Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Rail Occurrence Investigation
RO-2009-008
Final

Signal Passed at Danger by XPT ST24 Junee, NSW

9 September 2009

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Abstract

At about 1411 on Wednesday 9 September 2009, scheduled XPT passenger train ST24, en route from Melbourne to Sydney, passed signal JE02 at Junee by about 33 m while that signal was displaying a Stop (red) indication. No injuries or damage resulted from the occurrence.

The driver of ST24 said that signal JE26, the signal before JE02, was displaying a Medium Turnout indication and this meant that signal JE02 would be showing a Proceed aspect. Several other rail employees also said that signal JE26 was displaying a Medium Turnout indication. However, the investigation concluded that it was almost certain that signal JE26 was displaying a Caution Turnout indication rather than a Medium Turnout indication, which would have resulted in signal JE02 displaying a Stop indication. The investigation concluded that the driver's perception of signal JE26 was influenced by expectation, distraction and possibly fatigue, and that the employee witnesses' perception of the signal was influenced by expectation, 'confirmation bias' and 'group think'.

The report identifies three safety issues in relation to prioritisation of operational tasks, signal lamp voltage and signalling design standards.

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 it appropriate. 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 about 1411[1] on Wednesday 9 September 2009, scheduled XPT passenger train ST24, en route from Melbourne to Sydney, passed signal JE02 at Junee, New South Wales while it was displaying a Stop (red) indication, an event commonly referred to as a 'Signal Passed at Danger' (SPAD). The train stopped about 33 m past signal JE02. No injuries or damage resulted from this occurrence.

Having arrived at Junee about 15 minutes behind schedule, train ST24 remained at the platform for about 4 minutes, during which time a driver change occurred with the Sydney sector driver taking over to work the train to Sydney. Just before departure, the Melbourne sector driver advised the Sydney sector driver that he would need to contact network control in order to receive a Condition Affecting the Network (CAN) warning notice.

At about 1407, signal JE26 (located just beyond the platform) cleared to a proceed indication and train ST24 departed the Junee platform about 2 minutes later. The driver said that he believed signal JE26 was displaying a Medium Turnout indication, so he expected signal JE02 (located about 940 m beyond the platform) would have been displaying a proceed indication. However, the network controller had held signal JE02 at Stop to ensure that train ST24 did not depart the station yard limits until the CAN warning notice had been issued. While approaching signal JE02, the driver had been engaged in a conversation with the onboard passenger services supervisor about required stops later in the journey. The driver estimated that when he was about two and a half carriage lengths from the signal he realised that it was at Stop (red). He then made an emergency application of the train brakes but was unable to stop the train before it passed signal JE02.

The investigation found that signal JE02 had displayed a Stop indication since about 0930 on the day of the occurrence. The investigation also found that signal JE26 almost certainly displayed a Caution Turnout indication, not the Medium Turnout indication noted by the driver. The driver's recollection was however supported by witnesses on the platform at the time of departure.

The investigation concluded that the network controller chose a valid but rarely used method to hold train ST24 within the station yard limits at Junee until the CAN warning notice was issued. It was likely that the driver's perception of the indication displayed by signal JE26 was influenced by expectation, distraction and possibly fatigue. The perception of the witnesses who had reported sighting the indication displayed by signal JE26 were likely to have been influenced by expectation and reinforced by phenomena known as 'confirmation bias' and 'group think'. The report identifies three safety issues in relation to prioritisation of operational tasks, signal lamp voltage and signalling design standards.

[1] The 24-hour clock is used in this report. Eastern Standard Time (EST) is Coordinated Universal Time (UTC) + 10 hours. Unless shown otherwise, all times are EST.

1 FACTUAL INFORMATION

1.1 Overview

At about 1411 on Wednesday 9 September 2009, scheduled XPT passenger train ST24, en route from Melbourne to Sydney, passed signal JE02 at Junee while it was displaying a Stop (red) indication, an event commonly referred to as a Signal Passed at Danger (SPAD). The train stopped about one and three quarter carriage lengths past signal JE02. The train had only minutes before departed Junee platform after a driver changeover.

1.2 Location

Junee is located on the main Melbourne to Sydney corridor and is part of the Defined Interstate Rail Network (DIRN) in south-western NSW. Junee is 486 track km from Sydney and 468 track km from Melbourne (Figure 1). The railway corridor is managed and maintained by the Australian Rail Track Corporation (ARTC).

The rail line from Melbourne to Junee comprises a single line bi-directional track with crossing loops for the crossing/passing of trains. The railway from Junee to Sydney consists, for the most part, of two uni-directional tracks; an Up Main and Down Main[2] line.

Figure 1: Location of Junee

[2] Trains travel towards Sydney in the Up direction and towards Albury in the Down direction.

1.3 Train Information

The XPT passenger train was operated by CountryLink, an independent business under the NSW Government agency, Rail Corporation, New South Wales (RailCorp)[3]. Train ST24 is one of two daily return XPT passenger train services from Melbourne to Sydney. The train is operated by a single driver and four 'onboard' staff who cater for passenger requirements. It departs Southern Cross station in Melbourne at 0830 and is scheduled to arrive at Junee at 1350. At Junee a driver change-over occurs before departure for Sydney 2 minutes later at 1352; the scheduled arrival time at Central Station in Sydney is 1955 that evening.

On Wednesday 9 September 2009, train ST24 consisted of lead power car XP2018 and trailing power car XP2010 with six passenger cars in between, including a buffet carriage. The train length was approximately 180 m with an unladen train weight of approximately 266 t. The XPT has a maximum permitted speed of 160 km/h depending on track condition and posted speed limits[4].

Figure 2: CountryLink XPT approaching signal JE02 at Junee

Train drivers

The Melbourne sector driver, operating ST24 from Melbourne to Junee on 9 September 2009, had been employed for the previous 18 months as a CountryLink driver based at Junee. Prior to this, he was employed for 4 years as an electric suburban train driver in Sydney after earlier driving freight trains for Silverton Rail

[3] The body of this report refers to CountryLink in relation to the operation of XPT passenger train ST24. However, recommendations are directed to the accredited owner/operator, RailCorp.

[4] While maximum permitted track speed was 160 km/h, at the time of this incident, CountryLink had limited XPT trains to a maximum speed of 120 km/h due to an unrelated incident in 2004.

based at Chullora. He had arrived in Melbourne the Tuesday evening preceding the day of the incident, having driven the 'daytime' XPT from Junee to Melbourne.

The Sydney sector driver of ST24 was based in Sydney and had 30 years experience in the rail industry in NSW as a train driver. He had driven XPT passenger trains on the Sydney to Melbourne service (Sydney to Junee section) since starting his employment with CountryLink in 1994. During this time he had driven the XPT to and from Junee at least once every 6 weeks. The driver had driven the previous day's (Tuesday) southbound XPT from Sydney to Junee. His arrival time at Junee was 0235 on Wednesday 9 September 2009 and sign off time was 0247. He then rested at a motel where designated rooms are reserved for XPT drivers. The driver signed on again just under 11 hours later at 1342 on Wednesday 9 September 2009 to work the return XPT train (ST24) back to Sydney.

Records indicated that, at the time of the incident, both drivers' competencies were current and that they had been examined and assessed as medically fit in accordance with the *National Standard for Health Assessment of Rail Safety Workers*.

On board staff

The onboard staff consisted of a Passenger Services Supervisor (PSS) and three Passenger Attendants (PA). All four members of the on board staff were based at Albury and had signed on at 1132 on 9 September 2009 to work train ST24 from Albury to Sydney. At Sydney they were rostered to 'lay-over' and return to Albury on Thursday's XPT service.

The PSS had been employed in the rail industry for 35 years during which he had worked as a shunter, an assistant station master and as a signalman (for 15 years). He had been employed by CountryLink since 2003 and was appointed as a PSS in 2007. The PA (referenced in the report as a witness) had previously been employed as a signalman and signalman's assistant at various locations in the Melbourne suburban rail system. He then left rail employment for some years before returning and serving as a conductor on the Victorian rail system prior to employment as a PA by NSW CountryLink in 2006.

1.4 Train control

The network controllers are located at the ARTC Network Control Centre at Junee. The controllers and managers/supervisors are responsible for the day to day operational management of the rail corridor between Tottenham Yard (Melbourne) and Glenlee (New South Wales). Network controllers are stationed at control boards that are allocated geographically according to distances and traffic density. The control boards have electronic displays that mimic the status/occupancy of track circuits (field equipment) that detect trains in the field. Voice communication between train drivers and the network controller is via the respective Victorian and NSW train to base radio systems.

Signals JE26 and JE02 at Junee are controlled by a network controller stationed at the Main South C Board. The Main South C Board controls the DIRN from Tottenham Yard in Melbourne up to and including the Junee station yard limits. At the time of the occurrence this Board was new, having been brought into use on 30 August 2009 when the Junee train control assumed responsibility for managing part of the north-east Victorian train network.

