Australian Government
Australian Transport Safety Bureau

Signal SST535 passed at danger involving passenger train 8239 and near collision with another passenger train

Docklands, Melbourne, on 23 November 2020

ATSB Transport Safety Report
Rail Occurrence Investigation (Defined)
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Addendum

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Safety summary

What happened

At around 1736 on 23 November 2020, V/Line loco-hauled passenger service 8239 from Southern Cross to Melton passed signal SST535 at stop, about 700 m north-west of Southern Cross Station. The signal was at stop to protect the movement of V/Line passenger service 8156 (Wendouree to Southern Cross) that was to cross ahead of train 8239. Train 8239 passed the signal at about 23 km/h and continued for about 200 m before stopping across the junction through which train 8156 would pass. The driver of train 8156 brought their train to a stop about 100 m prior to that junction. The drivers of both services had stopped their trains following an emergency broadcast from the controlling signaller.

What the ATSB found

When approaching signal SST535 at stop, the driver of train 8239 was probably distracted by task unrelated thoughts. They did not respond to the indication of the signal and probably looked past to another signal further along the track that they incorrectly believed was the signal where they were to stop.

Once signal SST535 had been passed, the risk control to reduce the likelihood of a collision was primarily the action of the signaller to respond to system alarms. In this instance, the signaller responded by making an emergency broadcast to train 8156 and this was sufficient to stop that train. The driver of train 8239 also overheard this broadcast and stopped their train.

Some signals on the V/Line network were fitted with Train Protection and Warning System (TPWS) equipment that automatically initiated a brake application when a signal was passed at danger (SPAD). Signal SST535 was not fitted with TPWS and its absence at this signal increased the potential consequences of a SPAD. A 2014 V/Line risk assessment of signal SST535 had not considered a head-on or side-on collision as a credible scenario. Such a consideration would have increased the risk rating of this signal and probably led to the fitting of TPWS.

Train 8156 was approaching signal SST578 as train 8239 passed signal SST535 at danger. However, signal SST578 continued to show a proceed aspect and did not restore to danger until train 8156 had passed that signal. There were no further signals in front of train 8156 to warn that the junction ahead was occupied by train 8239. The V/Line signalling standards did not include specific reference to a design that would require signal SST578 to restore to danger in this scenario (flank-track protection).

What has been done as a result

V/Line Corporation has advised that a funding submission to fit TPWS to signal SST535 and other similar signals in the Southern Cross area was approved in July 2021. Plans are underway to complete this installation during 2022.

The Rail Industry Safety and Standards Board (RISSB) advised that flank - track protection has been recorded for inclusion when the signalling principles standard AS 7711 is next under review.

Safety message

This occurrence has highlighted the importance for passenger rail networks to have engineering controls in place to detect SPAD events and prevent potential consequences such as collision. In determining applicable SPAD risk controls, rail operators should consider all SPAD precursors and potential collision scenarios.

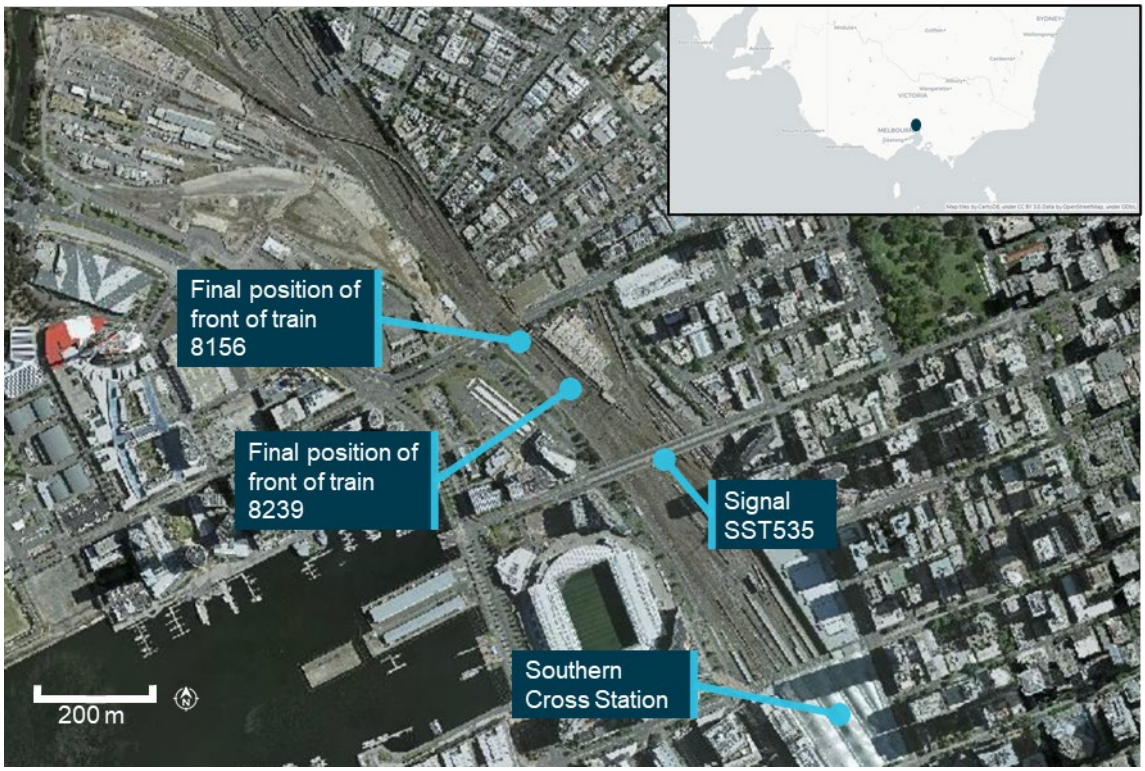
Contents

The occurrence

Prior to the event

The driver of V/Line Corporation[1] (V/Line) loco-hauled passenger service 8239 had signed on for duty at 1505 on the day of the incident and moved the train from the yard at Southern Cross Station to platform 3 at approximately 1600. At 1633 the conductor of train 8239 informed the driver that platform work had been completed. At the same time, a passenger approached the locomotive at the front of the train. The driver then turned on the headlights and revved the train engine to warn that the train was departing, and the train left without the passenger boarding.

