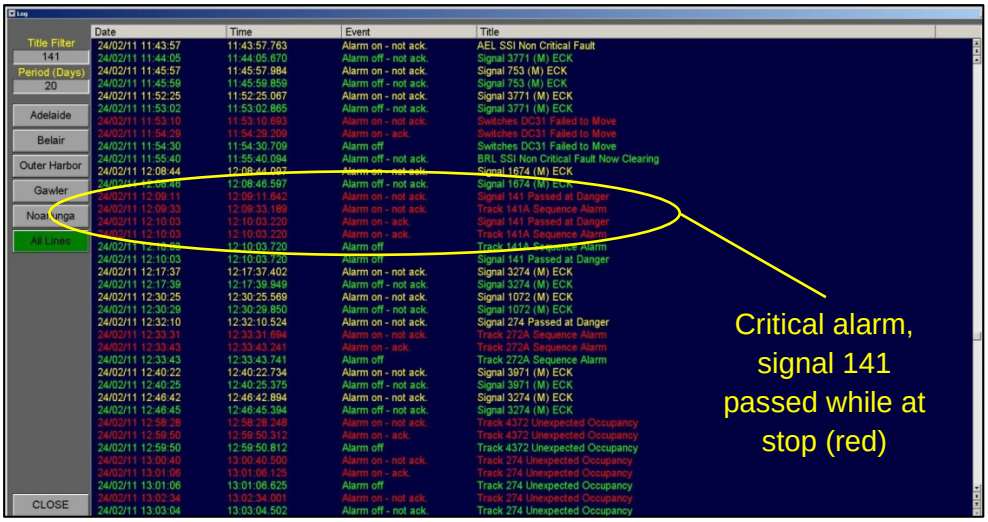


Figure 12: CTC replay 1209:11 - critical event alarm showing SPAD event



2.2 Examination of signal data

Following the collision, information from the SSI data log was examined for all commands issued to signal 141 for the period preceding the SPAD. It was established that there were no commands sent to signal 141 that would have caused it to falsely clear. An examination of the indication output report for signal 141 also established that it did not clear for the passage of train G231 at any stage prior the SPAD event.

The hardware that directly controls signal 141 was checked for operational integrity. It was established that it was functioning normally at the time of the SPAD event. The cables that feed signal 141 were examined and found to be in good condition; there was no evidence of earth leakage. This strongly indicated that system integrity was sound and that there were no false electrical feeds that may have caused the incorrect operation of signal 141.

A review of signal faults and incidents for the Adelaide Yard area, with a particular emphasis on wrong-side-signal failures[13] involving the SSI system, was undertaken. No instances of wrong-side-signal failures were identified that were similar in nature to the event as it was reported to have occurred on this occasion. All maintenance on the signal system had been performed in accordance with the PTS's standards.

Based on the examination of the signal data, past history and the tests performed on the system following the collision, it was concluded that signal 141 displayed a stop (red) indication for the entire period that train G231 was alongside platform 3 up to, and including, the time that the train passed the signal at stop. There was no evidence to suggest that the signalling system was faulty in any way.

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[13] Wrong-side-signal failure. A failure in the signalling system which causes a potentially dangerous situation to exist. For example, if a train is not detected by the signalling system, or if a train is approaching a level crossing and the flashing lights and/or boom gates fail to operate, or where a proceed signal is displayed where a STOP signal should be displayed. (Source: Glossary for the National Codes of Practice and Dictionary of Railway Terminology)

2.3 Train handling

Both train 215A and G231were fitted with Fischer data loggers. These data loggers captured a variety of events including time, train speed; distance travelled, throttle/brake handle position, brake pipe pressure, etc. After adjusting the time base and wheel diameter it was possible to show a high degree of correlation between the data obtained from the CTC, SSI and CCTV.

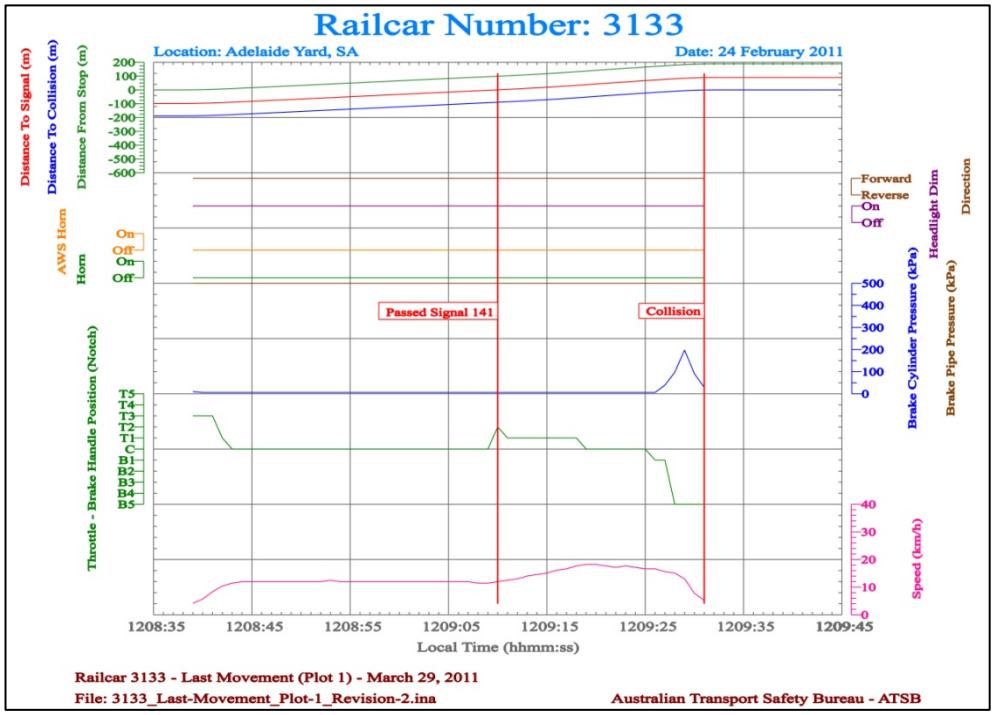
Train 215A

An examination of the recorded data for railcar 3027 (train 215A) established that while travelling through Adelaide Yard the speed of train was generally at or below the track speed limit of 35 km/h. The train then slowed to about 24 km/h in preparation for entering platform 5. At 1209:29 the driver made an emergency brake application after recognising that a collision was imminent. Shortly thereafter (1209:31) train 215A collided with G231. Train 215A came to a stand at 1209:40.

Train G231

An examination of the recorded data for railcar 3133 (train G231) shown at Figure 13, established that at 1208:39, about the time the driver received RoW, the train slowly accelerated to 15 km/h[14]. After passing signal 141 the train then accelerated to a maximum speed of 18 km/h before the driver made an emergency brake application at 1209:25. It was probably shortly before the emergency brake application that he realised his train would collide with train 215A. At 1209:31 the two trains collided; train G231 was virtually at stop at that time.

Figure 13: Loco log extract from railcar 3133



[14] Maximum allowable track speed alongside platforms in Adelaide railway Station is 15 km/h.

2.4 Departure procedure - Adelaide Station

Depending on train size and configuration, train drivers operating out of the Adelaide Station are given RoW as defined by PTS work instructions WI-RS-4003 and WI-RS-5535 for a:

- Passenger service attendant (PSA) working on a train when passengers are safely on board, using an audible bell (buzzer) code, and only when the starter signal is at proceed.
- Platform coordinator working on the platform when passengers are safely on board, at the timetabled departure time, regardless of the status of a platform starter signal. PTS work instructions have been drawn up to differentiate whether a starter signal displays stop, by giving a yellow RoW flag, or proceed by giving a 'green' RoW flag. There is no yellow RoW flag equivalent given by a PSA working on board a train.

Although the onus is always on a train driver to obey the indication provided by the starter signal, the context makes it reasonable to assume that the PC's provision of a yellow RoW flag is a cue marking the beginning of an anticipated signal clearance event. This is reinforced by a procedure in which a PSA can only ever give RoW when the starter signal is at proceed.