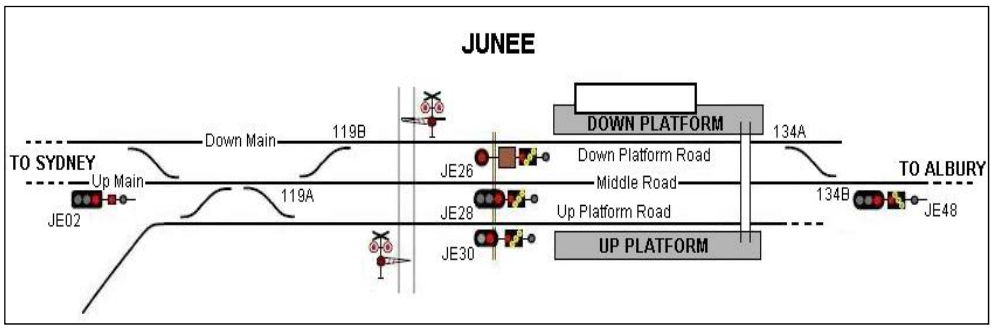
Network controller

The network controller who was working on the Main South C Board at the time of the incident had worked in the rail industry for 26 years and had been employed as a network controller at Junee for 3 years. He had been working on the Main South C Board since its inception on 30 August 2009 under the guidance of a mentoring controller who had been trained in the new arrangements. On the day of the incident, he had signed on for duty at 0700.

1.5 Track layout and signalling

The platforms at Junee have three tracks between them. The track closest to the Down platform is an extension of the Down Main from the north. The movement of rail traffic at Junee is controlled by fixed colour light signals using Rail Vehicle Detection (RVD)[5], remotely operated from the Junee Network Control Centre. For trains travelling from Albury towards Sydney, entrance onto the Down Platform Road is over 134 points set reverse and controlled by signal JE48. Departure from the Down Platform Road is controlled by signal JE26. Trains pass onto the Up Main over 119 points set reverse before travelling along the Up main to signal JE02. The Olympic Highway level crossing is located approximately 50 m north of Junee station (Figure 3).

Figure 3: Signal schematic (part) - Junee Yard



As with many SPADs, it is the train driver's response to indications displayed by the preceding signals that may influence the event at the SPAD signal. In this case, the SPAD occurred at signal JE02; the preceding signal was JE26.

Signalling – field equipment

The field equipment consists of signals, points, track circuits, etc. In railway systems employing colour light signals like those at Junee the '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. Signal JE26 was a colour light signal with a single light (red aspect) main head, a left hand turn out signal (route indicator), a Main Line Route Indicator, a Shunt Signal and a red marker light. The signal was located just beyond the northern end of the Junee Down Platform (Figure 4).

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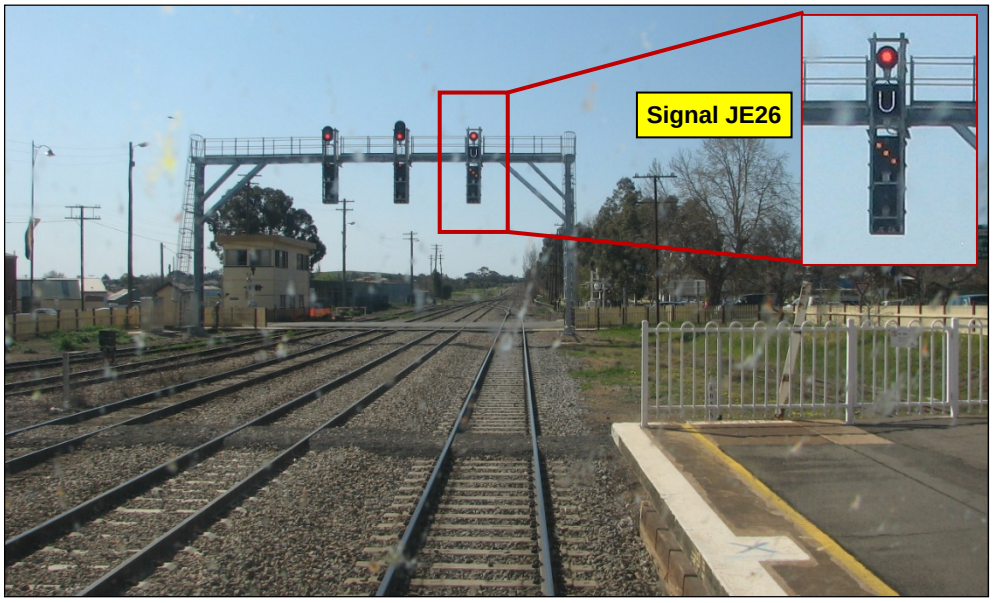
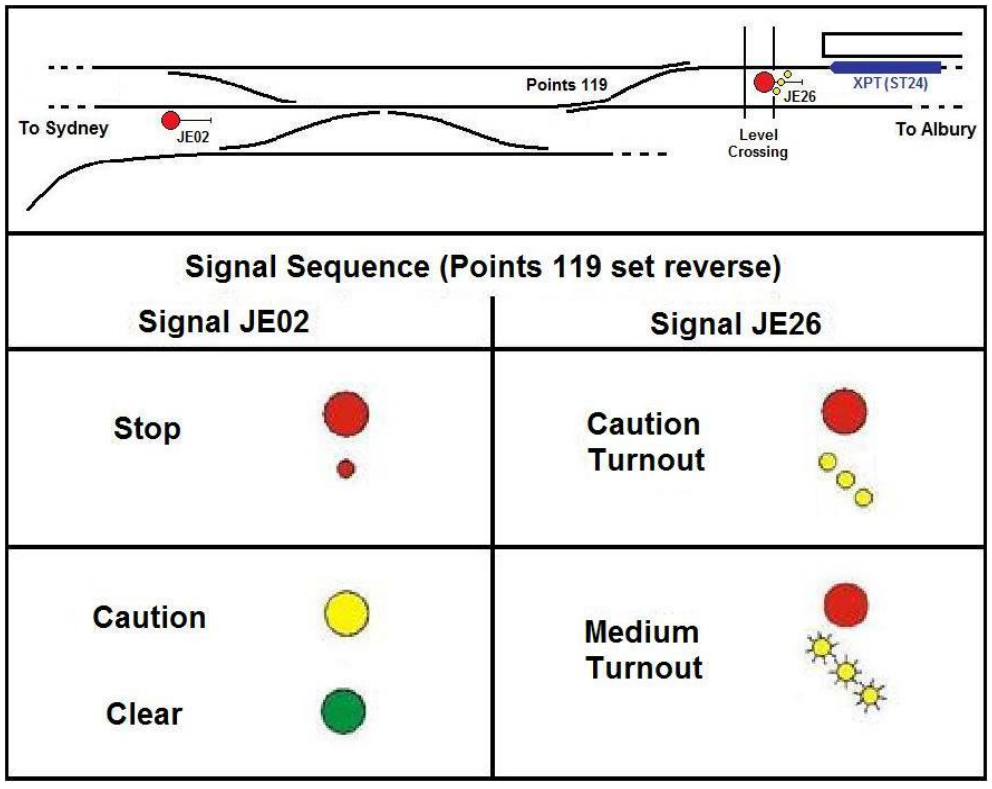
[5] The portions of line where the system of Safe-working relies on track-circuiting or axle counters. (ARA Glossary for National Code of Practice and Dictionary of Railway Terminology).

Figure 4: Photograph from XPT driving cab, northbound at Junee platform



Signal JE02 was a colour light signal with a three light main head. The signal was located about 940 m beyond the northern end of the Junee Platform. Figure 5 shows the signal sequence displayed to a train driver travelling from signal JE26 (departing the Junee Down Platform) onto the Up Main via points 119 set reverse.

Figure 5: Signal sequence for signals JE26 and JE02



Note: The radial lines on the Medium Turnout indications imply that the lights are pulsating indications.

A Caution Turnout indication is displayed on signal JE26 when signal JE02 is at stop. When sighting a signal displaying a Caution Turnout indication, a driver should be prepared to stop at the next signal.

A Medium Turnout indication is displayed on signal JE26 when signal JE02 displays a proceed indication[6] (Caution or Clear). When sighting a signal displaying a Medium Turnout indication, a driver can expect the next signal to be displaying a proceed indication.

Signalling – interlocking equipment

Interlocking equipment manages the safety interlocking function between points, signals and conflicting train routes. The Microlok interlocking system was installed at Junee to provide this function. The Microlok system is a proprietary microprocessor-based logic controller specifically designed for railway fail-safe[7] applications and incorporates two types of software programs:

- The executive program, which is common to all Microlok systems and contains the standard software applications that ensure vital outputs are fully controlled, verifies the state of vital inputs and outputs, and removes power to vital outputs if a system failure has occurred.
- The geographic application software which is specific to the signal layout that the interlocking is controlling.