Figure 1: Map showing location of incident



Source: PASS Assets (Department of Transport, Victoria) adapted by CITS

Train 8239 was a loco-hauled passenger train scheduled to travel from Southern Cross Station to Melton. Closed circuit television (CCTV) showed train 8239 departed Southern Cross Station on-time at 16:33:58, and passed signal SST537 at 16:34:53. This signal was located at the northern end of the station and displayed a red aspect over a yellow aspect,[2] which advised the driver to proceed at a limit of medium speed[3] but be ready to stop at the next signal. The train then approached the LaTrobe Street road-over-rail bridge and diverged onto the dual gauge track. On passing under the LaTrobe Street bridge, train 8239 passed signal SST535 showing a stop (red

[1] V/Line was a Victorian Government state-owned enterprise operating as a not-for-profit corporation.

[2] A red over yellow signal in Victorian three aspect speed signalling is referred to as a medium speed warning signal. Speed signalling indicates the speed at which a train may travel, and of any speed change required.

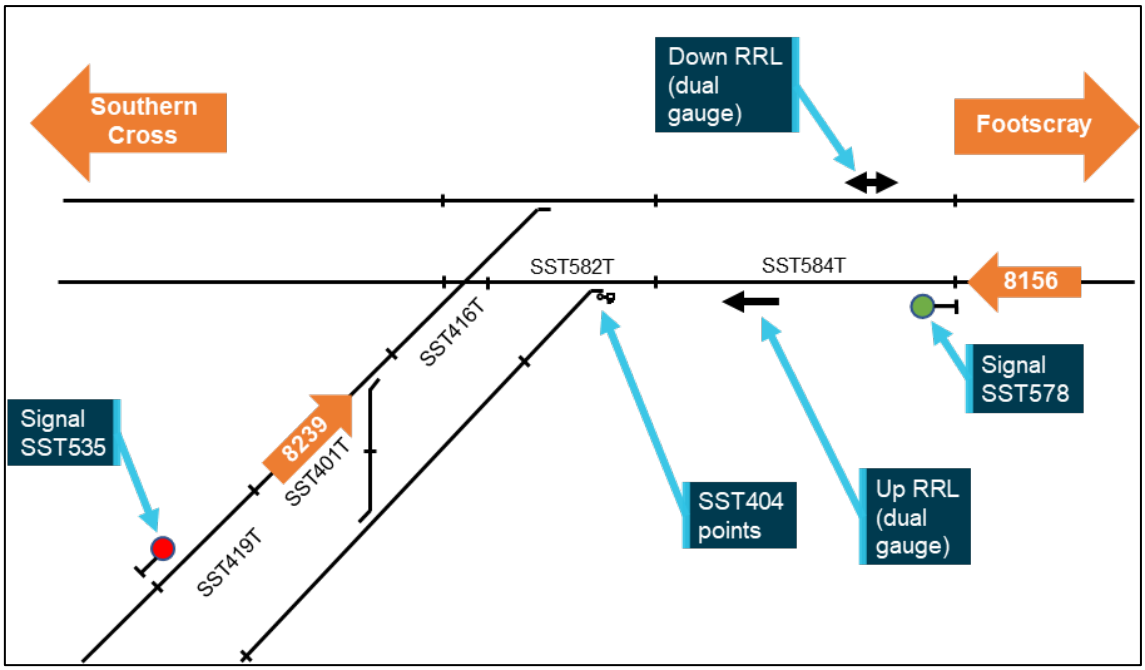
[3] Medium speed at this location was 40 km/h. However, a permanent speed restriction of 25 km/h applied to this section.

aspect over red aspect) indication and occupied the track circuit[4] past this signal at 16:35:40. Train 8239 passed the signal at 23 km/h. The speed limit for this section of track was 25 km/h.

At 16:35:50, train 8239 progressed onto the next track circuit that was located 53 m after signal SST535. At 16:36:03 the on-board event recorder[5] on train 8239 recorded the application of the train brakes, and at 16:36:13, with train 8239 having stopped approximately 228 m past signal SST535. This placed train 8239 over a junction that was on the intended route of train 8156. The driver of train 8239 reported having stopped on seeing train 8156 on the flyover approach to Southern Cross Station and hearing a radio communication from the signaller requesting train 8156 to stop.

The signaller had observed CCTV of train 8239 approaching signal SST535 and reported that based on their observations, anticipated that the train would not stop at the red signal. At approximately the same time, the signaller reported hearing and seeing a SPAD alarm warning from the train control system. Consequently, the signaller commenced a radio broadcast to the driver of train 8156, requesting that they stop owing to a train having passed a signal at danger.

Figure 2: Simplified layout of the relevant tracks and signals at Docklands (not to scale)



Journey of Train 8156

Train 8156 was a Diesel Multiple Unit (DMU) passenger train scheduled to run from Wendouree to Southern Cross Station. The on-board event recorder showed the train departed Footscray Station, the station prior to Southern Cross Station, on time at 1629. A recording of the signalling

[4] An electric circuit where current is carried through the rails and used to detect the presence of trains. Track circuits are used in the operation and control of points and signalling equipment.

[5] The station CCTV showed that the timings of the CCTV, signal interlocking, and on-board event recorders were aligned.

display[6] showed that the train was routed via the 'Up Regional Rail Link (RRL) dual gauge'[7] track (Figure 2).

On approaching Southern Cross Station, the driver received the radio communication from the signaller instructing the train to be stopped, and the on-board event recorder showed that the driver responded by making a brake application at 16:35:47. At this point the train was travelling at 27 km/h. At 16:35:57 the signal interlocking recorded that train 8156 passed signal SST578 at a proceed aspect and occupied track circuit SST584T. The on-board event recorder showed that the emergency brake was applied at 16:35:58 and that the train came to a stop at 16:36:01, approximately 20 m past signal SST578 and about 100 m from train 8239.

[6] A video recording of the signalling display, as seen at the time of the incident by the Southern Cross signaller.