Examination of available evidence established that at about 1208 the PC correctly gave train G231 a yellow RoW flag, signifying that platform work was complete and the train could advance up to signal 141 which was displaying a stop (red) indication.

2.5 Factors influencing driver actions

This type of SPAD event, where a stationary train starts towards a signal at danger, is not uncommon and may occur at a platform signal or at any signal at which a train is stopped. Data from the Rail Safety and Standards Board in the UK (RSSB)[15] has shown that start-against-signal SPADs account for between 14% and 24% of all SPAD events. Further analysis by the RSSB showed that approximately half of start-against-signal SPADs occur at stations[16].

There have been several significant accidents in the rail industry where a train has departed a platform towards a signal displaying a stop indication after receiving RoW, including the fatal accidents at Bellgrove Junction, UK on 6 March 1989 and Hyde North Junction, UK on 22 August 1990. In both cases, the guard gave a bell code for the train to depart, but neither the driver nor the guard confirmed the signal at the platform was clear. It was determined that, having been given a bell code, the driver believed the signal was clear when it was in fact it was displaying a stop indication. In both incidents, the train collided head on with another train on a single section of track, with the accident at Bellgrove Junction resulting in the death of one driver and one passenger. These types of occurrences where a train starts towards a signal displaying a stop aspect after receiving a RoW are often referred to as 'ding-ding and away'.

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[15] Rail Safety and Standards Board (2010), *Category A SPAD and TPWS activity report, Quarter 1 – 2010/2011,* London

[16] Rail Safety and Standards Board (2002), *Driver reminder appliances: effectiveness study,* London

Having determined that the technical systems (train, track and signalling system) have operated correctly, the factors that then contribute to a SPAD event are most likely to be associated with the human interface (driver and other involved personnel). The following sections examine the human factors associated with start-against-signal SPADs and how these factors may have influenced the incident that occurred at Adelaide Railway Station on 24 February 2011.

Attention

Human information processing is limited in that each person has limited mental or attentional resources available to attend to information or perform tasks during any particular time period. In general, if a person is focussing on one particular task, then their performance on other tasks will be degraded. In the context of a railcar driver responding to a signal indication, the extent of performance degradation may depend on factors such as:

- the extent to which the signal is conspicuous or easy to observe
- the extent that a particular signal indication is expected
- the driver's workload at that point in time and the existence of any distractions
- the influence of other factors such as fatigue, drugs, alcohol or a medical condition.

In this instance, the primary task of the driver of train G231 was to safely depart from the Adelaide Station, which required him to correctly perceive the indication displayed by signal 141. If the driver's attention was elsewhere (or part of his attention), then it is possible that the driver may not have correctly perceived the indication displayed by signal 141.

The following sections look at possible factors which may have influenced the driver's perception of signal 141 on the day of the incident.

Signal sighting

Signal 141 was located under the Adelaide Convention Centre deck and generally protected from sun glare and reflection. At the time of day when the incident occurred, 1209, the sun was approximately 40 degrees east of true north and at an altitude of approximately 59 degrees, that is, directly above the Adelaide Convention Centre deck. Reflection and sun glare was highly unlikely to have affected the visibility of the signal for an approaching train driver.

An examination of signal 141 established that each aspect, red, yellow and green was distinct and clearly visible along platform 3. There were no physical obstructions that may have compromised the driver's view of the signal. Based on a train speed of 15 km/h the driver had 17 seconds of uninterrupted sighting, to correctly recognise and respond to the signal.

- The colours displayed by signal 141 were clearly distinguishable as 'red', 'yellow' or 'green' with the 'multilamp route indicator' distinctly visible (white lights) when illuminated.
- The driver had clear and ample sighting available approaching the signal along the length of the platform.

As a result, the sighting of signal 141 was not considered to be a factor in the incident.

Expectation

Research has shown that a person's perception of the probability of a given event is strongly influenced by past experience and the frequency with which they encounter the event.[17] In effect, a person's performance is better if the event is expected and worse if it is unexpected. Furthermore, the user's perception that an event is likely to occur is reinforced every time the user encounters that event.

There is also a phenomenon called inattentional blindness, where a person does not notice an object which is fully visible because their attention is engaged on another task. This does not necessarily mean an individual was not paying attention, rather that their limited attentional resources were occupied elsewhere. In short, a person may fail to detect an object even though they were looking directly at it. Research into inattentional blindness has shown that when people focus their attention on a particular task, they tend not to notice unexpected objects, even if the object is conspicuous, potentially important, and right where they are looking[18].

For example, a train driver's perception that a red signal will clear to yellow or green before they get to it is reinforced every time that driver approaches the signal and they observe it as clear. If the driver's attention is focussed on a task other than reading the signal, then they may not correctly perceive the signal indication, especially if the indication is not that which was expected.

In this case, the driver of G231 had been driving for about 8 months before this event. During that time he would have observed the starter signals at the end of the Adelaide Station platforms regularly clear on time[19]. For this event, the driver received a 'Yellow' RoW flag[20] from the PC and accelerated towards signal 141. However, when approaching the signal, his attention was focused on other non-driving activities. It is therefore quite possible that in his mind he perceived signal 141 as clearing and displaying a '*SS and a green light*' (as expected) rather than actually observing the signal to be at stop (red).

Distractions and work demands

Distraction and conflicting work demands are an example of something which can divert attention from tasks such as perceiving a signal aspect. Distraction has been defined for automobile drivers by the American Automobile Association Foundation (AAAF) as occurring:

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[17] Schoppert and Hoyt, 1968 cited in National Transportation Safety Board (1998a). *Safety at passive grade crossing.* Volume 1: Analysis. Safety study NTSB/SS-98/02. Washington DC.

[18] Chabris, C., and Simons, D., 2010, *The Invisible Gorilla*, HarperCollins Publishers.

[19] Delays in clearing the platform starter signals mainly occur during periods of service delay.

[20] 'Yellow' RoW flag given if the PC observes the starter signal to be displaying a stop (red) indication.

> …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[21].

Driver distraction and conflicting work demands can include a range of factors either inside or outside a vehicle that draws on the limited physical, visual and cognitive resources, resulting in a degradation of the driver's performance. For example, eating, drinking, operating devices integral or brought into the vehicle, smoking, and conversing with another occupant are all factors that may reduce the amount of attentional resources available for the driving task. While the AAAF research was conducted in the context of driving road vehicles, the findings are equally pertinent to the operators of other machinery, including trains.

In this instance the workload of the driver of train G231 encompassed a range of tasks in the compressed time frame between boarding the train and passing signal 141. It was established that the driver had less than 3 minutes from the time he boarded the train to the time of departure. During this time the incident driver conversed with the relieved driver (who had just brought the train into Adelaide Station) to determine if there were any technical or operational issues with the train. He then boarded the train and began his pre-departure checks and passenger announcements before receiving RoW from the PC. Although the driver had a rostered break of about two and a half hours before working train G231 it was apparent that he only commenced a range of operational tasks, including reviewing timetable and train notice information, after receipt of RoW and while the train approached signal 141.

Although most of the work was of a routine operational nature, it is likely that the driver's attentional resources in the undertaking of pre-departure tasks and subsequently checking train notices while driving along the platform was a demand on his visual and cognitive resources to the extent that the he did not perceive the aspect displayed by signal 141 as he drove towards it.

Fatigue

In the context of human performance, fatigue is a physical and psychological condition which can arise from a number of different sources, including time on task, time awake, acute and chronic sleep debt, and circadian disruption (disruption to normal 24-hour cycle of body functioning). A review of fatigue research has noted that fatigue can have a range of influences, such as decreased short-term memory, slowed reaction time, decreased work efficiency, reduced motivational drive, increased variability in work performance, and increased errors of omission.[22]

The PTS uses FAID[23] to assist with the fatigue management of its railcar drivers based on rostered hours. There are however a number of documented limitations

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

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

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

with bio-mathematical models (such as FAID) as noted by the Independent Transport Safety Regulator (ITSR) of New South Wales[24] which include:

> .... models that are based on group average data should not be used as the sole basis for decisions on fatigue ....
>
> .... current models only partially represent the factors that impact on fatigue ....