The Microlok 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.

Signalling – train control equipment

The control system in Junee is a non-vital CTC[8] system that provides real time monitoring and control of signals, points and track circuits (via the interlocking equipment). The system operating in the ARTC Network Control Centre at Junee was the Phoenix control system. The Phoenix system provided graphical representation and control of field equipment from the network controller's workstation (Figure 6) plus the facility to capture data on an event logger. This data could be viewed at a later date to assist with the replay of events and the examination of incidents/accidents.

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6 Proceed indication – Any signal indication other then Stop. (Source: Engineering Standard-NSW Signalling SGS 01 Infrastructure Engineering Manual – Glossary of Signalling Terms). Note: Throughout this report where 'Proceed Indication' is used it excludes a shunt signal used for a shunt or low speed movement.

7 Fail-safe – The capability of an item or system to ensure that any failure in a predictable or specified mode will result only in that item or system reaching and remaining in a safe condition (Source: AS4292 Part 4).

8 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).

Figure 6: Graphics Overview - Phoenix Control System

1.6 The occurrence

On 9 September 2009, XPT Passenger Train ST24 departed Melbourne at 0833. While train ST24 was travelling between Melbourne and Junee (a 468 km journey), the network controller (Main South C Board at the Junee network control centre) received advice from the network controller working (the adjacent) B board[9] that the level crossing equipment near Marinna (7.3 km to the north of Junee) may be faulty. At the time of receiving this advice a 'block'[10], which had been put in place earlier in the day to prevent signal JE02 from being cleared, was still in place. The controller left this block in place, intending to issue the driver of ST24 with a Condition Affecting the Network (CAN)[11] notice before the train departed the Junee station yard limits.

Due to track work and delays between Melbourne and Junee, train ST24 was about 15 minutes late arriving at Junee. The train entered the southern end of Junee yard on the single line from Melbourne and crossed over to the Down Platform Road in the usual manner. The front of the train came to a stand at the XPT 'stop board' which was adjacent to a fire hose on the wall of the small storage building to the north of the main station building. The Sydney sector driver, who was waiting to join the train, used the fire hose to wash insects from the windscreen of the leading power car, while the Melbourne sector driver operated the windscreen wipers. While the Sydney sector driver was hosing the windscreen, the Junee train controller called the XPT driver's cabin in order to issue the CAN notice. The Melbourne sector driver answered the call and told the network controller that they had not yet finished their hand-over but that he would speak to the Sydney sector driver and tell him to contact network control in order to acquire the CAN notice.

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9 The B board controller controls the DIRN from the yard limits at Junee north to Joppa Junction (Goulburn).

10 Block/blocking facility - A device applied by signallers to the controls of signals and points and to other safe-working equipment in order to prevent the controls or equipment from being operated.

11 A Condition Affecting the Network (CAN) form is used to provide written warning to drivers and track vehicle operators about conditions that can or do affect the safety of operations on the ARTC Network in NSW.

When the driver had finished cleaning the windscreen, the Melbourne sector driver briefed the Sydney sector driver about the train condition[12] and of the need to call train control when he could about a CAN notice. The Melbourne sector driver then left the XPT driver's cabin and the Sydney sector driver boarded.

Upon hearing radio communications between the PSS and the Sydney sector driver that indicated the crew of train ST24 were closing the passenger doors in readiness for departure, the network controller set signal JE26 to clear to allow ST24 to depart the Junee platform. Setting signal JE26 to clear initiated the operating cycle for the Olympic Highway level crossing protection equipment. When the gates had lowered, signal JE26 cleared to a Proceed aspect indicating train ST24 could depart the Junee platform. The network controller said that anticipating the departure of the XPT in this manner was a common practice and resulted in less delay for the XPT as signal JE26 could not clear until the level crossing gates had lowered.

Departure from Junee

The Sydney sector driver (now referred to as the driver of ST24) said he looked up at signal JE26 shortly after the Olympic Highway level crossing boom gates were lowered. After he received the 'right away'[13] signal from the PSS, he again looked at signal JE26 before releasing the train brakes and moving off in the usual manner. During this action he also noted that the Olympic Highway level crossing boom gates were lowered and that the road traffic was stationary. The driver's recollection was that each time he looked at signal JE26 he 'took it to be pulsating'. That is, he thought it was displaying a Medium Turnout indication (pulsating band of yellow lights)

Once through the cross-over points (points 119) and on the Up Main, the driver said he commenced accelerating the train towards its (then) maximum permitted speed of 120 km/h while, at the same time, trying to return the network controller's earlier phone call regarding the issue of a CAN. He said he made the call to the network controller via the 'quick auto-send button' rather than manually dialling the number. However, the driver terminated the call after it went unanswered for an estimated 30 to 40 seconds. He then called the PSS on the train intercom about which doors he would require to be opened at the various stops en-route; he said this was a routine practice while leaving Junee and going 'up the hill'. While talking to the PSS the driver said he was looking ahead through the windscreen in the direction of the signal, but not directly at it. When an estimated two and a half carriage lengths from signal JE02, while still talking to the PSS on the intercom, he saw that the signal was displaying a red aspect. He said he immediately dropped the intercom phone, pushed the throttle closed and applied emergency braking. However, the train did not stop before passing signal JE02 by an estimated one and three quarter car lengths.

When the SPAD event occurred the network controller, who was positioned at the Main South C Board, saw the SPAD alarm illuminate. About 5 seconds later the driver of ST24 contacted the C board network controller who asked if he had 'gone past that signal'. The driver replied that he had. The network controller then conveyed the CAN to the train driver. Once the CAN had been issued the network

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[12] This included advice that the brakes on one bogie of the trailing power car had been isolated due to air leaks and that one toilet in car 2216 was not working.

[13] 'Right away' is a signal to the driver that the platform work has been completed and that passengers are either onboard or clear of the train.

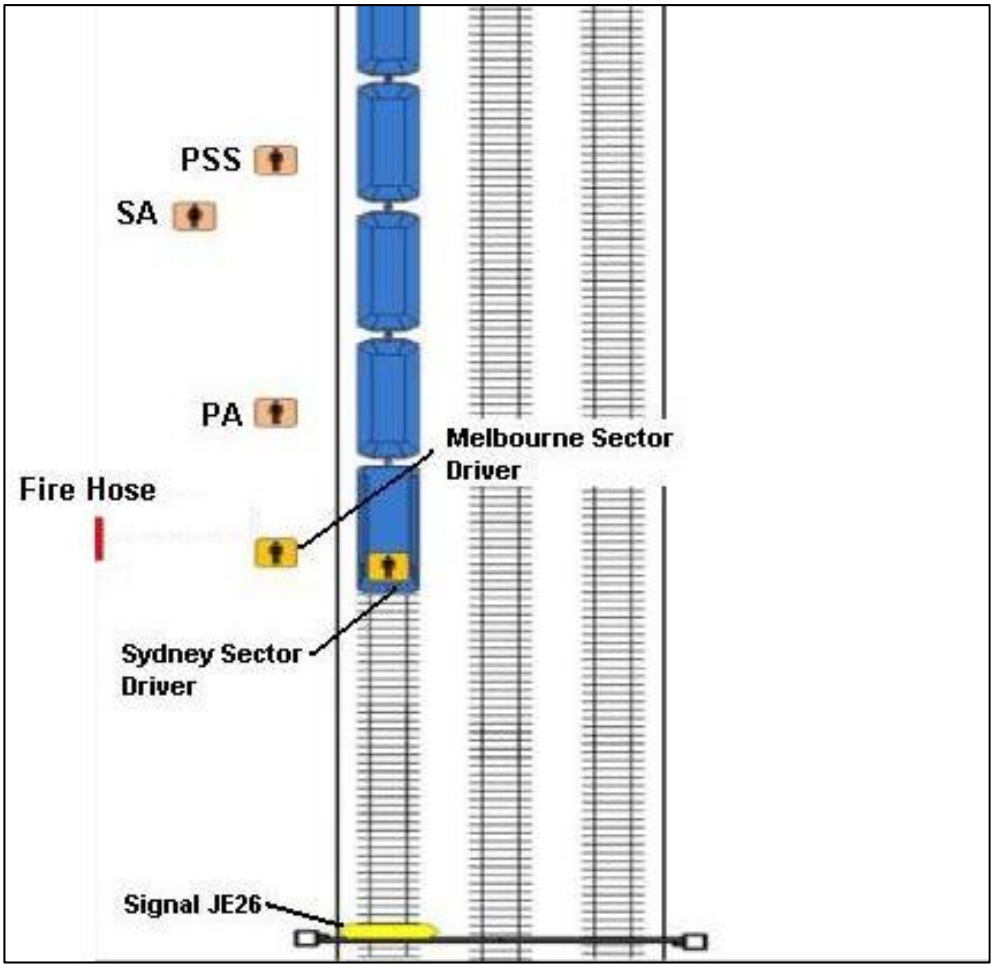
controller told the driver to stay where he was until he spoke to his supervisor. The driver was asked whether he had misjudged the signal, or if he thought it was clear. He responded that he initially thought the signal was at Proceed but as he got closer, he saw that it was red. After about 7 minutes the network controller contacted the driver again and told him to change ends and bring the train back into Junee station platform. The driver then changed ends and, after receiving an authority to return to Junee platform, moved back to the Junee platform.