[7] The Up Regional Rail Link (RRL) dual gauge is the name given to the track by V/Line. It indicates that the track is for trains heading in the direction of Southern Cross Station (up), was installed as part of the Regional Rail Link project and accommodates both broad-gauge and standard gauge trains.

Context

Location

The SPAD occurred on a section of track that had been constructed in 2014 as part of the Regional Rail Link project (RRL). The RRL project included extensive track and signalling works for accessing platforms 1 to 8 at Southern Cross Station. V/Line provided both the infrastructure management and train control functions for this section of track, under a lease arrangement with VicTrack.[8]

Train and driver information

Details of trains

Train 8239 was a scheduled passenger service operated by V/Line. It consisted of an N-class locomotive and six carriages, with an overall length of 136 m. Train 8156 was a three carriage VLocity DMU with a length of 76 m. Both trains were operated by solo drivers.

Driver of train 8239

The driver commenced with V/Line as a trainee driver in 2017 and qualified as a V/Line driver in August 2019. A V/Line train driver safety re-accreditation audit was conducted in September 2020 and no non-conformances were recorded. Medical records provided by V/Line showed the driver had undertaken a medical assessment (rail category 1 – high-level safety worker) in 2017 and was assessed as fit for duty. The fitness certificate was still valid at the time of the incident. V/Line information did not record any safety incidents related to the driver during the 36 months prior to the SPAD, and reported the driver was compliant with the V/Line driver fatigue policy. The driver advised that they were feeling physically well and had a good night's sleep prior to the incident. The driver was familiar with the route taken by train 8239, having last driven the same service over the same route two weeks earlier.

The driver had signed on for duty at 1505 on the day of the incident and following some train preparation duties, train 8239 was their first passenger service of the day. The driver reported being distracted by a personal issue on the afternoon of the incident and that they were reminded of this issue by a passenger who had just missed the departure of the train from Southern Cross Station. The passenger event, that was captured on station CCTV, was not reported to Train Control and was not required to be reported. At the time of the SPAD, the driver was not in conversation with the train's conductor and there was no record of the driver using a mobile phone at the time.

The driver reported thinking about the passenger they had left behind when passing signal SST537 on the departure from Southern Cross Station. This signal displayed a red indication over a yellow indication, which advised the driver to be ready to stop at the next signal. The driver reported seeing signal SST537 and acknowledging it by repeating the aspect to themselves. While the driver reported acknowledging this warning signal, they also advised that they did not at that time think about the next signal, SST535, which was 351 m ahead of signal SST537. The driver reported they looked past ground-mounted signal SST535 at LaTrobe St bridge and saw gantry-mounted signal SST991 at Dudley St showing a red indication (Figure 3). The driver

[8] VicTrack is the trading name of Victorian Rail Track Corporation, a Victorian Government state-owned enterprise which owns the track where the incident occurred.

reported they erroneously matched stop signal SST991 to the warning (to be ready to stop at the next signal) provided by SST537.

The driver saw train 8156 and around the same time heard the signaller on the train radio requesting train 8156 to stop. The driver of train 8239 then applied emergency braking.

Following the incident, testing of the driver returned a zero blood alcohol result and nil presence of drugs.

Figure 3: Signals SST535 and SST991 at stop

Source: CITS. Photo taken from the cab of an N-Class locomotive post-incident.

Driver of train 8156

The driver was qualified for the operation of this train on this route and was medically fit for duty.

Recordings of the train radio and the on-board event recorder show that the driver promptly stopped the train on being requested to do so by the signaller.

Environmental conditions

Meteorological conditions recorded at Melbourne for the afternoon indicated mild and cloudy conditions, 7 oktas[9] of cloud cover, and light south westerly winds.[10] Ambient temperature was recorded as 17.8 °C at 1500. The cloud cover recordings were consistent with CCTV recordings from Southern Cross Station. It was determined that the environmental conditions did not contribute to the incident.

[9] Cloud cover is measured in eighths or oktas.

[10] Cloud observations are from Melbourne Airport, temperature and wind are from Melbourne Olympic Park.

Train control and signalling

Overview

The signalling of the V/Line infrastructure at Southern Cross Station was operated from Southern Cross Number 1 signal box. Absolute Block Signalling rules applied at this location.[11] A computer-based interlocking controlled points and signals to prevent conflicting movements of signals, and to make sure routes were set correctly.

In relation to the real-time monitoring and management of field signalling equipment, the train control system provided the signaller with a video display unit (VDU) and interface to enter control requests. The signaller was responsible for the day-to-day operational management of the rail corridor for V/Line trains departing and entering Southern Cross Station.

Signal, points, track, and train movement data were captured by a computer-based interlocking event logger. Voice communication between train drivers and the signallers at the Southern Cross Number 1 signal box was via channel one of the Local Radio System (LRS), which was recorded. The radio channel was an open system and communications from the signaller could be heard by the drivers of all train in the area.

Signalling system playback

The status of signals and the movement of trains were captured by the Southern Cross train control system (TCS) event logger. Figure 4 shows the position of trains, the status of signals and points, and routes set at 16:35:31 (9 seconds prior to the SPAD event), as were shown on the signaller's train control system display. Red indicated the presence of a train on a section of track and green indicated the track was clear and the route was set. Train 8239 approached signal SST535 at stop. A route had been set for train 8156 to pass in front of train 8239 and onto the 'Through Country' track, with signals SST986 and SST578 both at proceed.

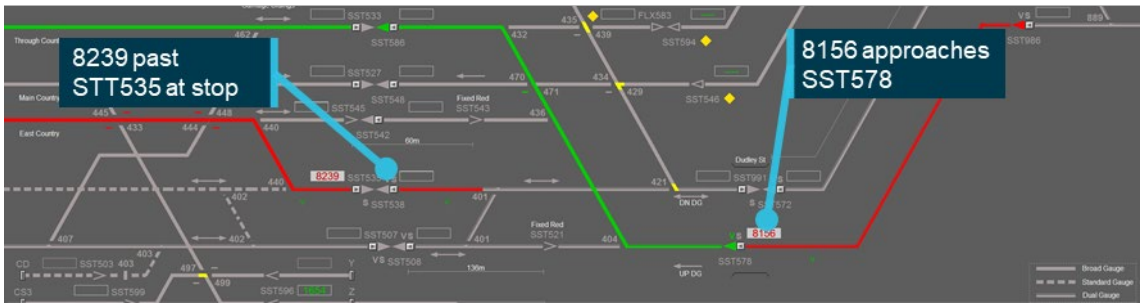
Figure 4: TCS playback showing train 8239 approaching SST535 at stop

Source: V/Line Southern Cross Train Control System, annotated by CITS.