Examination of the driver's (G231) rostered and actual hours worked for the previous 14 days indicated that work related fatigue was unlikely to have been factor, with a FAID score of 66, however ITSR's Transport Safety Alert 34 also points out that:

> A FAID score (such as less than 80) does not mean that a work schedule is acceptable or that a person is not impaired at a level that could affect safety.

When questioned, the incident driver stated that he did not feel overly tired or fatigued and considered that he had had adequate rest. However, the driver did indicate that his personal lifestyle demands (especially in supporting his family) may occasionally result in a less than the ideal level of rest and could cause him to experience some level of fatigue and associated performance degradation.

Formal fatigue policies/procedures identify organisational expectations with respect to the management of fatigue and include issues such as risks associated with shiftwork, employer/employee responsibilities, legal/OH&S compliance and personal lifestyle influences on work performance.

During the investigation the PTS advised that they do not have a formal fatigue policy/procedure and currently manage fatigue through the rostering process but have recognised the current deficiency and intend to develop appropriate policies and procedures.

Drugs, alcohol and medical condition

The driver of train G231 was tested for the presence of alcohol and drugs immediately after the incident; the results were negative. There was no evidence (or suggestion) that he was in any way affected by alcohol or drugs.

An examination of the driver's records indicated that he was medically fit and in date as prescribed by the *National Standard for Health Assessment of Rail Safety Workers*. There was no evidence to suggest that medical or physiological factors affected his performance.

When questioned about his health he indicated he was well.

2.5.1 Summary of factors influencing driver actions

The principal task of the driver of train G231 on 24 February 2011 was to safely depart the train from the Adelaide Station. The driver believed that signal 141 displayed a '*SS and a green light*' and there was no reason to doubt his sincerity. However, recorded data and testing of the signalling system found that it did not clear at any stage prior the SPAD event and continuously displayed a stop (red) indication for the passage of train G231.

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[24] ITSR, 2010, *Transport Safety Alert 34 - Use of bio-mathematical models in managing risks of human fatigue in the workplace*, www.transportregulator.nsw.gov.au

In this instance, it is quite probable that the driver experienced some form of inattentional blindness related to his expectation that signal 141 would clear. It is also possible that workload, distraction and fatigue contributed to limit the attentional resources applied to the driving task.

2.6 History of SPADs - Adelaide Station

An examination of PTS statistical data showed that the greatest number[25] of SPAD events occurred within the Adelaide Yard. The high occurrence rate in this area is probably influenced by issues such as traffic frequency, signal density, route complexity and train turn-around demands. Of the SPAD events occurring in the Adelaide Yard about one third are 'Starting against Signal'. Accordingly, TransAdelaide (PTS) has endeavoured (over time) to implement a range of strategies and procedures to reduce the Starting against Signal risk at the Adelaide Station.

The ATSB report RO-2006-003 *Signal 161 Passed at Danger TransAdelaide Passenger Train H307 Adelaide, South Australia* was a Starting against Signal event on 28 March 2006. One of the issues identified by the ATSB in that investigation was the practice of the PC providing a green RoW indication while the starter signal (161) was at stop.

The ATSB concluded that:

> 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.

After the SPAD on 28 March 2006 TransAdelaide introduced a new departure process intended to reduce the risk of cue association by implementing a two tier departure strategy that relies on the PC providing:

- a 'yellow' flag if the PC observes the starter signal to be displaying a stop (red) indication or
- a 'green' flag if the PC observes the starter signal to be displaying a proceed indication.

While the intent of the amended work instruction was to protect against train drivers associating a green RoW indication and a starter signal at stop, the context makes it reasonable to assume that the PC provides a RoW indication is a cue to an imminent signal clearance event.

To be an accredited rail operator in South Australia, and as part of the change management process, TransAdelaide was required to provide the regulator with details of any new safety process affecting its rail services. This was done when introducing the new RoW procedure (yellow RoW flag) but caused the regulator to raise a series of questions regarding inconsistencies between the Rules[26] and new Work Instructions. Of particular note was the use of the yellow flag which can be

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[25] The data was a measure of SPAD events and has not been normalised for number of train movements.

[26] Rules – Refers to the 'Common General Operating Rules and General Appendix to the Common General Operation Rules and Other Instructions Part 1 & 2' issued by the Rail Commissioner.

used ‘To signal shunt movement when no fixed signal exists at an interlocked station’ or as a ‘Warning’ signal by the Rules but was used as a starting/RoW signal within the Work Instructions. Although TransAdelaide’s intent was to improve operational safety a difference of interpretation between the Rules and the Work Instructions was considered an area of risk by the regulator that required (and still requires) resolution.

In May 2009 TransAdelaide commissioned the Halcrow consulting firm to review SPAD management. In their report the consultant identified:

> The risk posed by despatching trains towards starting signals at the Adelaide Railway Station was identified as an area of significant SPAD exposure.

They recommended that the practice be discontinued:

> As the dispatch of the train is the same for a starting signal at either proceed or stop, there is a risk that a driver may assume the more familiar “starting signal at clear” routine despite the starting signal being red if a mind-set has developed, or a distraction has occurred at the point where the decision is made to stop or continue.

In its investigation report RO-2006-003 the ATSB also examined RoW procedures used by passenger operators in New South Wales and Victoria. In both cases it was noted that these organisations require that station staff check the status of the starter signal and confirm that it is showing a proceed aspect before giving RoW. A similar procedure applies for dispatching trains in the United Kingdom.

Had the PTS procedure for dispatching trains from Adelaide Station required the signal to be cleared to a proceed indication before giving the driver RoW, it is almost certain that the SPAD event on this occasion would not have occurred.

Following the collision of G231 and 215A on the 24 February 2011 the PTS has introduced a further iteration of its RoW procedure. However, the latest procedure continues the practice of dispatching trains towards a starting signal displaying a stop (red) indication, but now includes a requirement for the PC to physically point at the signal at stop to bring it to the clear attention of the train driver.

2.7 Signal Passed at Danger (SPAD) - general

A ‘signal passed at danger’ (SPAD) event occurs when a train passes a stop signal without authority to do so. Although signalling systems are designed with high levels of integrity, train drivers can be susceptible to error and misjudgement that can result in SPAD events. Most SPADs occur as a result of a combination of factors such as the configuration of the railway, operating and environmental conditions and factors associated with human performance. Driver initiated SPAD events have long been an area of concern for the rail industry and whilst most SPADs result in minimal harm (because they involve a minor misjudgement of distance or train braking capability) they can pose significant risk where the incident involves higher train speed or a collision with another train or infrastructure.

Whilst technical solutions such as ‘Positive Train Control’ (PTC - see Appendix B) reduce the risks associated with driver initiated SPAD events financial or operational constraints may influence the adoption of these systems.

2.7.1 SPADs - Physical risk controls

In common with many metropolitan rail commuter operations, the PTS work their trains with only one driver. As a defence against driver error, the PTS have provided their railcars with vigilance management comprising a 'dead man's control' and an Automatic Warning System (AWS) that operates in conjunction with the rail signalling system.

Both the dead man's control and AWS have been widely used throughout the rail industry as a driver supervisory system; however, neither provides the continuous monitoring of permitted train speed and movement authorities afforded by modern Positive Train Control systems.

Dead man's control

The dead man's control on the PTS railcar fleet comprises an electronic module that monitors a foot pedal, which the driver must keep depressed, plus a variety of other inputs such as train throttle movement, etc. This information is intended to detect driver incapacity. If incapacity is detected the system enforces an automatic brake application. However, there are many circumstances where a dead man's control is ineffective[27]. In particular it cannot protect against driver distraction or incorrect interpretation of critical signalling information (e.g. signal displaying stop) as occurred at the Adelaide Station on 24 February 2011.