While waiting at Junee, the train crew and the Melbourne sector driver (who was still at the Junee station) discussed the events that had occurred with the driver involved in the SPAD. Train ST24 continued its journey to Sydney at 1445 with the PSS accompanying the Sydney sector driver in the lead power car cabin.

1.6.1 Witness accounts

Figure 7 illustrates the location of witnesses while train ST24 was waiting at the Junee station.

Figure 7: Location of witnesses



Onboard staff

When train ST24 first arrived at Junee station, the PSS had alighted from the train to assist passengers on and off the train. The PSS was positioned almost mid-way

along the train, at the third carriage behind the power car. He said that about 2 minutes after arriving at the station he saw the boom gates at the nearby Olympic Highway level crossing begin to descend, which he said is a precursor to the signal changing to allow the train to depart. Shortly after he saw signal JE26 change to an aspect which he described as “scattered flashing aces”. He then walked back to the PSS workstation towards the rear of the train, observed the driver enter the driver’s cabin, and blew his whistle as a warning to passengers of the train’s imminent departure. He checked that signal JE26 indicated that the train still had the authority to proceed and operated the push button that gave the driver ‘right away’. The train then departed from Junee station.

The PA had alighted from the train with the PSS. He said he saw the Melbourne sector and Sydney sector train drivers change over. He walked towards the drivers at the front of the train and overheard one of the drivers tell the network controller that ST24 was ready to proceed. The network controller responded with ‘yes, the signal is coming up’. The PA then saw the nearby Olympic Highway level crossing boom gates come down. He then glanced up and saw signal JE26 change. He stated that he had looked at signal JE26 for at least 5 seconds and thought that the signal was displaying a ‘flashing arrow’. He was of the opinion that if the signal displayed had been different, with his experience, he would have queried it. He then walked back to the luggage van and boarded. He advised the PSS that he was on board the train and that all luggage had been stowed. He then watched the side of the train from the door of the luggage van as the train left the platform.

After the train departed the station, the PSS said that he received a call from the driver on the intercom requesting information as to which of the ‘on demand’ passenger stations between Junee and Sydney would require a stop for passengers. The PSS said that during the course of the conversation the driver suddenly said words to the effect ‘that he was going to run past a red light’. The brakes were felt coming on and the train came to a halt. The PSS then looked out of the door from his position towards the rear of the train and saw that the train had passed the signal by at least one carriage length. The PSS remarked that the red light indication of the signal was so dull that he could not see it from his position on the train, an estimated 140 m from the signal.

After several minutes, the PSS was advised by the driver that the train would be returning to Junee station. The driver then changed ends, and the PSS walked in the opposite direction to the other end of the train. The train then returned to Junee station platform. The PA had remained in the luggage van.

Once back at the Junee station, the PSS and the PA conferred. The PA said he thought it was unusual that a red light was displayed at signal JE02 because he believed an ‘arrow’ on signal JE26 had been flashing. The PSS then asked the PA if he was sure he saw it flashing. The PA said that he had never seen signal JE26 display anything other a ‘flashing arrow’ when cleared.

Upon departure from Junee the PSS joined the incident driver in the driver’s compartment where he remained until Goulburn. At Goulburn an additional driver had been called in for duty to accompany the driver of ST24 for the remainder of the journey to Sydney. After departure from Goulburn the PSS returned to his normal duties.

Melbourne sector driver

The Melbourne sector driver said that after the Sydney sector driver entered the driver's cabin, he looked up and saw that the train 'had the road'. He said that he was '80 percent' certain that he saw a pulsating signal, that is, a Medium Turnout indication in signal JE26. He also said that signal JE02 was not visible from the platform in daylight because it was a 'very faint signal'.

After the train departed Junee station, the Melbourne sector driver walked towards the CountryLink office, pausing to give the train a 'roll-by' inspection as it moved away. He was in the office preparing to sign off when the Junee station attendant drew to his attention that the train had stopped just past JE02 signal. He then went back out onto the platform and saw that the train was stationary. He returned to the office and made two attempts to ring the driver of ST24. No response was received. He then rang one of the onboard staff, who advised him that the train had passed a signal at danger. The Melbourne sector driver remained on the platform until ST24 returned whereupon he spoke to the driver, the PSS and the PA. The Sydney sector driver said that he had a Medium Turnout indication in signal JE26 when he departed the platform; this opinion was shared by the PSS and PA.

The Melbourne sector driver also said that he had only ever seen signal JE26 display a Medium Turnout indication when at proceed. He said 'I would have said something if the signal was not showing its normal indication'.

Junee Station Assistant

The Junee Station Assistant said that she had observed signal JE26 prior to the departure of train ST24, and was '90 percent certain' that it was displaying the flashing 'scattered aces' consistent with a Medium Turnout indication. She said that in the two and a half years that she had worked at Junee that she had never seen the signal display a Caution Turnout indication with steady 'scattered aces'.

1.6.2 Post incident response

Immediately following the SPAD event, when the Sydney sector driver of ST24 returned to Junee platform, he was tested for the presence of alcohol by a NSW Police constable from the Junee Police Station. At about the same time the network controller was also tested for the presence of alcohol by an accredited ARTC employee. The train driver and the network controller both returned zero readings.

2 ANALYSIS

Investigators from the Australian Transport Safety Bureau (ATSB) sourced a variety of evidence pertaining to the SPAD incident at Junee on 9 September 2009 from the Australian Rail Track Corporation (ARTC) and the Rail Corporation, New South Wales (RailCorp). ATSB investigators examined the operation of the signalling system at Junee, undertook on-site signal sighting inspections from both ground level and from the driver's cabin of the XPT and conducted interviews of all persons who were either directly involved or who were witnesses to the events leading to the SPAD incident.

Based on the driver's account, the fact that Signal JE02 was displaying a red (Stop) indication as train ST24 approached is not in contention. Nor is the fact that train ST24 passed the signal while it was displaying a red (Stop) indication. However, there was a discrepancy in relation to the aspect displayed in signal JE26. If JE02 was displaying a red indication, then JE26 should have been displaying a Caution Turnout indication (steady yellow lights), but the driver of ST24 and witnesses said the signal was displaying a Medium Turnout indication (pulsating yellow lights).

Resolution of this discrepancy is important because a train driver's actions at, or approaching, signal JE02 are influenced by what indications were observed at signal JE26. Consequently, the analysis focuses on:

- the verification of signal aspects
- the actions of the train driver
- factors that may have influenced the driver's actions
- factors that may reduce the SPAD risk.

2.1 Signalling system analysis

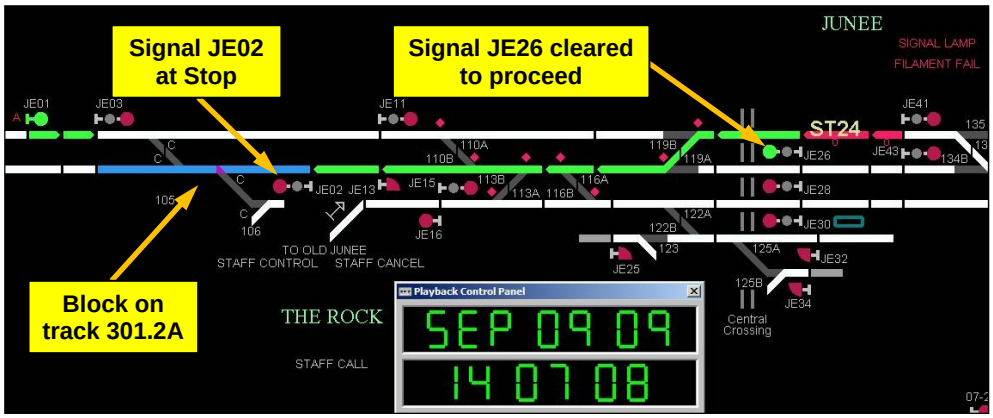
The examination of recorded data (Phoenix control system and Microlok interlocking system) showed that, at about 0915, signal JE02 had been set and cleared for the passage of a work train (3M72). The Phoenix system also showed that the network controller placed a block on 301.2A track (the track in advance of JE02) immediately after clearing the signal. The block was applied to prevent the Phoenix system from sending any further commands that would clear signal JE02 until such a time that the block was removed. The recorded data showed that the block had remained in place from about 0915 and was still in place when train ST24 arrived at Junee station at about 1405. Similarly, the data showed that no attempt was made to clear signal JE02 during this time.