Figure 5 shows that at 16:35:47, train 8239 had passed signal SST535 at stop, and train 8156 was approaching signal SST578 at proceed. It is estimated that train 8156 was between 50 m and 80 m from signal SST578 when train 8239 passed signal SST535 at stop.

[11] A system of train operation that prevents more than one train being in the block section at any one time.

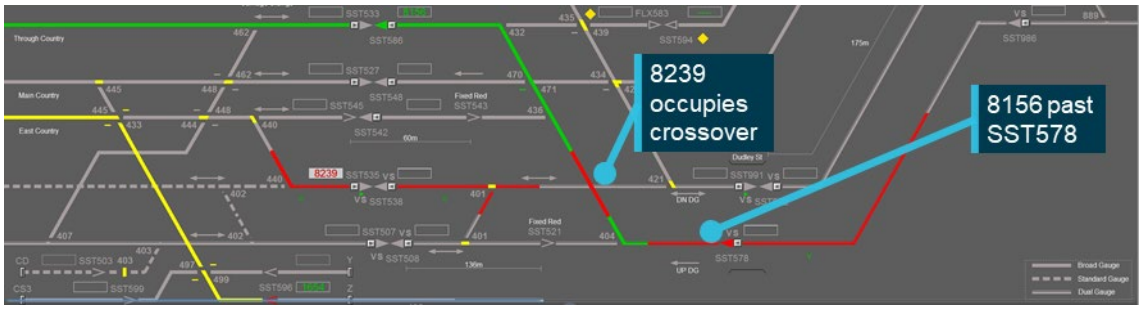
Figure 5: TCS playback showing train 8239 having passed SST535 at stop



Source: V/Line Southern Cross Train Control System, annotated by CITS

Figure 6 shows that at 16:36:03 train 8239 was continuing to travel towards the route set for train 8156. The system playback shows train 8156 had passed SST578 when it showed a proceed indication, and this signal had subsequently restored to danger once the train had moved onto the track circuit past the signal. Both trains had come to rest by 16:36:13.

Figure 6: TCS playback showing train 8156 having passed SST578 showing proceed



Source: V/Line Southern Cross Train Control System, annotated by CITS

Signaller

The signaller advised that they commenced work as a signaller at Southern Cross in 2018, having worked previously for another rail infrastructure manager for 25 years in various safeworking roles. The signaller was qualified to operate the signalling control panel at Number 1 signal box at Southern Cross.

On 23 November, the signaller had signed on for duty at 1300 to commence an eight-hour shift. The signaller reported observing CCTV of train 8239 approaching signal SST535 and based on their observations, anticipated that the train would not stop at the red signal. Consequently, the signaller commenced a radio broadcast directed to the driver of train 8156, requesting that they stop owing to a train having passed a signal at danger. At approximately the same time, the signaller reported hearing and seeing a SPAD alarm warning from the train control system. Following the communication with the driver 8156, the signaller directed a broadcast to the driver of train 8239.

The signaller was subjected to post-incident drug and alcohol testing returning negative results for both tests.

Signaller radio communications

The following communications took place between the signaller and the driver of train 8156 (Table 1). The time log on the radio communication showed that the initial call from the signaller to the driver of train 8156 was followed 8 seconds later with a second ‘urgent’ call. The driver of train 8156 replied immediately after this second call.

Table 1: Radio communications between signaller and driver of train 8156

Person	Dialogue
Signaller	Number 1 calls 8156, urgent, urgent to number 8156.
Signaller	Number 1 calls 8156 urgent.
Driver, train 8156	8156 receiving.
Signaller	Drive [sic], stop where you are, stop where you are, the down train has just SPAD the signal in front of you.
Driver, train 8156	Uh, …, yeah, I've just got it now, thanks.
Signaller	Roger that and thanks drive [sic].

The following communications then took place between the signaller and the driver of train 8239 (Table 2).

Table 2: Radio communications between signaller and driver of train 8239

Person	Dialogue
Signaller	Number 1 to 8239.
Signaller	Number 1 calls 8239.
Driver, train 8239	8239 receiving.
Signaller	Alright drive [sic], you realise what's happened, have you stopped clear of the points?
Driver, train 8239	No, I believe I've just gone onto the points.
Signaller	Alright drive [sic], stop and hold where you are, stop and hold where you are.

Signal STT535 information

Overview

Signal SST535 (Figure 7) was commissioned in 2014 as part of the RRL project as a ground mounted mainline three-position home signal. The main signal aspects were displayed as light-emitting diode (LED) colour light combinations on the "A" and "B" lights. The "C" light could display a yellow low speed aspect when both A and B lights were red. As the signal was located on a dual gauge line, it was provided with "V" and "S" indicators. A "V" indicator displayed in conjunction with another proceed aspect authorised a broad-gauge train to pass the signal, and an "S" indicator displayed in conjunction with another proceed aspect authorised a standard gauge train to pass the signal. The signal was not equipped with Train Protection and Warning System (TPWS)[12] or other train protection equipment.

Post-incident observations from the driver's cab showed that signal SST535 was visible to the driver for approximately 60 seconds when approached in compliance at the allowable track speed from platforms 1 to 5 at Southern Cross Station.

Risk of SPAD at signal SST535

In May 2014, the V/Line RRL Management of Change and Risk Team undertook a risk review to determine which signals should be fitted with TPWS. At that time, the Rail Safety National Law (RSNL), the V/Line Safety Management System (SMS), and the RRL Scope and Technical

[12] TPWS stops a train by automatically initiating a brake demand, where TPWS track and train-borne equipment is fitted, if the train passes a signal at danger without authority.