Automatic Warning System (AWS)

Due to technical limitations AWS can only provide two driver alert warnings, one is for a main line clear aspect and the second is for a restrictive signal aspect, including stop (red). When a signal being approached[28] displays a main line clear aspect the AWS sounds a brief alert tone. When the signal displays a restrictive aspect, the AWS sounds a continuous loud *warning* until acknowledged by the train driver who operates a push button. When acknowledged, the audible alert is cancelled and a visual indicator provides a reminder to the driver that they have reset the AWS system. If not acknowledged the system enforces an automatic brake application. However a recognised weakness with AWS is that it is an advisory system and can be cancelled or overridden by automatic driver reaction[29] whereas PTC systems always enforce compliance braking.

Starter signals like 141 located at the end of the Adelaide Station platforms always display a restrictive (medium speed) aspect. Accordingly an AWS trigger point

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[27] The New South Wales Waterfall train disaster probably occurred as a result of the driver slumping on the dead man's control, keeping it depressed when he died suddenly of a heart attack. The driver's action caused the system to become ineffective with the train continuing at speed until it derailed.

[28] AWS is a magnetically activated trigger system, typically located about 70 m to 80 m before the signal it protects. If a signal displays a restrictive aspect when the train passes over the trigger point the AWS is activated and sounds a continuous warning within the driver's cab until acknowledged.

[29] This resulted in at least one significant collision on 5 October 1999 at Ladbroke Grove Junction in the UK with 31 people being killed and many more injured. The investigation into the collision concluded that the driver probably automatically cancelled the AWS warning as he approached a signal displaying stop (red) having incorrectly assumed that it was displaying a yellow.

would always result in a *warning* being sounded, thereby encouraging an automatic driver reaction of cancelling the AWS warning. As such AWS trigger points were considered undesirable and not provided for starter signals located at the end of the Adelaide Station. AWS can therefore not protect against SPAD events involving Adelaide Station platform starter signals[30].

Detection of SPAD events

The Adelaide CTC system provides real time monitoring of train movements throughout the network and the real time monitoring and control of all signals, points and track circuits. As part of the monitoring process the CTC system provides a *Critical* SPAD alarm whenever a train passes an *Absolute Signal*[31] displaying a stop (red) indication. The SPAD alarm is designed to alert Train Controllers and Area Controllers that a SPAD event has occurred so that they can take appropriate action. Following a SPAD alarm the train controller initiates a radio 'stop train alert' to the SPAD driver and any other trains at immediate risk from the SPAD event. When all affected trains are confirmed to be at stop, the controller implements mandated policies and procedures for:

- drug and alcohol testing of drivers and other parties as necessary.
- ensuring the preservation of data to be used in subsequent analysis and report preparation.

The CTC SPAD alarm has been an effective tool for trapping SPAD events. There was evidence to show that when faced with a SPAD event, train controllers (time permitting) take appropriate action and warn train drivers regarding the risk of the event. In this case however there was insufficient time for train control to warn the driver of train G231 and 215A regarding the SPAD event and the need to take appropriate action to avoid a collision.

Summary

As a defence against driver error PTS provide their railcars with a vigilance system comprising a dead man's control and an Automatic Warning System. On this occasion both technologies were ineffective in preventing the SPAD event and there was insufficient time, following operation of the *Critical* SPAD alarm, for train control to warn the driver of train G231 and 215A regarding the SPAD and for the need to take appropriate action to avoid a collision.

2.7.2 SPADs - Human factor management

Technical solutions such as Positive Train Control (PTC) which continuously monitor and control permitted train speed, and validate movement authorities, reduce the risks associated with driver initiated SPAD events by enforced train

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[30] The South Australian State Government has recently announced that an 'automated train protection system' will be provided across the metropolitan rail network to protect against driver error as part of its 'Rail Revitalisation Project'

[31] Absolute Signal – A signal that must not be passed at stop (displaying a red indication) without the authority of the Train Controller.

braking. In the absence of PTC it is incumbent legally[32] on operators to focus on the effective identification, analysis, evaluation and treatment of SPAD events.

The PTS has explored opportunities for reducing SPAD risk through the identification and treatment of driver error and enhancing driver performance with a range of SPAD strategies. This process has included the initial 'Detection of SPAD events' followed by:

1. ***Identification:***
    - recording and analysis
    - investigation.
2. ***Treatment:***
    - monitoring and review
    - driver recruitment and training.

The section below examines the effectiveness of actions taken by TransAdelaide (PTS) with respect to identification and treatment of SPAD events.

1. Identification

Recording and analysis

The recording and analysis of SPAD events is a vital management strategy that has the potential to identify underlying SPAD safety risk. As part of the SPAD management process, collection of SPAD data and subsequent analysis can help to identify the underlying factors that contribute to SPAD events. However, if managed poorly, SPAD performance is unlikely to improve.

Since about 1999 TransAdelaide (PTS) has re-focused its efforts in the examination of SPAD events with the intent of identifying strategies to avoid future occurrences. Data was historically collected on the form 'Signal Passed at Stop' (RS-ADL-121).

Following a review of the old form a new 'SPAD Investigation Form' (RS-ADL-283) was developed and has been in use since about 18 May 2010. The PTS has advised that the new form reflects on work undertaken by the New South Wales Independent Transport Safety Regulator (ITSR) and the Rail Safety and Standards Board of the United Kingdom.

In order to effectively manage driver initiated SPAD events it is essential to identify those issues that may be related to human performance. An examination of the data captured on form RS-ADL-283 suggests that the PTS are concentrating more on the 'what happened' rather than 'why it happened' and do not collect data on many of the human factor issues, such as have been identified by ITSR in its *SPAD Data Collection for Rolling Stock Operators* (Form B). Collection of relevant data on human factor issues would facilitate a better understanding of driver error types. As an example, ITSR's Form B at Section 3.3 solicits the following information:

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[32] South Australian Rail Safety Act 2007 prescribes at Section 3 the requirements for *the management of risks* and *control of particular risks* and at Section 8 further defines obligations in meeting these requirements.

3.3 Were there internal distractions that may have caused the driver to have a SPAD?

With a [YES]/[NO] response including:

3.3.5 Was the driver distracted by any in-cab non-operational activity (e.g. adjusting the driver's chair, boiling the kettle or obtaining a drink, packing a bag, reading newspapers or mobile phone use)?

Similarly Section 3.7 solicits the following information:

3.7 Did the driver make an incorrect early assumption about the signal aspect?

With a [YES]/[NO] response including:

3.7.6 Did the driver expect the SPADed signal to conditionally clear?

There are no equivalent questions on Form RS-ADL-283. Both questions are probably relevant for this SPAD event.

The PTS has also developed an Excel database for the recording of data collected on form RS-ADL-283. The database facilitates the high level analysis of SPADs with the intent of developing strategies to mitigate the risk of future events. The database currently spans a period of about 14 years, 1997 through to 2011. While the database provides sound high level analysis it would be beneficial if it had active drill down capability so that specific issues could be easily isolated.

TransAdelaide (PTS) – SPAD investigation reports

The PTS undertakes investigations of all SPAD events and provides a written report[33] to South Australia's Office of the Rail Safety Regulator as and when required. As part of this investigation the ATSB reviewed nine SPAD reports (covering the period 2006 through to 2011) most of which were tabled with the Office of the Rail Safety Regulator. An examination of the reports identified the following points of interest:

- In those cases where the testing of the signalling system was undertaken, it was found to be operating correctly. There were no cases where signal sighting issues compromised the driver's view of the SPAD signal. AWS was operating correctly.
- Drivers were determined to be medically fit; drug and alcohol testing returned zero readings in all cases.
- Fatigue was not identified as a likely factor.
- The reports showed that over 75% of incidents involved drivers with limited experience, generally less than 2 years.
- The majority of SPAD events fell into two categories – where the driver was:

[33] The *South Australia Rail Safety Act 2007* at Section 75 'Investigation of notifiable occurrences' prescribes that the 'Regulator may, by written notice to a rail transport operator, require the rail transport operator to investigate notifiable occurrences'. Under the *Rail Safety (General) Regulations 2008* at Section 26 – 'Reporting of notifiable occurrences' a SPAD event is defined as a Category B notifiable occurrence.

1) Unaware of the SPAD event and Train Control intervened (on observing a SPAD alarm), calling the train to a stop.