Further examination of the recorded data showed that no attempt had been made to clear signal JE26 until 1406:46 when the network controller 'called'[14] the signal for the departure of train ST24. Signal JE26 took about 22 seconds to display a Proceed aspect, primarily due to the time required for the level crossing boom gates to be lowered (a requirement for the signal to clear).

[14] When a signal is 'called', a command is sent to the signal interlocking system requesting the signal to clear, but the signal will only clear to a Proceed aspect when all the required conditions (such as tracks clear, points set, level crossings operating) are met.

Figure 8 shows the Phoenix replay system displaying the signal data that was recorded at 1407:08. Signal JE26 has cleared to a Proceed aspect and the route up to signal JE02 is shown as available (green track indications). However, it is evident that signal JE02 has not been called, is displaying a red indication and track 301.2A is shown as blocked (blue track indication).

Figure 8: Phoenix replay system – Event time 1407:08



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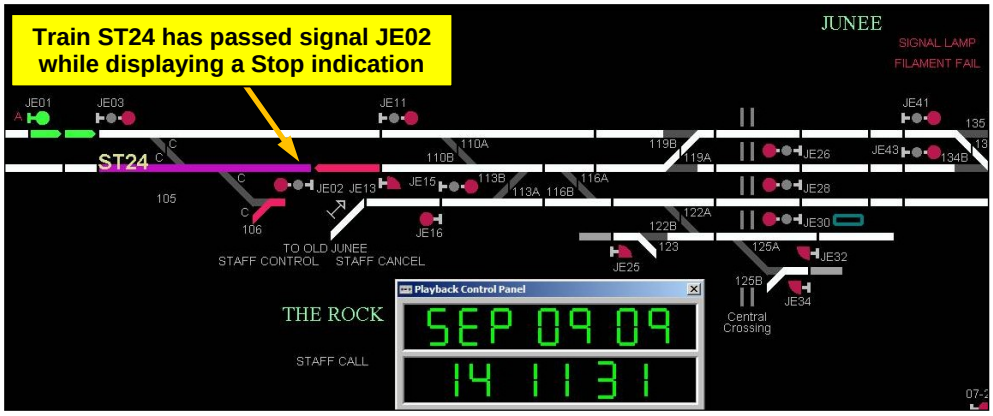
The recorded data indicated that train ST24 departed Junee station, travelled over the points and advanced through the block section towards signal JE02. At 1411:31, the data indicates that train ST24 passed signal JE02 while this signal was displaying a Stop indication (Figure 9).

Figure 9: Phoenix replay system – Event time 1411:31



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The recorded data showed that for the entire sequence, from the time train ST24 was at the station through to the time of the SPAD, signal JE02 was displaying a red Stop indication and a block was applied to track 301.2A.

The driver of train ST24 confirmed that JE02 had displayed a Stop indication and the signal had remained at Stop until the train passed it, though he had only observed it for a relatively short distance. The network controller confirmed that at no point did he attempt to clear signal JE02, nor had he removed the block on track 301.2A.

Based on available information, it is concluded that signal JE02 had only ever displayed a red indication for the entire event sequence.

Signal JE26

Having established that signal JE02 had continuously displayed a Stop indication, it was necessary to examine signal JE26 for correct operation.

The data recorded by the Phoenix control system was only designed to record if a signal has displayed a Stop or Proceed indication. That is, it did not record what level of Proceed was displayed (that is, a Caution Turnout or a Medium Turnout indication for signal JE26). This level of data recording is normal for a train control system, but it is equally normal for a computer based interlocking system, such as Microlok, to record the level of Proceed.

In this case, the investigation revealed that the Microlok program design did not log internal data that would have been of assistance in determining whether signal JE26 was displaying a Caution Turnout or a Medium Turnout indication. Therefore the operation of JE26 could only be determined through post incident functional tests and observations. Functional testing found:

- With signal JE02 set to Stop, signal JE26 was examined and found to only display a Caution Turnout aspect (steady diagonal band of lights).
- With a block applied, signal JE02 could not be cleared.
- With the block removed and signal JE02 set to Proceed, JE26 displayed a Medium Turnout aspect (pulsating diagonal band of lights).

The Microlok system date and time was also checked; it was found that the events for 9 September 2009 were showing correct date and time. The Microlok system error log was also downloaded and examined. No errors were recorded on 9 September 2009. Therefore, it was considered highly unlikely that there were any abnormal events associated with the Microlok system that could have contributed to an incorrect operation of signal JE26.

The cables that feed signal JE26 were examined and found to be in good condition. The earth leakage detectors were correctly set with no evidence of any earth leakage having occurred. This strongly indicated that cable integrity was sound and that there was no false electrical feed that may have contributed to an incorrect operation of JE26 signal.

A review of signal faults and incidents for the Junee area, with a particular focus on any wrong-side signal failures[15] involving Microlok systems, was undertaken. No instances of wrong-side-signal failures in the Junee area were found. In addition, in the lead-up to the incident there were no reported events similar in nature to that reported by the driver of the train ST24 that necessitated further investigation. It was also found that maintenance was performed in accordance with the appropriate ARTC standards.

Based on available information, there was no evidence to suggest that the signalling system was faulty in any way. Consequently, it is almost certain that signal JE26 had been displaying a Caution Turnout indication (steady yellow lights) when train ST24 departed the Junee station.

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[15] A failure in the signalling system which causes a potentially dangerous situation to exist. For example, ... if 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).

Irrespective of these findings, any allegation of a wrong-side signal failure is serious as it rightly or wrongly calls into question the integrity of the signalling system. An investigation into such an allegation should ideally have the ability to determine, as conclusively as possible, the actual indication displayed in a given signal.

ARTC signalling standard SCP23 - 'Design of Microlok Interlockings' states:

> "As a minimum, the bits to be logged are:
>
> • All inputs (vital and non-vital)
>
> • All outputs (except flashing, pulsing or toggled outputs)
>
> • Any internal bit that may give a concise report of an event. As a general rule logging of all internal variables is not required. Internal bits that initiate flashing, pulsing or toggled outputs are to be logged."

In this case, the Microlok signal interlocking system installed at Junee did not log all bits that initiate flashing, pulsating or toggled outputs. Logging these functions would have been of assistance in determining the signal indications for JE26. As such the system probably did not meet the design requirements specified in the ARTC signalling standard, with respect to data logging.

Conclusion

Based on available information, it was concluded that signal JE02 displayed a red indication for the entire time that train ST24 was at the Junee station up to, and including, the time that the train passed the signal at Stop. Also, there was no evidence to suggest that the signalling system was faulty in any way. Consequently, it is almost certain that signal JE26 displayed a Caution Turnout indication (steady yellow lights) when train ST24 departed the Junee station.

2.2 Train handling

Both XPT power cars were fitted with tape based Hasler data loggers. The tape from lead power car XP2018 was found to be in good condition; however, the tape from the trailing power car XP2010 was damaged. After correction for actual wheel diameter, it was never-the-less possible to show a high degree of correlation between the two data sets.

Examination of the recorded train data found that ST24 departed the Junee station, passed over the crossover points 119 at about 30 km/h and accelerated along the Up Main towards signal JE02. When ST24 was about 76 m from JE02, it was travelling at about 56 km/h. At this point in time, the data indicated that the train's throttle had been placed back to the idle position and the brake cylinder air pressure had begun to increase (that is, the train brakes were beginning to apply). This shows that the driver had reacted to the red Stop indication on signal JE02 and was attempting to stop the train before passing the signal. The data indicated that train speed reduced to about 29 km/h by the time it reached signal JE02 and stopped completely soon after passing the signal.

The driver said he saw the signal at Stop when about two and a half carriage lengths (about 60 m) from signal JE02. However, the data shows the train brakes applying 16 m before this point. Allowing for reaction times of one or two seconds in

addition to the recorded brake application at 76 m, it would seem the driver was between 91 m and 107 m from signal JE02 when he first realised it was at Stop. This equates to between four and 4.5 carriage lengths rather than the driver's estimation of two and a half carriage lengths.

The recorded data also appears consistent with a train driven in a manner where signal JE02 was expected to be displaying a Proceed indication. The driver of ST24 had stated that this was the first time in the 15 years driving on this route that he had ever encountered signal JE02 at Stop. Combined with his belief that signal JE26 had been displaying a Medium Turnout indication, it is conceivable that the driver had expected signal JE02 to be displaying a Proceed indication.