Requirements required risk assessments to be undertaken to assess the risk of train-to-train collision and determine whether additional signal enforcement mitigation measures were required. This work assessed a total of 54 signals. Twenty-six of these signals were in the Southern Cross Station to West Footscray area, which was defined as work package B of the RRL project.

Signals that had experienced a SPAD event[13] on more than one occasion were chosen to be fitted with TPWS, as were those that V/Line ranked as 'Potentially Severe'. Seventeen signals were ranked as 'Potentially Significant' and subjected to a cost-benefit analysis to determine if fitment of TPWS was cost effective. The ranking was determined using a 'SPAD Ranked Risk Tool' (SRRT), and a ranking of 'Potentially Significant' was evaluated to be equivalent to a 'medium risk' in accordance with the rankings used by the V/Line Enterprise-Wide Risk Model (EWRM).[14]

The SRRT was made up of three elements: an initial collision potential assessment, an accident vulnerability ranking, and a final risk ranking score. For signal SST535, the analysis of the SRRT considered a potential collision type of '*Plain line rear-on or buffer*'.

V/Line used the Signal Passed at Danger Assessment Model (SPADAM) to assist in the ongoing assessment and control of risks associated with trains passing signals at danger. An assessment using the model that was dated 1 December 2020 was provided by V/Line as being that applicable to SST535 at the time of the SPAD on 23 November 2020. The signal had been ranked as the 50th highest for risk. Approximately 250 signals had been assessed using the SPADAM tool by around the time of the incident. Signal SST535 had obtained a semi-quantitative risk exposure score of 1940, which fell below the normal V/Line threshold of 2500 for increasing the priority of introducing further risk controls.

[13] Some signal locations were retained at Southern Cross during the RRL project.

[14] The output from the SPAD Risk Ranking Tool ranked the risks as 'severe', 'significant' or 'no significant risk', which mapped onto the V/Line risk ranking of 'high', 'medium' and 'low' respectively.

Figure 7: Signal SST535 at stop

Source: CITS, observed post-incident

Other SPADs at or near SST535

Signal SST535 was located on the 'Down Dual Gauge' line, one of five bi-directional lines leading to platforms 1-5 at Southern Cross Station. Parallel to SST535 were three other mainline signals (SST533, SST527 and SST507). All were located at ground level and under the LaTrobe St bridge, as shown in Figure 3.

On 22 December 2017, a SPAD at signal SST533 was reported. The driver of train 8921 had received a medium speed warning aspect on the preceding signal. Train 8921 passed signal SST533 at stop by approximately 255 m. The driver was reportedly distracted by a person walking near the track. The South Geelong to Southern Cross service (train 8742) was waiting for a proceed aspect on signal SST578, which briefly displayed a proceed aspect before reverting to stop. The driver of train 8742 then saw train 8921 approaching in head-to-head conflict and flashed the headlight and sounded the whistle. Train 8921 stopped approximately 60 m from train 8742.

Eight SPADs[15] at signal SST507 involving shunting moves were reported between 11 December 2014 and 16 January 2021. A SPAD at signal SST535 involving a shunt move was also reported on 23 December 2019.

[15] Reported as either driver misjudged, completely missed, or limit of authority missed by train crew, in accordance with the reporting requirements of the Office of the National Rail Safety Regulator (ONRSR) at the time of reporting.

Risk management

Overview

The V/line Safety Management System (SMS)[16] had risk controls in place to manage the risk of a train-to-train collision because of a SPAD. Additional risk controls had been identified but not adopted at the time of the incident.

Procedural SPAD controls

V/Line applied the requirements of the 1994 Book of Rules and Operating Procedures for train operations. Section 2 rule 14b stated that no train must pass a home signal showing a stop aspect except under certain circumstances, which did not apply for this incident.

Engineering controls

SPAD Detection (in conjunction with radio communication)

The train control system at Southern Cross was equipped with SPAD detection such that an alarm was activated at the signaller's workstation in the signal box if a train passed a controlled signal[17] at stop. Therefore, the system had the potential to mitigate the consequences of a SPAD occurrence by the signaller making a radio broadcast requesting trains to stop (as was the case in this instance).

The V/Line *Book of Rules and Operating Procedures* (revision 7) referred to a SPAD alarm in section 36, rule 14, part g. This rule defined the steps a controlling signaller must take on observing a SPAD alarm in relation to a SPAD at a TPWS location. SST535 was not a TPWS location and the V/Line *Book of Rules and Operating Procedures* did not define actions to be taken on observing a SPAD alarm for non-TPWS locations.

Train Protection and Warning System

Trains 8239 and 8156 were equipped with TPWS equipment that would activate a brake application where a train passed a signal at stop and the signal was linked to track-mounted TPWS transmitters. The system was also capable of enforcing medium speed signal aspects and train speeds through junctions at chosen locations. The V/Line passenger train fleet was equipped with this system to facilitate operation on the Regional Fast Rail (RFR) network which began operations with a maximum speed of 160 km/h in 2005. TPWS was extensively utilised on the V/Line network however signal SST535 was not equipped with TPWS at the time of the incident.

Flank protection

Flank protection is defined as protection from overrunning movements approaching on converging tracks, usually by additional point interlocking or train detection.

The V/Line standard for signal principles (NIST-12.0, revision 3, dated 10/8/2020) referenced catch protection as providing physical protection of main line moves from the unauthorised movement of vehicles from sidings, yards, or maintenance facilities. It is described in the standard as a form of flank protection[18] which is provided to prevent a train from being hit in the side by another train. No other references to flank protection were provided in the standard.