2) Aware of the SPAD event. In these cases the driver observed the signal to be at stop but was travelling at a speed that no longer allowed the train to be brought to a stand before passing the signal.

- TransAdelaide (PTS) identified distraction and/or expectancy as a likely cause in each of these SPAD events. Initial training and periodic SPAD awareness re-training were identified as opportunities that would help reduce SPAD risk. The training was to focus on an understanding of the signalling system (e.g. risks associated with automatic signal clearing) coupled with better route knowledge and the need to be alert during periods of high risk (distraction avoidance while approaching signals/areas of high risk, etc). The PTS advised that it was developing a 'Professional Driving Standard' which includes a range of instructional/training elements targeted at reducing the occurrence of SPAD events by focussing on issues such as distraction, task prioritisation, expectancy, etc.

- PTS investigation reports reflect the data captured on form RS-ADL-283, that is, the reports tend to centre on 'what happened' rather than 'why it happened' and therefore do not identify underlying human factor error where this has contributed to a SPAD event.

- The PTS responses to questions generated by the Office of the Rail Safety Regulator regarding some of the SPAD events well exceeded close-out times required by the regulator. When asked about this issue the PTS advised it was endeavouring to ensure that adequate resources were allocated to the task including better document control to minimise the risk of close-out overrun.

TransAdelaide independently commissioned SPAD reports

The ATSB also examined three reports separately commissioned by TransAdelaide, dealing with:

- Human Factors of Signals Passed at Danger Project – To identify human error and develop preventative strategies to reduce the influence of human factors that contributes to SPAD risk - June 2008.

- A review of the TransAdelaide safety management system (SMS) and to determine the suitability of the system for the management of Signals Passed at Danger - May 2009.

- Human Factors Review - Proposed Departure Procedures for Adelaide Railway Station - November 2009 (referred to in section 2.6 above).

Each of the three reports raised issues worthy of consideration. The following points are summarised as pertinent to this event:

- Distraction was identified as a primary cause for SPAD events and was seen as more likely to occur with inexperienced drivers. Of particular note was the difficulty for new drivers in prioritising their attention between the primary driving tasks and secondary tasks, such as the checking of 'Train Notices'.

It was noted that as drivers become more experienced they begin to anticipate the automatic clearing of signals (expectancy). This creates a SPAD risk on occasions when a signal does not clear.

TransAdelaide (PTS) had identified 'distraction' and 'task prioritisation' as key areas of high risk for drivers and communicated these concepts during initial driver training. It was noted however that drivers are only occasionally reminded that distraction on lesser tasks reduces the amount of attentional resource available for critical driving duties and that this significantly increases the risk of driver error.

- The risk posed by dispatching trains towards starting signals at the Adelaide Station was identified as an area of significant SPAD exposure.
- It was considered that the current Automatic Warning System (AWS) does not offer the level of protection afforded and expected of modern PTC systems. Drivers become complacent and respond automatically to the AWS *warning*. It was suggested a Driver's Reminder Appliance[34] (DRA) as introduced in the United Kingdom may offer some protection against the shortcomings of the AWS system, particularly with respect to 'Starting against Signal' SPAD events.

The three reports identified that driver training should be considered as a strategy for reducing the risk of SPAD events, with a focus on:

- Signal system awareness, that is, how the signalling system works and its relationship with AWS (limitations of AWS) should be part of the curriculum.
- SPAD awareness, that is, the consequence of SPAD events and factors giving rise to SPAD events.
- Training in human factors with a focus on understanding individual, personal limitations (issues such as distraction, expectancy and fatigue) with respect to the driving task and strategies to reduce the associated driving risk with a focus on SPAD events.
- Training in human factors for senior drivers to improve SPAD investigations, driver training, assessment and monitoring.
- Additional training aids including the use of simulators and CCTV footage.

2. Treatment

Monitoring and review

The monitoring and review of SPAD events is essential in developing appropriate risk mitigation strategies and should be an ongoing process.

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[34] Driver's Reminder Appliance (DRA) - Is a manually operated switch located within the driver's cab that can be set by the driver as a reminder that the signal ahead may be at stop (red). When set the DRA prevents the train from being powered up. Use of the DRA is mandatory for drivers of British passenger trains as prescribed by the Drivers' Rule Book. DRAs were introduced in the operation of United Kingdom on passenger trains in the 1990s in response to a series of accidents where a train driver had started away from a station against a stop (red) signal.

The PTS has been quite active in its endeavours to reduce the number of SPAD events. This was reflected in its ongoing SPAD Program, which consolidates on the findings and recommendations of past SPAD events and consultancy reports independently commissioned by TransAdelaide.

The 'Rail Operations Group' regularly reports to a 'SPAD Committee' and the executive with respect to:

- Recent SPAD incidents. The report summarises each individual event and identifies findings.
- Trends. A range of graphs (three graphs shown at Appendix C - Figure 15, Figure 16 and Figure 17) designed to illustrate trends with respect to SPAD occurrence.
- SPAD management activities and progress against plan. Details recent engineering and administrative controls with actions intended to mitigate the risk of SPAD events.
- Signal sighting assessments. The PTS has a program for reviewing signal conspicuity. Where sighting is identified as a potential risk, action is taken to enhance the conspicuity of a signal as necessary and appropriate.

A review of the PTS SPAD management process established that while the organisation recognised the importance of human factors with respect SPAD events it continues to have a strong focus on hard data within its reports. That is, SPAD reports focus on data such as frequency, where events occur, etc. There was little evidence of the use of human factor data, that is, there was no clear attempt to quantitatively analyse issues such as expectancy, distraction, complacency, etc. Although the hard data types provide an indication of overall SPAD performance it is not effective in identifying why many of the SPAD events occur. This issue was previously identified by the ATSB in its report RO-2006-003 '*Signal 161 Passed at Danger TransAdelaide Passenger Train H307 Adelaide, South Australia*'.

Treatment, including driver recruitment and training

Following on from the analysis of SPAD events and developing appropriate mitigation strategies, the next step in reducing the number of SPADs is the effective implementation of strategies.

- Technical developments – The PTS has implemented a number of engineering solutions aimed at reducing the occurrence of SPAD events and includes:

    1. A risk assessment tool/form used to identify/prioritise high risk SPAD signals. Deficiencies identified as part of the assessment are corrected (e.g. foliage affecting sighting). The form is also used following a SPAD event to validate 'Signal Sighting'.
    2. A program of replacing incandescent signal lamps with LED equivalents to enhance conspicuity.

3. An ongoing examination of technological developments for mitigating the risk of SPAD events including PTC[35] and possible enhancements of the current AWS.

- Recruitment & Selection - During the 2005/07 period TransAdelaide was faced with a significant shortfall in driver numbers as a result of unexpected levels of resignation. This exposed the organisation to a high level of risk associated with engaging new employees and a loss of skilled driver trainers. The PTS identified that a key area in mitigating the risk of SPAD events was associated with the initial recruitment and selection of its train drivers.

  The PTS now not only checks for the physical and mental health of its driver recruits, it also undertakes psychometric testing[36] to determine whether the applicant's mental abilities and aptitudes are suited to the driving role. New selection criteria were developed and commenced operation in January 2009. The PTS believes that this strategy has met with some success, citing their statistical trends (Appendix C - Figure 16) as evidence of success. Specifically, PTS referred to a sharp downward trend in the period 2009 through to 2010 (drivers recruited under the new selection criteria) compared to an increasing trend between 2005 and 2008 (drivers recruited under the previous selection criteria). However, following discussions with the PTS and an examination of recent SPAD events it was evident that recent SPAD events predominantly involve newly recruited drivers, implying that the new selection criteria may not be the primary influencing factor for any improvement in SPAD statistics.

- Training & Competence - Instruction in train handling, the signalling system/AWS and human performance/understanding SPAD events are essential ingredients in reducing the risk of SPAD events. Training must be complemented by the effective assessment and monitoring of driver performance to ensure individuals are competent and that competencies are maintained. The PTS has engaged in a number of strategies embracing:

  1. Extending the timeframes for driver training and proposes to implement a 'Professional Driving Standard' which will include further instruction aimed at reducing the occurrence of SPAD events and cover issues such as distraction, task prioritisation, expectancy, etc.