2.3 Factors influencing driver actions

As mentioned previously, a train driver's response to indications displayed by a preceding signal is likely to influence the actions taken when approaching the SPAD signal. Trains are driven 'in advance' and, as a consequence, signal and safe-working systems are designed to give advance notice and authority to train drivers with respect to traversing a section of track. In this instance, signal JE26 not only provided authority to travel up to signal JE02, but also provided information on the status of signal JE02.

The testing of the signalling system at Junee found that it was almost certain that signal JE26 was displaying a Caution Turnout indication consisting of a steady band diagonal of lights. This almost certainly indicates that the driver of train ST24 has made an error in that he did not correctly perceive the indication displayed in signal JE26. Consequently, the following analysis focuses on the factors that may influence a driver's incorrect perception of a signal indication.

Errors that occur while executing familiar tasks are sometimes referred to as 'automatic' or 'absent minded' errors. Misreading a signal, either the signal passed at stop or the previous signal, is an example of this type of error. Consequently, the influences that may lend themselves to an error of this type were examined.

Looked but did not see

Research has shown that in road accidents, critical or important information may have been detectible but the motorist did not attend to or notice that information[16]. These are often termed 'looked but did not see' events and include a phenomena known as 'inattentional blindness'.

Inattentional blindness occurs when 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', but rather that their limited attentional resources were occupied elsewhere. Research suggests that inattentional blindness can occur when attention is mistakenly filtered away from important information and can be affected by mental workload, expectation, conspicuity and capacity. In short, a person may fail to detect an object even though they were looking directly at it.

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[16] Green, M., Senders, J. (2004). *Human error in road accidents*. Visual Expert

In this instance, the train's Hasler data logger showed a dwell time, between arrival and departure at Junee platform, of just less than 4 minutes. During this time the Sydney sector driver was given a 'hot-seat' handover from the Melbourne sector driver. Change over involved advice of train defects, pending safe-working requirements and 'secondary' tasks such as cleaning the windscreen, gathering personal belongings, vacating and entering the driver's cabin and adjusting the position of the driver's seat, controls etc. There was also the possibility that a desire not to delay an already late running train was a factor in departing as quickly as possible.

Given the demand on the driver's attentional resources at the time of departure, it is possible that he perceived signal JE26 was displaying a Proceed indication, but failed to notice it was a Caution Turnout indication (as opposed to a Medium Turnout indication) even though he looked directly at the signal. This action would be consistent with the phenomena known as 'inattentional blindness'.

Expectation

Another factor which can influence behaviour is expectation. If an individual does not expect to see something then they may simply not look for that information and behave accordingly or they may look but not see what is there because they were not expecting to see it. 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]. The user's perception that an event is likely to occur is reinforced every time the user encounters that event.

The driver of ST24 had been driving XPT trains between Junee and Sydney since 1994, a period of some 15 years. During this time he said that he had never seen signal JE26, when at Proceed, display anything other than a Medium Turnout aspect. Similarly, he had never seen signal JE02 at Stop. It follows that a low expectancy of seeing a Caution Turnout aspect may have resulted in visual scanning that did not include looking for a Caution Turnout aspect, but merely the presence of an indication to proceed, and the driver responded in line with past experience.

Receipt of 'right-away'

In NSW the driver of a passenger train is given a 'right away' to proceed by the guard or PSS when the platform work has been completed and the starting signal or guards indicator, if provided, is displaying a Proceed aspect. The 'right away' signal indicates to the train driver that the platform work is complete and that the train may depart. However, the onus is on the driver to ensure that the applicable signal is displaying a Proceed indication before departure.

Previous instances of SPADS have occurred because a driver has departed a platform against a signal displaying a Stop indication after receiving 'right away' from the PSS or guard. Investigations into these occurrences have coined the term 'ding-ding and away'. The term basically describes a scenario wherein the driver is given the 'right away' by the guard or PSS to proceed but has not confirmed or checked the aspect of the signal before doing so.

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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.

When the driver of ST24 was given 'right away' by the PSS before departing Junee platform signal, JE26 was displaying a Proceed indication. Therefore, the procedural requirements pertaining to signal indications when 'right away' was given by the PSS and received by the driver were met. However, there is still a possibility that the driver's expectation of an unimpeded departure from the Junee yard limits was further reinforced by the routine receipt of 'right away' from the PSS, thereby contributing to the mindset that signal JE26 was displaying a Medium Turnout indication.

Distraction

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

> …when a driver is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object or person within or outside the vehicle compelled or tended to induce the driver's shifting attention away from the driving task[18].

Driver distraction 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 (mobile telephone), smoking, and conversing with another occupant are all factors that may distract from the driving task. While some of this research was conducted in the context of the driver of a road vehicle[19], the findings would, in all probability, be pertinent to the operator of other machinery, including trains.

In this instance the driver's workload while at Junee platform encompassed a range of tasks. A number of these tasks were routine but others, such as the advice of a brake cut out and the need to contact network control to receive a CAN, were additional. It is possible that the train driver's thought processes associated with comprehending the advice from the other driver, then departing from the platform may have drawn on his visual and cognitive resources to the extent that he misread the aspect displayed by signal JE26.

Although the driver's perception of the aspect displayed by signal JE26 was critical to his expectation at signal JE02, there may still have been the opportunity to sight JE02 and react earlier than what occurred. The driver said that, after departing the platform, he tried to contact the network controller regarding the CAN. Having failed to contact the network controller, he then contacted the PSS regarding stops en-route. It is possible that these actions contributed to a level of distraction that may have drawn on his visual and cognitive resources to the extent that he failed to notice the red indication displayed by signal JE02.

RailCorp Network Rules and Network Procedures provide a comprehensive set of instructions in regard to the operation of rail traffic over the RailCorp network. However, there is no guidance or instruction that specifically refers to the need of a

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

[19] It has been estimated that driver inattention contributes to 25% of road accidents, and that distraction is a contributing factor in over half of these inattention accidents (Young et al. (2003)

train driver to prioritise tasks at safety critical locations or at times when workload is high.

Without doubt, the principal task of the driver of ST24 on 9 September 2009 was to safely depart the train from the Junee yard limits. The attempt to contact the network controller and the subsequent conversation with the PSS, while required at some point, were a diversion of the driver's attention from the principal task. Based on available information, it is likely that diversion of attention contributed to the driver's perception of signal JE26 and the subsequent failure to sight signal JE02 in sufficient time to stop train ST24 before passing the red signal.

Fatigue

In the context of human performance, fatigue is a physical and psychological condition that is primarily caused by prolonged wakefulness and/or insufficient or disturbed sleep. Fatigue can have a profound effect on an individual's performance. It can reduce attention, increase reaction time and affect memory. It can also affect a person's ability to judge distance, speed and time. Research has shown that partial sleep loss from going to sleep later or waking earlier can also influence performance. For example, it has been shown that waking two hours earlier than normal can lead to a decline in performance of more difficult short-term memory tasks.

Rail safety laws in NSW require that Rail Transport Operators implement a fatigue management program for rail safety workers and integrate it into the safety management system. The fatigue program is required to be risk-based according to the kind of tasks undertaken and scope of operations. To comply with these requirements, RailCorp has a high level 'Fatigue Management Policy' whereby each division, including CountryLink, is required to have its own 'Fatigue Management Plan'. At the time of the incident, the Fatigue Management Policy appeared to be based around the use of InterDynamics Fatigue Audit InterDyne™ (FAID) to assess the risk of fatigue from a roster.

The most commonly used output of FAID is a numerical score between 0 and 140 which is known as the fatigue management index (FMI)[20]. In relation to the FMI, the policy states that master rosters should achieve a FMI of less than 100 and conduct a review of actual roster trends to target a FMI of less than 95. FAID should also be used to examine risk factors and assist in reviewing risk management strategies for rosters with a FMI greater than 90. If a roster has a score of less than 90 then there was no requirement to assess or manage the risks that may be present. The roster and actual hours recorded for the Sydney sector driver were examined to assess the possibility of fatigue induced performance degradation. On the day of the SPAD occurrence, the driver of ST24 was on his eighth consecutive day of work. The shift times varied significantly and included early starts, part nights, afternoons and evenings. Despite this, the roster generally had a FMI score of less than 90. However, at the end of the previous block of continuous shift work, a peak score of 93 was recorded. There did not appear to have been any review of risk factors as a result of an FMI score recording greater than 90.