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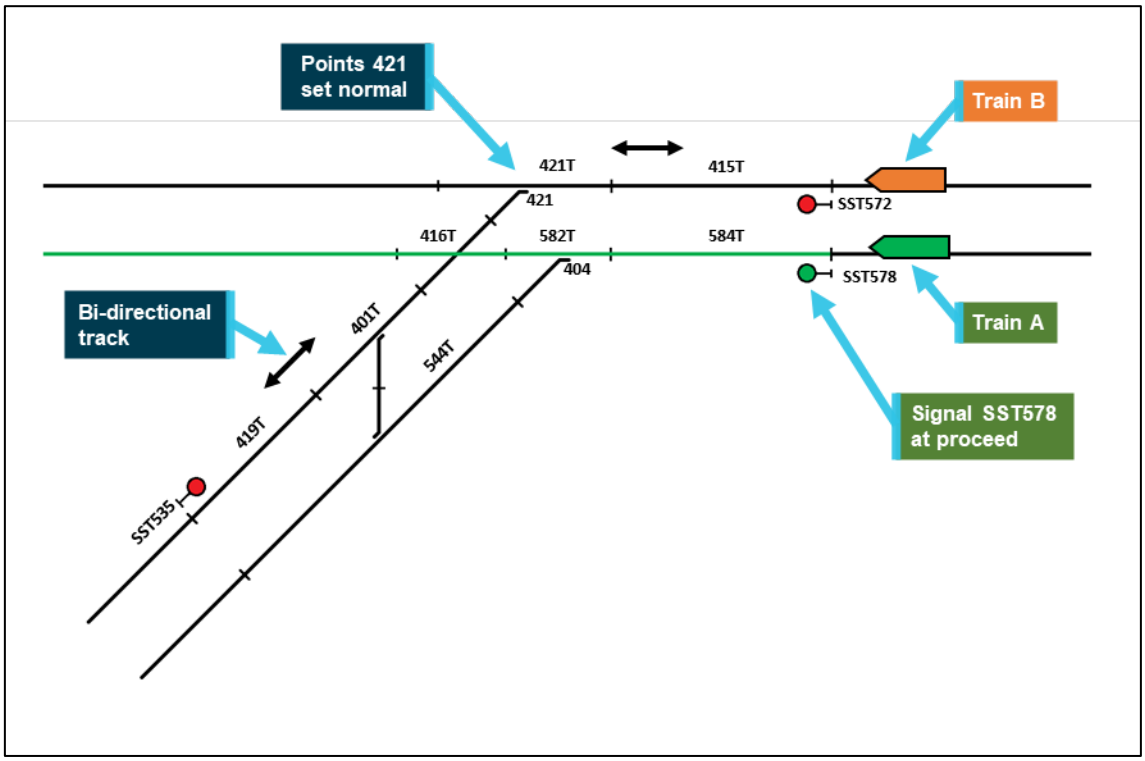
16 It is a requirement of Rail Safety National Law for accredited rail transport operators have an appropriate SMS in place.

17 A signal that is, or may be, controlled or operated by a signaller, network control officer or competent worker.

18 RISSB AS 7711:2018 *Signalling Principles,* listed flank protection as a means of mitigating the risk of collision owing to rolling stock exceeding its limit of authority. Flank protection was defined in the RISSB glossary as protection from overrunning movements approaching on converging tracks, usually by additional point interlocking or train detection.

Flank protection is often provided through the setting of signals and points. In Figure 8: for example, a route from signal SST578 is at proceed for train A. Points 421 are set to the normal (straight through) position so that if train B proceeds past signal SST572, it is not routed into the side of train A. That is, the flank of train A is protected by points 421 set normal and routing train B straight ahead rather than towards the junction.

Figure 8: Simplified track layout for the relevant tracks at Docklands



Source: ATSB and CITS

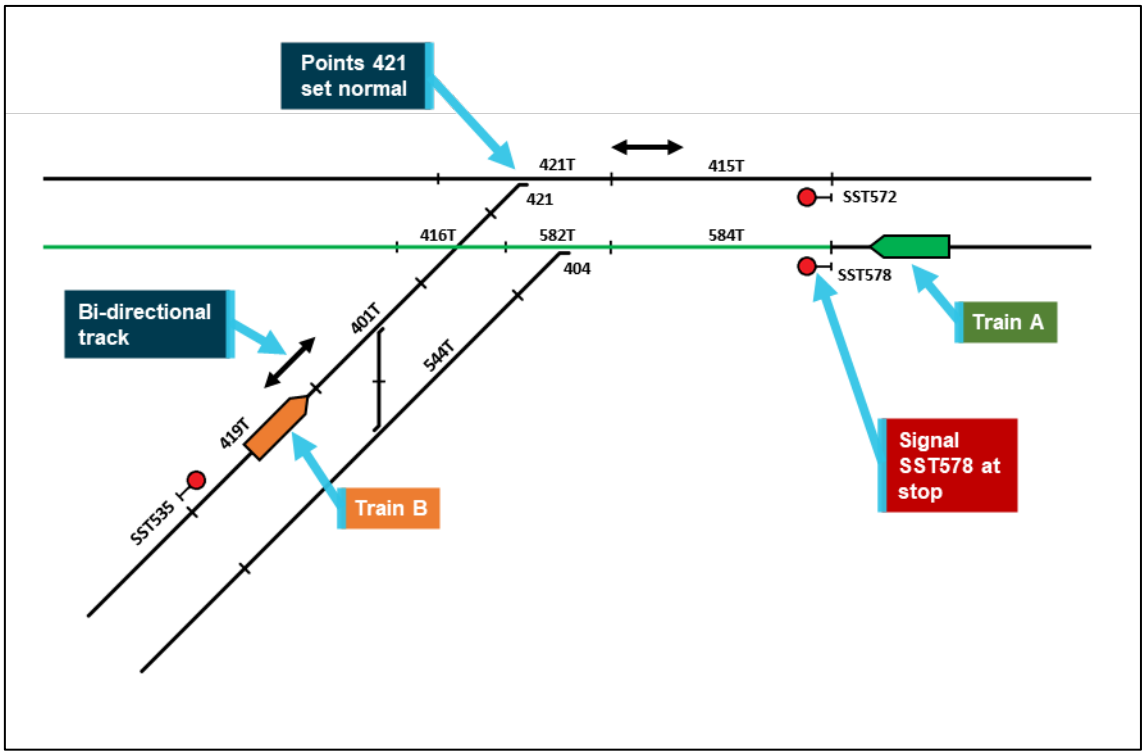
However, for the SPAD that occurred on 23 November 2020, similar protection was not available for an unauthorised movement past signal SST535 since there were no facing points to route the movement of train 8239 away from the junction.