  2. The redevelopment of a route knowledge assessment tool that is used during initial driver training and as an ongoing basis for driver re-assessment.

  One area identified in reports previously commissioned by TransAdelaide as a training opportunity involves the use of simulator technology. These reports highlight that the provision of simulator training would offer the PTS the ability to engage trainee drivers interactively, helping them to practice, retain and apply what they have learned, without the risk associated with driving trains in traffic.

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[35] The South Australian State Government has recently announced that an 'automated train protection system' will be provided across the metropolitan rail network to protect against driver error as part of its 'Rail Revitalisation Project'.

[36] PTS train drivers undergo psychometric testing using a program developed by the Teleran Group specifically for TransAdelaide (PTS).

3 FINDINGS

3.1 Context

At 1209 on 24 February 2011 a suburban commuter train (215A) with 17 passengers on board was being routed from the Up South Main Line into number 5 platform at the Adelaide Station. At about the same time a second commuter train (G231) with 22 passengers on board while departing the Adelaide Station passed signal 141 at the end of number 3 platform displaying a stop (red) indication. Shortly thereafter both drivers realised that their trains would come into conflict and applied their train brakes but it was too late to avoid a collision.

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

3.2 Contributing safety factors

- After receipt of Right of Way indicating that train G231 could advance up to signal 141 at stop (red), the driver accelerated his train towards the signal but diverted his attention onto a lesser task of checking train notices and subsequently did not correctly perceive signal 141 before passing it at stop.
- Public Transport Services procedures permit trains to be dispatched from Adelaide Station towards starting signals that are displaying a stop (red) indication. *[Significant Safety Issue]*

3.3 Other safety factors

- As a defence against driver error Public Transport Services provide their railcars with a vigilance system comprising a dead man's control and an Automatic Warning System. However, the current system does not protect against 'Starting against Signal' SPAD events as occurred at Adelaide Station.*[Significant Safety Issue]*
- SPAD Investigation Form (RS-ADL-283) used by Public Transport Services does not collect data on many of the human factor issues that would facilitate a better understanding of why SPADs are occurring. *[Minor Safety Issue]*
- Public Transport Services driver training does not adequately address the risk of distraction and areas of human performance error with respect to SPAD events. *[Minor Safety Issue]*
- Public Transport Services have not implemented simulator training or a similar interactive system which would allow new drivers to practice, retain and apply what they have learned without the risks associated with driving trains in traffic. *[Minor Safety Issue]*
- There are inconsistencies between Right of Way procedures used by platform coordinators and passenger service attendants. *[Minor Safety Issue]*
- There are inconsistencies between Right of Way Work Instructions and the Common General Operating Rules. *[Minor Safety Issue]*

- Public Transport Services do not have a formal fatigue policy/procedure. *[Minor Safety Issue]*.

3.4 Other key findings

- Signal 141 displayed a stop (red) indication for the entire period train G231 was alongside number 3 platform up to and including when passed at stop. There was no evidence to suggest that the signalling system was faulty.
- Examination of the driver's (G231) rostered/actual hours worked indicates that roster related fatigue was an unlikely factor. However personal life style demands may have resulted in less than the ideal pre-requisite level of rest.
- The actions of the driver of train 215A did not directly contribute to the incident.
- Work undertaken by signal technicians in the vicinity of platform 9 at the time of the incident did not contribute to the incident.

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.

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.

4.1 Public Transport Services

4.1.1 Dispatching trains towards starting signal

Significant safety issue

Public Transport Services procedures permit trains to be dispatched from Adelaide Station towards starting signals that are displaying a stop (red) indication.

Action taken by Public Transport Services

Public Transport Services has advised that the following action is proposed with respect to Adelaide metropolitan rail system.

> Public Transport Services advises that it is significantly increasing staff numbers through recruitment to address this issue. This is being undertaken through the recruitment of additional drivers and the inclusion of undertaking Platform Coordinator duties as part of the training of new drivers.
>
> The additional staff available for Platform Coordinator duties will result in all departures from Adelaide Railway Station being given Right of Way by a Platform Coordinator only when a proceed aspect is displayed on the starting signal, unless under direction due to a signal failure condition. It is anticipated that sufficient staff will be trained to implement this, with the procedure amended to reflect the process, by 15 September 2011.
>
> In the interim, as mentioned in Section 2.6 of the report, PTS has revised its starting procedure to include a requirement for the PC to physically point at the signal at stop to bring it to the clear attention of the train driver, similarly to processes used on Japanese railways and in aviation.

ATSB assessment of action

The Australian Transport Safety Bureau is satisfied that the action proposed by Public Transport Services adequately addresses the safety issue.

4.1.2 Vigilance control

Significant safety issue

As a defence against driver error Public Transport Services provide their railcars with a vigilance system comprising a dead man's control and an Automatic Warning System. However, the current system does not protect against 'Starting against Signal' SPAD events as occurred at Adelaide Station.

Action taken by Public Transport Services

Public Transport Services has advised that the following action is proposed with respect to Adelaide metropolitan rail system.

> The South Australian State Government has recently announced that an 'automated train protection system' will be provided across the metropolitan rail network to protect against driver error as part of its 'Rail Revitalisation Project'.

ATSB assessment of action

The Australian Transport Safety Bureau is satisfied that the action proposed by Public Transport Services will adequately address the safety issue.

4.1.3 SPAD Investigation Form

Minor safety issue

SPAD Investigation Form (RS-ADL-283) used by Public Transport Services does not collect data on many of the human factor issues that would facilitate a better understanding of why SPADs are occurring.

Action taken by Public Transport Services

Public Transport Services has advised that the following action is proposed with respect to collection of SPAD data.

> ... that it will review its SPAD Investigation Form to ensure that human factors issues are addressed as part of the initial SPAD Investigation process.

ATSB assessment of action

The Australian Transport Safety Bureau is satisfied that the action proposed by Public Transport Services will adequately address the safety issue.

4.1.4 Driver training

Minor safety issue

Public Transport Services driver training does not adequately address the risk of distraction and areas of human performance error with respect to SPAD events.

Action taken by Public Transport Services

Public Transport Services has advised that the following action is proposed or already happening with respect to driver training:

> ... prioritisation/awareness of distractions is widely scattered through documentation, so there is no single module as such. This will be created once our work on the Professional Driving Standards are complete which consolidates issues such as this ...

Public Transport Services further advised:

> ... that its Professional Driving Standards are currently being consulted with stakeholders prior to their finalisation and implementation.
>
> ... that the increased number of drivers as detailed in the response above to the Safety Issue at 4.1.1 will in turn result in an increase of Senior Driver numbers, allowing additional resources for additional monitoring of drivers.
>
> ...that it regularly reminds Trainee Drivers of the need to maintain concentration and attention as part of its training program and as part of the follow up review process once a Trainee Driver becomes a Suburban Train Driver.
>
> SPAD alerts, produced to communicate any identified issues that have contributed to SPADs that have occurred.
>
> Event specific briefings to highlight changed circumstances that require additional information, such as a briefing for Royal Show operations that includes a reminder to Drivers about maintaining concentration despite the additional distractions present ...
>
> Daily Briefings that are given to drivers, that have SPADs, distractions and signals as the first three topics on the agenda.

Action taken by Public Transport Services

The Australian Transport Safety Bureau is satisfied that the action taken and proposed by Public Transport Services will adequately address the safety issue.

4.1.5 Interactive driver training

Minor safety issue

Public Transport Services have not implemented simulator training or a similar interactive system which would allow new drivers to practice, retain and apply what they have learned without the risks associated with driving trains in traffic.

Action taken by Public Transport Services

Public Transport Services has advised that the following action is proposed with respect to interactive driver training.

> ... that it is considering including the option provided by the manufacturer to have a simulator provided as part of the tender for the new electric multiple unit railcars that are being purchased ...

ATSB assessment of action

The Australian Transport Safety Bureau is satisfied that the action proposed by Public Transport Services will adequately address the safety issue.