While it appeared in this case that the roster was structured to retain an FMI below a score of 90, there are a number of limitations which operators need to be aware

[20] It is noted though that, depending on inputs, scores in excess of 140 is achievable. For example, a week of 12 hour shifts from 2200 to 1000 produces a score of 148.

of[21]. FAID, and other fatigue bio-mathematical models, often fail to appropriately address an individual's natural bio-rhythms and the effects that working the early shift (between 0300 and 0500) has on fatigue accumulation. For example, an individual may still be fatigued after their first night shift in a roster, even when the FMI score was considered low. Similarly, the effects of attempting to gain recovery sleep (and the quality of sleep gained) during daylight hours, when it is unnatural for the body to do so, have not been adequately accounted for. The driver of ST24 reported that he did not feel fatigued. However, he also reported that he had limited sleep before the start of the shift. The driver had driven the XPT from Sydney at 2040 the previous day and had arrived in Junee at 0224 the day of the incident. While the driver had a break between shifts at Junee of about 11 hours he only slept for a maximum of 6 hours, 2 of which were described as dozing. Sleep disturbance and reduced sleep duration is commonly associated with irregular shifts where sleep is displaced into daylight hours.

Research has found that there is often a discrepancy between self-report of fatigue and actual fatigue levels and that people generally underestimate their level of fatigue. Given the nature of the roster and elements of broken sleep reported by the train driver, it is possible that he was experiencing some level of fatigue which may have resulted in a level of performance degradation, possibly leading to an incorrect perception of the signal.

It is also noteworthy that RailCorp has since implemented a complete review of their fatigue risk management processes.

Toxicology

The driver of ST24 was tested for the presence of alcohol by the NSW Police and registered a blood alcohol reading of zero. There is no evidence (or suggestion) that he was in any way affected by alcohol or drugs.

Medical and physiological factors

The records for the driver of ST24 indicated that at the time of the incident he had been medically examined and was deemed fit for duty in accordance with the *National Standard for Health Assessment of Rail Safety Workers*. There was no evidence to suggest that medical or physiological factors affected his performance.

Environmental conditions

Research has shown that significant deteriorations in road user visual performance have been found with the position of the sun at an angle of 45 degrees to either side of a road user's line of sight and at 20 degrees above the road level[22]. At the time of the incident, the sun had an azimuth of about 317 degrees and altitude of about 40

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[21] The Independent Transport Safety Regulator for NSW issued a Transport Safety Alert (TSA no. 34) on 27 July 2010 to rail transport operators outlining some of the potential limitations of bio-mathematical models used for the management of risks associated with human fatigue in the workplace.

[22] Gray, R., & Regan, D. (2007). Glare susceptibility test results correlate with temporal safety margin when executing turns across approaching vehicles in simulated low-sun conditions. *Ophthal. Physiol. Opt*, 27, 440-450

degrees above the horizon[23]. As the train track runs in a direction slightly easterly of north, the sun, relative to the driver's line of sight along the track, was greater than 45 degrees to the side and 20 degrees above the horizon. Therefore, visual impairment due to the position of the sun should not have been a factor.

At the time of the incident, the weather was reported as overcast with a light layer of high cloud. The weather conditions (and the position of the sun) were not considered to have contributed to any decrease in visual performance of the driver of ST24.

Signal conspicuity

Conspicuity refers to an object's ability to capture attention. With respect to signals, it can include factors such as brightness, focus, direction and surrounding environment.

Signal JE26 was mounted on a gantry above and slightly to the left of the track. The light source comprised of high intensity LEDs mounted on a black background and hoods (covers) to reduce the risk of glare. When viewed from the train cab, at the usual stopping position, the signal head was set against the background of the sky. Investigations established that at the time the Sydney sector driver accepted the indication displayed by signal JE26 it should have been distinct and unambiguous.

Signal JE02 was mounted on a pole to the left of the Up Main line. The signal was equipped with an older style incandescent globe. Unlike LED signals, the light output from incandescent lamps is critically dependent on voltage and the optical performance of the lamp also makes focusing a critical factor. Onsite observations noted that the performance of signal JE02 appeared inferior to that of other signals in the Junee Yard. The voltage at signal JE02 was tested by the ARTC and found to be below the requirements of the ARTC standard. When the voltage was raised to the appropriate value, the brightness of the signal indication improved appreciably.

While signal JE02 appeared to have exhibited degraded performance at the time of the SPAD, the train driver should have been aware of its indication based on the aspect displayed by the previous signal (in this case JE26) and driven the train accordingly. Consequently, the performance of signal JE02 was not considered to have directly contributed to the SPAD. However, it was still considered a safety issue that could increase the safety risk to train operations.

2.3.1 Summary of factors influencing driver actions

The driver believed that signal JE26 displayed a Medium Turnout indication and there was no reason to doubt his sincerity. However, testing of the signalling system at Junee found that it was almost certain that signal JE26 was displaying a Caution Turnout. The following factors are likely to have influenced the driver's incorrect perception of the signal indication:

- Looked but did not see: Given the demand on the driver's attentional resources at the time of departure, it is possible that he failed to notice that signal JE26 displayed a Caution Turnout indication (as opposed to a Medium Turnout indication) even though he looked directly at the signal.

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[23] Geoscience Australia (Uhttp://www.ga.gov.au/geodesy/astro/smpos.jspU).

- Expectation: In 15 years of driving, the driver had never experienced JE26 display a Caution Turnout, nor had he seen signal JE02 at Stop. Reinforced by the routine receipt of ‘right away’ a low expectancy of seeing these indications may have resulted in the driver responding in line with past experience.
- Distraction: It is likely that diversion of attention contributed to the driver’s incorrect perception of signal JE26 and the subsequent failure to sight signal JE02 in sufficient time to stop train ST24 before passing the red signal.
- Fatigue: It is possible that the driver was experiencing some level of fatigue which may have resulted in a level of performance degradation, possibly leading to an incorrect perception of signal.

While signal JE02 appeared to have exhibited degraded performance at the time of the SPAD, it was not considered to have directly contributed to the SPAD. It was likely that the performance of signal JE26 was distinct and unambiguous.

2.4 Factors influencing witness observations

On the day of the occurrence there were four other rail personnel who said they observed the indication displayed by signal JE26 in the moments (approximately 2 minutes) before train ST24 departed Junee; the Melbourne sector driver, the PSS, the PA and the Junee station assistant. The safe-working qualifications of each varied from very basic knowledge, to the extensive qualifications required by the Melbourne sector driver. Each of the witnesses had their own tasks to perform while train ST24 was at the Junee platform. That is, it was not a requirement of any of them, during the course of their respective duties, to verify the aspect being displayed by signal JE26 (although the PSS was required to ensure that signal JE26 was displaying a Proceed indication). Be this as it may, it is apparent that their action in looking at the signal applicable to the passage of the train may be a common practice; a practice that should be commended.

None of the four witnesses reported any difficulty in sighting the aspect displayed by signal JE26 in the moments before the departure of ST24 (nor were any records found during the investigation of signal JE26 being difficult to sight on other occasions). All four said that a Medium Turnout was displayed by signal JE26 (albeit in language ranging from ‘scattered aces’ to ‘scattered flashing aces’ and ‘a flashing arrow’). All four witnesses stated that they had never seen signal JE26 display anything other than this indication when at Proceed.

As mentioned previously, testing found it was almost certain that signal JE26 was displaying a Caution Turnout indication consisting of a steady band diagonal of lights. As the witness accounts contradicted the test results, it was important to examine the various factors that may have influenced the perceptions of the four witnesses.

Confirmation bias

The term confirmation bias describes the tendency of individuals to seek information that confirms what they already believed to be the case. Confirmation bias can also result in individuals not seeking or even discounting information that would not support their belief. An experiment examining confirmation bias, found

that almost 80% of participants chose to confirm a theory while only 4% actively sought to disprove it[24].

All the witnesses stated that they had only ever seen JE26 display a Medium Turnout. It is possible that, when later asked what JE26 displayed, they only sought information that confirmed the indication they had always seen previously. That is, they may have looked briefly towards the signal and seen the yellow lights illuminated. However, the phenomenon of confirmation bias may have influenced their belief that the signal was showing a Medium Turnout, regardless of the lights pulsating or not, especially considering that reading the signal was not their job and any look at the signal was likely to be very brief.

Group-think

Group-think occurs when members of a group try to minimise conflict and reach consensus without critically testing, analysing, and evaluating alternative ideas. Cohesive groups where members are similar in background are especially vulnerable to group-think. While group-think does not necessarily lead directly to an incorrect decision or belief, it has the potential to increase the likelihood of an incorrect decision or belief. This is particularly true during high workload, high-stress, and non-normal operational environments.

Another phenomenon linked to group-think is that known as 'risky shift'. Risky shift occurs in a group environment when, in reaching a consensus such as the signal showed a Medium Turnout aspect, group members shift their opinions in order to accommodate the opinions of others.

In this case, several of the witnesses reported that after the incident, and upon returning to the platform, they had a discussion relating to the event which included the aspect displayed by signal JE26. The witnesses reported that when they discussed the incident they each concluded that JE26 displayed a Medium Turnout indication. It is possible that a level of group-think and risky shift occurred that may have influenced their consensus (rightly or wrongly) that the signal JE26 was displaying a Medium turnout indication.