Flank-track protection

Where flank protection cannot be provided by setting flank points, the provision of flank-track protection can be considered. If a route is set over a junction, flank-track protection requires the tracks between a signal protecting a converging route and the junction to be clear before the signal will display a proceed aspect.

Figure 9 provides an example of a route called from signal SST578 for train A. However, if train B passes signal SST535 at stop (SPAD) and occupies a track circuit between the signal and the junction (tracks 419T and/or 401T), a potential conflict with train A would be imminent. If flank-track protection was provided, any unauthorised occupancy of track circuits 419T or 401T would revert signal SST578 to a stop aspect. This would provide the opportunity for the driver of train A to react and stop prior to the junction and the potential conflict with train B (braking distances permitting and assuming train A had not already passed signal SST578).

Figure 9: Simplified track layout for the relevant tracks at Docklands



Source: ATSB and CITS

However, the risk control of flank-track protection was not provided for the section of track where the SPAD occurred on 23 November 2020.

Train Vigilance System

Trains 8239 and 8156 were both equipped with vigilance control systems that verified the driver was not incapacitated by monitoring task-linked activities. In the absence of any such activities, the systems would provide intervention through alarms and subsequently by applying the train's brakes. In this instance, recordings from both trains indicated that the drivers were providing active task-linked inputs and there were no activation of the trains' brakes by the vigilance systems.

Safety analysis

Driver distraction

Interview comments revealed that the driver was distracted by task unrelated thoughts on the approach to signal SST535. While there is diversity in the definition of distraction, a version commonly referenced is:

> the diversion of attention away from activities critical for safe driving toward a competing activity.[19]

Attention is conceived as a focusing response to a stimulus or task that reflects a state of arousal or concentration.[20] Studies indicate that attention paid to a particular stimulus or task generally occurs in the context of competition among multiple stimuli or tasks for limited processing capacity.[21] [22] Multiple stimuli or tasks that make simultaneous demands on an individual's central processing mechanism will tend to interfere with each other. These demands can come from 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. Thought intrusions, or mind-wandering, can be a type of distraction. In train driving, the inherent propensity to mind-wandering can generate an unacceptable level of operational risk.

Should one or more of these competing demands be of sufficient magnitude to interfere with or divert attention from the original focus of attention, then the individual becomes distracted.[23] It is within the context of attention that the process of distraction occurs. According to Nelson et al. (1993) this involves (i) a primary task (ii) a secondary or distracting stimulus or task (i.e., distractor) and (iii) the diversion of attention in response to the secondary task.

The driver of train 8239 reported being distracted by a personal issue on the afternoon of the incident and that they were reminded of this by a passenger who had just missed the departure of the train from Southern Cross Station

Distraction is strongly linked to decrements in driving performance and a higher risk of accident by motor vehicle drivers.[24] [25] While rates of distraction amongst train drivers in Australia are not available, research from the U.K.[26] of 1021 reported SPADs between 2006 and 2009 on Network Rail managed infrastructure found approximately one third of SPADs in this period were associated with some form of distraction or inattention. [27]

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19 Lee JD, Young KL, and Regan, MA (2008) Defining driver distraction. In: Regan MA, Lee JD, Young .L (Eds.) Driver Distraction: Theory, Effects, and Mitigation, CRC Press Taylor & Francis Group, Boca Raton, FL, USA.

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27 In comparison, during 2020, 563 SPADs where the limit of authority was passed by a train crew were reported to ONRSR by train operators in Australia. However, the number because of distraction were not available as this information is not required to be reported. Sighted at Office of the National Rail Safety Regulator (n.d.) national-safety-data, ONRSR website, accessed 2 July 2021.

The driver of train 8239 reported they sighted another stop signal further down the track (signal SST991 at Dudley St) and associated this signal with the warning provided by SST537 that the next signal would be at stop. Attention plays an important role in visual inspection strategy, especially in planning eye movements either toward locations preselected by expectations or toward an object that automatically attracts attention.[28] Research has found that mind-wandering is associated with horizontal narrowing of motor vehicle drivers' visual scanning process.[29] [30]

During their training, V/Line trainee train drivers were made aware of the importance of controlling distraction and advised of factors which can lead to distraction. Drivers were also made aware of techniques to manage distraction, and to refocus after distraction. This information was also published by V/Line in their Professional Driving Booklet. While these techniques to control distraction are not mandatory, drivers were encouraged to determine or develop the ones that worked best for themselves.

In this incident the distraction was at a critical time after departure and when the train was approaching signal SST535. While the driver was familiar with techniques to manage distraction and reported having acknowledged the warning signal before signal SST535, this was insufficient in preventing the SPAD.

Reading through signal SST535

Reading through or reading across to another signal was listed as a common cause of passing a signal at stop in the V/Line Professional Driving Booklet. Often, the scenario considered is not stopping at a signal due to sighting a proceed signal beyond the stop signal and incorrectly acting in response to the proceed signal. However, just as relevant is the scenario that existed in this case. The driver advised not observing SST535 and intending to stop at another signal beyond.

To assist in the assessment and control of risks associated with trains passing a signal a danger, V/Line used the Signal Passed at Danger Assessment Model (SPADAM). For the signal being assessed, information relating to the signal location, signal characteristics, rail traffic volumes, consequence factors (such as track speed), and control measures were inputs to the model. As an output, the model provided a 'likelihood score', 'exposure score', and 'consequence score' which were combined to provide an overall risk exposure score for the signal.

In relation to the input of 'signal sighting', there were 13 factors considered, including 'read across (adjacent line/track)' and 'read through (same line/track). Signal SST535 had been assessed against the model on a number of occasions. For the assessment of January 2020, 'read across' had been assigned a risk score of five, corresponding to 'definite potential to read across'. Signal SST535 had been assigned a risk score of zero for 'read through', corresponding to there being no potential to read through to another signal. Had the signal been assessed as having a 'definite potential to read through', then the risk score for the signal would have increased from 1940 to 2116 and would have still been below the normal V/Line threshold of 2500 for increasing the priority of introducing further risk controls.