4.1.6 Inconsistencies between RoW procedures

Minor safety issue

There are inconsistencies between Right of Way procedures used by platform coordinators and passenger service attendants.

Action taken by Public Transport Services

Public Transport Services has advised that the following action is proposed with respect to RoW procedures.

> ... that there will always be inconsistencies between the Right of Way procedures used by a Platform Coordinator as compared to those used by Passenger Services Attendants.
>
> However, the action as detailed at 4.1.1 where all departures will be given Right of Way by a Platform Coordinator will eliminate this as an issue.

ATSB assessment of action

The Australian Transport Safety Bureau is satisfied that the action proposed by Public Transport Services will adequately address the safety issue.

4.1.7 Inconsistencies between Work Instructions and the Common General Operating Rules

Minor safety issue

There are inconsistencies between Right of Way Work Instructions and the Common General Operating Rules.

Action taken by Public Transport Services

Public Transport Services has advised the following with respect to Work Instructions and the Common General Operating Rules.

> ... concurs that ATSB's comparison of the Right of Way Work Instructions with Rule 43(q) can be seen as an inconsistency, however Rule 43(p) aligns much more closely with the Work Instructions. Public Transport Services advises though that:
>
> - the action as detailed at 4.1.1 where all departures will be given Right of Way by a Platform Coordinator will eliminate this as an issue; and
> - it intends introducing a new rule book that aligns with the Australian National Rules and Procedures suite to replace the Common General Operating Rules and Appendix, commencing from early 2012.

ATSB assessment of action

The Australian Transport Safety Bureau is satisfied that the action proposed by Public Transport Services will adequately address the safety issue.

4.1.8 Fatigue management

Minor safety issue

Public Transport Services do not have a formal fatigue policy/procedure.

Action taken by Public Transport Services

Public Transport Services has advised that the following action is proposed with respect to fatigue management.

> ... that a draft Fatigue Management Policy and Process is currently being consulted with stakeholders prior to its finalisation and implementation.

ATSB assessment of action

The Australian Transport Safety Bureau is satisfied that the action proposed by Public Transport Services will adequately address the safety issue.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of Information

Public Transport Services

South Australian Railway Safety Regulator

References

ATSB report 2006/003 'Signal 161 Passed at Danger TransAdelaide Passenger Train H307 Adelaide, South Australia'

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

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ITSR SPAD Management an Information Paper (Sep 2009).

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National Standard for Health Assessment of Rail Safety Workers.

PTS Work Instruction WI-RS-5535 (12 Jan 10) 'Giving Right of Way'

PTS Work Instruction WI-RS-4003 (7 Sep 10) 'Giving Right of Way at the Adelaide Railway Station – Platform Coordinators'

PTS Staff Notice (10 Mar 2011) 'Clarification Points to Employee Notice (TARDIS # 318391) – Trains Departing Platform at Adelaide Railway Station'

PTS Staff Notice (25 Feb 2011) 'Trains Departing Platforms at Adelaide Railway Station'

Regulations under the South Australian Rail Safety Act 2007 - Rail Safety (General) Regulations 2008

Rail Commissioner (1 Nov 2010), Common General Operating Rules

Rail Commissioner (1 Nov 2010), General Appendix to the Common General Operating Rules and Working Timetables and Other Instructions (Part 1 and Part 2)

Rail Safety and Standards Board (2010), Category A SPAD and TPWS activity report, Quarter 1 – 2010/2011, London

Rail Safety and Standards Board (2002), *Driver reminder appliances: effectiveness study*, London

Schoppert and Hoyt, 1968 cited in National Transportation Safety Board (1998a). Safety at passive grade crossing. Volume 1: Analysis. Safety study NTSB/SS-98/02. Washington DC.

Staff Notice – Trains Departing platforms at Adelaide Railway Station (25 Feb 2010)

The *South Australia Rail Safety Act 2007*

TransAdelaide Commissioned Report - Human Factors of Signals Passed at Danger Project – To identify human error and develop preventative strategies to reduce the influence of human factors that contributes to SPAD risk - June 2008.

TransAdelaide Commissioned Report -A review of the TransAdelaide safety management system (SMS) and to determine the suitability of the system for the management of Signals Passed at Danger - May 2009.

TransAdelaide Commissioned Report - Human Factors Review - Proposed Departure Procedures for Adelaide Railway Station - November 2009.

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 ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to:

- Public Transport Services
- South Australian Railway Safety Regulator
- a number of individuals.

Submissions were received from Public Transport Services and the South Australian Railway Safety Regulator. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

APPENDIX B: SIGNALLING AND POSITIVE TRAIN CONTROL

Signalling systems – general

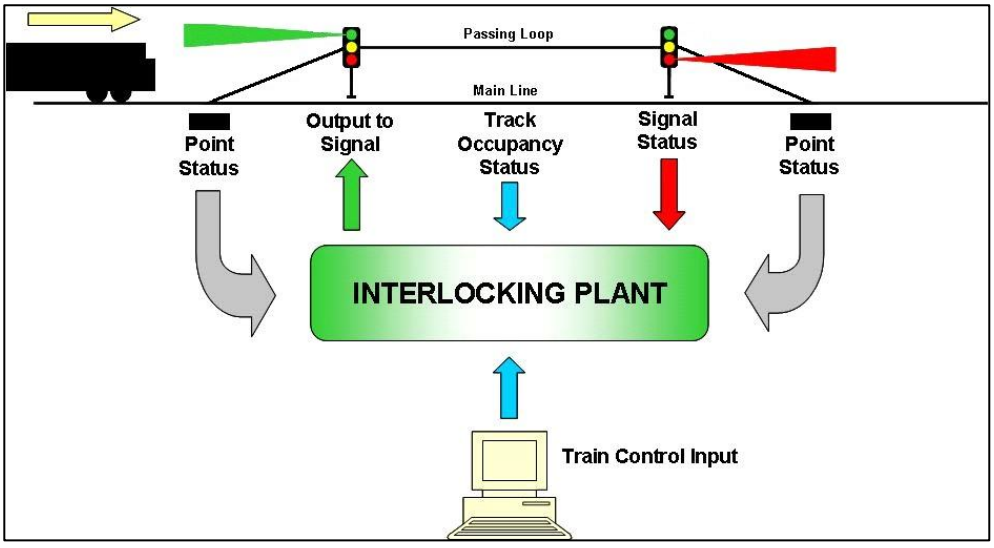
The principal purpose of a railway signalling systems is to:

- Regulate train movements, i.e. satisfy a timetable demand/traffic pattern.
- Maintain a safe distance between train movements.
- Safeguard trains movements at/through junctions and crossings.

Today, the majority of contemporary railway signalling systems comprise (Figure 14):

- Multiple-Aspect Colour Light Signals: Similar to road traffic light signals, these provide a simple and clear indication to train drivers regarding the status of the line ahead.
- Train Detection Systems: Provide geographic train location information for the purpose of positive train detection and to ensure that the positions of trains on running lines are known.
- Interlocking Plant: For ensuring effective interlocking between conflicting train routes, thereby ensuring the safe passage of train movements.

Figure 14: Elements of Railway Signalling Plant



The signalling system used by the PTS for the Adelaide metropolitan passenger rail system comprises a contemporary three aspect colour light system. The PTS uses computer based and relay based interlocking systems for the vital control of its signalling system with an overlay CTC system, based on a non-vital supervisory control and data acquisition (SCADA) control system that provides for the real time monitoring and control of field hardware, such as signals, points, track circuits and the associated real time management of all train movements operating over the network. As with most safety critical systems it is designed to be inherently fail safe.

Over the years, rail safety has dramatically improved as technology and engineering solutions have eliminated many of the early railway operational risks, however one of the primary risks that still remain is a reliance on the train driver to respond correctly to external stimuli.

In most cases, information regarding the status of the line/track ahead as provided by a signalling system is quite basic. It comes in the form of information communicated through the signal indication. This information is essential to a driver in ensuring effective control of a train which due its speed and heavy mass may take a significant distance before it can stop.