2.5 Factors influencing network controller actions

A network controller has the responsibility of managing the safe and efficient passage of rail traffic on the rail corridor that is under their control. A component of this responsibility is that a network controller must advise the operator (driver) of any rail traffic of any condition that would, or could, affect the passage of this traffic.

In this instance, the network controller at the Main South C Board had responsibility for the passage of train ST24 from Melbourne to Junee, including the Junee station yard limits (up to and including signal JE02). A controller at Main South B Board was to become responsible for ST24 (Sydney bound) once it passed beyond signal JE02. In effect, signal JE02 was the interface at which the Main South C Board network controller and the Main South B Board network controller transfer control of rail traffic passing between the two control areas.

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[24] Wason, P.C., & Johnson-Laird, P.N. (1972). *Psychology of reasoning: Structure and content.* Cambridge, MA: Harvard University Press

Before train ST24 had reached Junee, the controller at the B board advised the C board controller that the level crossing equipment at Marinna, about 7 km beyond signal JE02, may be malfunctioning. There were only automatic signals between signal JE02 and the faulty crossing. Network controllers cannot control automatic signals, so any signal to be put at Stop to protect rail traffic travelling towards Marinna would have to be at Junee (JE02 or earlier). It is relatively common that a controller would protect the section by placing a block preventing the final entry signal into the section (such as JE02) from being cleared. However, blocks could just as easily be placed on other signals.

In this instance, the 'C board' network controller chose to leave an existing block on track 301.2A (preventing signal JE02 from clearing) and intended to issue the driver of ST24 with a CAN notice before authorising the train to proceed beyond JE02. During driver hand-over of train ST24, the Melbourne sector driver told the Sydney sector driver of the need to speak to the Junee network controller regarding a CAN notice. Neither driver had any knowledge of the location or intent of the CAN, nor did they know that the CAN would be required before passing signal JE02.

Given that train ST24 was already required to stop at the Junee platform (signal JE26), an obvious alternative would have been to keep signal JE26 at Stop until the CAN notice could be issued to the Sydney sector driver. Once this task was completed, the train could then be released from Junee platform by clearing the signal. However, since the block on track 301.2A had been in place since about 0915, it probably appeared logical to the controller to leave the block in place rather than remove it and re-apply it to act on signal JE26. This action meant that train ST24 could depart the platform without having received the CAN, but would need to stop at signal JE02 and obtain the CAN before entering the section to Marinna. While this strategy did not contravene any operational rule, it does have several disadvantages:

- The train was, in effect, required to depart Junee twice. Once from the station platform and once from signal JE02. For the Sydney sector driver of train ST24, having just been given a hand-over by the Melbourne sector driver, the workload was high. Each additional step in the process, particularly at a time of high workload, added to the complexity of the task, and hence associated risk.
- The use of signal JE02 required the train to decelerate to a stop, the Sydney sector driver to take the CAN notice, the signal to be cleared, then the train to accelerate up a grade to resume its journey. It is likely that this process would have added several minutes time to a service that was already behind schedule.
- The option to hold signal JE02 at Stop was rarely, if ever, used. Indeed, the network controller himself said he had never used this method to depart an Up XPT service previously. As discussed previously, the risk of an unintended error due to expectancy and distraction are heightened when dealing with unusual or unexpected situations.

The practice of leaving a block on a signal until it is again needed for train running purposes and placing the block on the signal that is the final entry point into the section that is being protected (such as JE02) is sound from a number of perspectives. However, in this instance the option chosen by the network controller, while not in contravention of any rule or procedure failed to recognise the associated risk confronting the Sydney sector driver.

In terms of train running, the onus for observing and obeying signals and safe-working authorities resides with the driver of a given train or rail vehicle. This is arguably the most fundamental component of railway safe-working. In this instance, the driver of ST24 almost certainly failed to correctly perceive the indication that was displayed by signal JE26.

3 FINDINGS

3.1 Context

From the evidence available, the following findings are made with respect to scheduled XPT passenger train service ST24 passing signal JE02 on Wednesday 9 September 2009 when the signal was displaying a Stop (red) indication. The findings should not be read as apportioning blame or liability to any particular organisation or individual.

3.2 Contributing safety factors

- The driver of train ST24 perceived signal JE26 to be displaying a Medium Turnout indication while the signal almost certainly displayed a Caution Turnout indication. Train ST24 was then driven in a manner consistent with the driver's expectation that signal JE02 would be showing a Proceed indication.
- It is almost certain that the driver's perception of the indication displayed in signal JE26 was influenced by expectation and distraction.

3.3 Other safety factors

- It is possible that the driver's perception of the indication displayed in signal JE26 was influenced by fatigue.
- The network controller chose a valid but rarely used method to hold train ST24 within the station yard limits at Junee until the Condition Affecting the Network (CAN) warning notice for the Marinna level crossing was issued.
- There was no RailCorp instruction that specifically referred to the need for train crew to prioritise tasks at safety critical locations or at times when workload is high. *[Significant Safety Issue]*
- The voltage of signal JE02 was below the ARTC standard for the type of globe installed. *[Minor Safety Issue]*
- The Microlok signalling program design did not meet the requirements of ARTC signalling standard SCP23 'Design of Microlok Interlockings' in regard to the logging of internal bits that initiate flashing, pulsing or toggled outputs. *[Minor Safety Issue]*

3.4 Other key findings

- The testing of signal JE26 and associated infrastructure established that it was almost certainly displaying a Caution Turnout indication to the driver of ST24 prior to that train's departure from the Junee station platform.
- The existing defences of the safe-working system at Junee were adequate in preventing an unabated passage of train ST24 to the Marinna level crossing. These defences performed as expected and the train came to a halt about one and three quarter carriage lengths past signal JE02.

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. In addressing those issues, the ATSB prefers to encourage the relevant organisation 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 RailCorp

4.1.1 Prioritisation of tasks when departing a station yard.

Significant safety issue

There was no RailCorp instruction that specifically referred to the need for train crew to prioritise tasks at safety critical locations or at times when workload is high.

Action taken by RailCorp

RailCorp has advised that a driver's routine activities include speaking with network control and that they question the need for an instruction for drivers to prioritise tasks as drivers are trained to respond to both planned and unexpected situations and conditions and, as such, practice prioritisation.

ATSB assessment of response/action

It is acknowledged that communications of a safety critical nature with network controllers and others involved in railway safeworking is a routine, and very necessary, activity of a train driver. In this instance communication with the network controller related to obtaining a Condition Affecting the Network advice that was directly associated with the imminent passage of the train. This issue required the driver's immediate attention whereas communication with the Passenger Services Supervisor was not immediately associated with the safe passage of the train and was not safety critical in nature. Therefore this communication was not necessary at the time of departing Junee station yard.

The ATSB believes that safety could be improved if train crews were provided with guidance regarding prioritisation of critical tasks such as when departing stations, running through station yards, approaching track gangs or level crossings and so on.

ATSB safety recommendation RO-2009-SR-034

The Australian Transport Safety Bureau recommends that RailCorp takes action to address this safety issue.

4.2 Australian Rail Track Corporation

4.2.1 Voltage of signal JE02

Minor safety issue

The voltage of signal JE02 was below the ARTC standard for the type of globe installed.

Action taken by Australian Rail Track Corporation

The voltage of signal JE 02 was adjusted to comply with the ARTC standard within days of the SPAD occurrence in the presence of ATSB personnel. The signal visibility was observed to improve immediately.

ATSB assessment of response/action

The ATSB is satisfied that the action taken by the ARTC has adequately addressed this safety issue.

Conformance to signalling standard

Minor safety issue

The Microlok signalling program design did not meet the requirements of ARTC signalling standard SCP23 ‘Design of Microlok Interlockings’ in regard to the logging of internal bits that initiate flashing, pulsing or toggled outputs.

Action taken by the Australian Rail Track Corporation

The ARTC has advised its intention to prioritise and scope the task and to incorporate the work into its future works program.

ATSB assessment of response/action

The ATSB is satisfied that the action to be taken by the ARTC will adequately address this safety issue.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of Information

Australian Rail Track Corporation

Bureau of Meteorology

Crew of ST24

RailCorp/CountryLink

Station staff and Train Control staff at Junee

References

ARA Glossary for National Code of Practice and Dictionary of Railway Terminology

ARTC Code of Practice – NSW

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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:

- Australian Rail Track Corporation
- Independent Transport Safety and Reliability Regulator
- RailCorp Pty Ltd
- The Melbourne sector Driver of train ST24
- The Main South C Board Network Controller, Junee Network Control Centre
- The Passenger Attendant of train ST24
- The Passenger Services Supervisor of train ST24
- The Sydney sector Driver of train ST24.

Signal Passed At Danger by XPT ST24
Junee, NSW, 9 September 2009