However, railway signalling systems in their most basic form do not directly control train speed or braking. Controlling the train is often totally dependent on the train driver(s) who must respond to visual cues provided by the signal indications and other external stimuli, such as ‘Speed Boards’, curves, level crossings, etc.

Positive train control

Positive train control (PTC) is a system of monitoring and controlling train movements to provide increased safety. The main concept in PTC is that the train receives information about its location, permitted speed and movement authorities. Equipment on board the train then monitors this information and enforces speed and movement authorities thereby preventing any unsafe condition from occurring. Most PTC systems are an adjunct to existing signalling systems, i.e. they do not replace the core signalling system.

In recent years PTC systems like ATP have evolved and are increasingly being used by railway administrations. In many cases some PTC systems are now fairly mature technologies and have been highly effective in reducing the occurrence of SPAD events.

In addition to PTC systems there is a suite of lesser ‘Driver Supervisory Systems’ such as ‘Train Stops’ and ‘Automatic Warning Systems’ (AWS) that provide some level of train braking and speed enforcement.

APPENDIX C: SPAD STATISTICS/GRAPHS

Figure 15: Twelve month rolling SPAD report

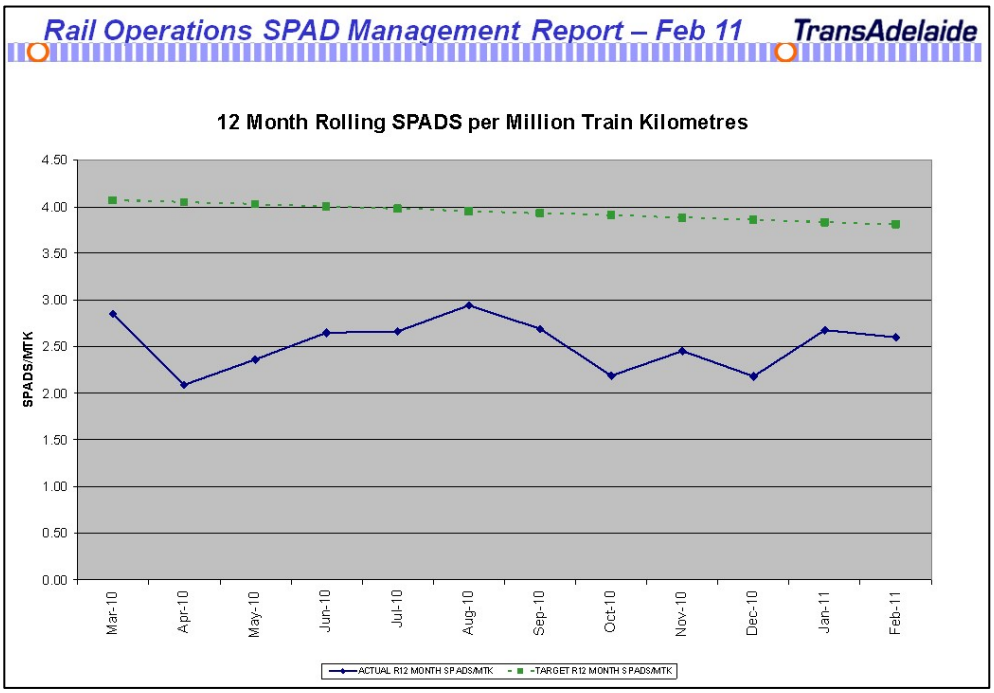


Figure 16: SPAD report – locations having more than two SPAD events

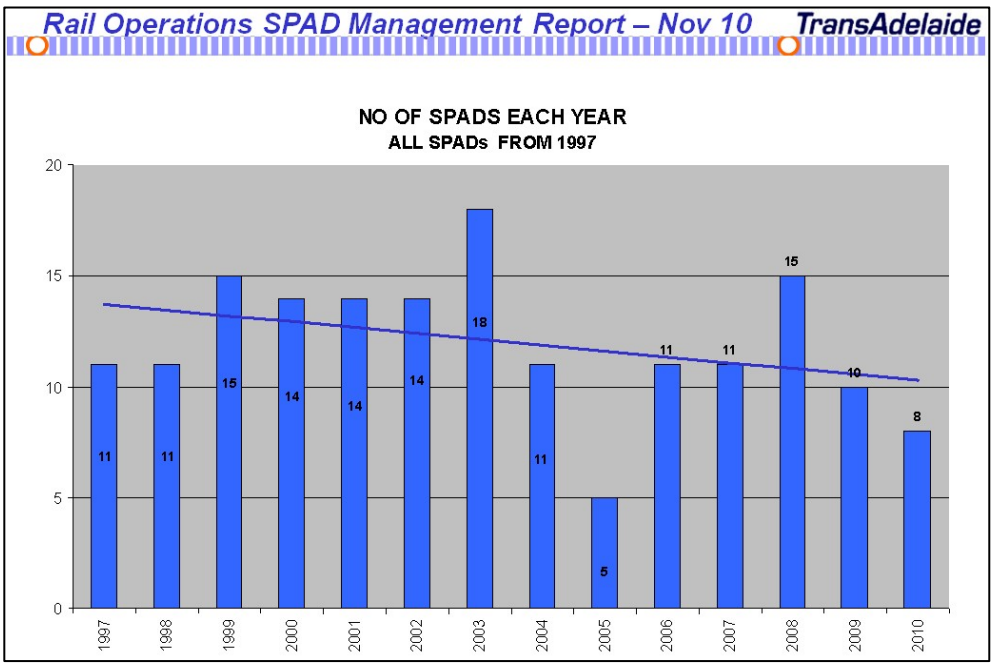
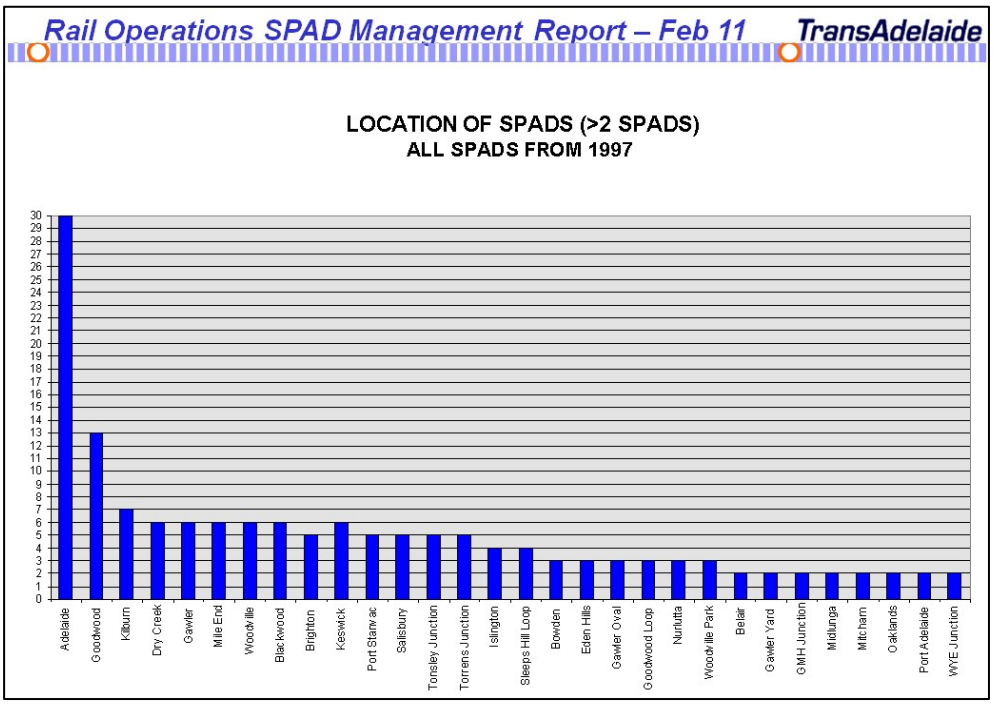


Figure 17: SPAD report – number of annual SPAD events



Collision between suburban passenger trains G231 and 215A in Adelaide Yard, South Australia, 24 February 2011