Based on the risk score calculated for signal SST535, TPWS was identified as a potential control for further investigation. The model identified 'adequate length of signal overlap' and 'SPAD alarm and signaller response' as existing signal location control measures.

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[28] Henderson JM (1993) 'Visual Attention and Saccadic Eye Movements in Complex Visual Tasks', Behavioural and Brain Sciences, 16(3), 579-580.

[29] He J, Becic E, Lee Y, and McCarley JS (2009) 'Identifying Mind-wandering Behind the Wheel', Proceedings of the Human Factors and Ergonomics Society 53rd annual meeting.

[30] Recarte M, Nunes L (2000) 'Effects of Verbal and Spatial-Imagery Tasks on Eye Fixations While Driving', Journal of Experimental Psychology: Applied, Vol. 6, No. 1,31-43.

Flank and flank-track protection

At junctions, flank protection is a means of preventing collisions of trains by setting points to prevent unauthorised movement of another train from also occupying the junction. That is, points are set to route the unauthorised movement away from the junction. In the SPAD incident of 23 November 2020 such flank protection was not available for an unauthorised movement past signal SST535 since there were no facing points to route the unauthorised movement of train 8239 away from the junction.

Where flank protection cannot be provided, flank-track protection can be considered. If a route is set over a junction, flank-track protection requires the tracks between a signal protecting a converging route[31] and the junction to be clear before the signal will display a proceed aspect.

When train 8239 passed signal SST535 at stop and continued towards the junction, signal SST578 continued to display a proceed aspect for train 8156. Consequently, both trains were on a converging path and the risk of collision was significantly increased. Had flank-track protection been included in the signalling design, any SPAD at signal SST535 would have restored signal SST578 to stop. In this instance, train 8156 was relatively close to signal SST578 when the SPAD occurred at signal SST535, so there may have been insufficient time to stop prior to passing the signal. However, the installation of flank-track protection at this location would have reduced the risk of collision.

Infrastructure standards pertinent to this event did not specifically reference the potential application of flank-track protection. V/Line signalling standards did not call for flank-track protection to be considered.

Although not published at the time of the 2014 commissioning of new infrastructure at this location, subsequent RISSB standards[32] also did not reference the potential control of flank-track protection,[33] although the control of flank protection was referenced in RISSB AS 7711:2018 Signalling Principles, and RISSB AS 7724:2020 Unauthorized movement protection - Operational requirements.

Flank-track protection was referenced by some infrastructure managers in Australia. Signalling principles[34] for the Adelaide network required flank protection to be provided where a risk assessment determined the track layout warrants additional protection. The standard stated:

> Where it is not practicable to provide flank protection by setting flank or trap points, and a significant safety benefit would arise, the provision of flank track section overrun detection at vulnerable signals should be considered. It may be initiated by overlap track section, or treadle, occupied without signal having cleared, or by sequential operation of track sections (e.g. overlap track occupied after berth track occupied). It may effect automatic replacement of conflicting signals…

An inquiry[35] [36] into the Ladbroke Grove (U.K.) incident on 5 October 1999 considered the availability of automatic replacement of a signal at danger where a SPAD had occurred, and the layout was such that there was a significant danger of collision. A recommendation of the inquiry

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31 A signal protecting a converging route, or an opposing train movement, may also be referred to as a conflicting signal.

32 RISSB is accredited as a Standards Development Organisation, and all new standards commenced by RISSB after 31 July 2007 were published as Australian Standards.

33 AS 7711 does refer to the case of overlap protection on a single line, stating *that the overlap should extend from the home signal as far as the opposing main and loop starting signals controlling the entrance to the single line block and should incorporate loop and flank protection*. This could be considered a specific and basic case of flank-track protection, but it is not referred to as such.

34 As stated in Government of South Australia Rail Commissioner (2017) *South Australia Signalling Principles and Practices for the Adelaide Metropolitan Passenger Rail Network, Engineering Standard,* Adelaide.

35 Cullen Rt. Hon Lord (2000a) The Ladbroke Grove Rail Inquiry: Volume 1, Health and Safety Commission, London.

36 Cullen Rt. Hon Lord (2000b) The Ladbroke Grove Rail Inquiry: Volume 2, Health and Safety Commission, London.

resulted in a Railway Group Standard being produced for U.K. railway infrastructure managers[37] which stated:

> Overrun detection shall usually be provided so that where a train overruns a stop signal which protects an area of conflict, other stop signals protecting the same area of conflict are automatically placed or maintained at danger. The replacement of signals to danger shall take place as quickly as possible after an overrun occurs.

Authority-overrun protection at SST535

Risk review for the initial installation in 2014

The risk review to determine fitment of TPWS considered a potential collision type of '*Plain line rear-on or buffer*' for a SPAD at signal SST535. A potential collision input for the model of a head-on or side-on collision, that may have been experienced on 23 November 2020, was not considered for the 2014 analysis of a SPAD at signal ST535. Using the semi-quantitative input rankings of the model, a 'head-on' collision type would have resulted in a higher overall risk ranking score for signal SST535. If a 'head-on' potential collision type had been attributed to signal SST535, the resulting consequence potential score and final risk ranking score would have placed signal SST535 in the 'Potentially Severe' category, and the signal would probably have been equipped with TPWS.[38]

TPWS proposal of 2020

V/Line provided documentation to the investigation that showed that in January 2020 V/Line costed a series of projects for installing TPWS, one of which was for the Southern Cross area and included signal SST535. The proposal was based on Southern Cross being identified as a high risk SPAD location and included input from the SPADAM model.[39] V/Line had commenced the funding process, but it had not been finalised at the time of the SPAD in November 2020.

Radio communications

Instructions for radio communications during an emergency were provided in documents SAPR-78 *Verbal Safety Critical Communications Protocol* and train control training unit NCT5, titled *Communications*. Both documents allowed for an emergency message to be sent when the passage of a train is endangered and require an emergency message to be answered immediately. Both documents stated that an emergency message is commenced with the phrase "Emergency, Emergency, Emergency."

The V/Line *Book of Rules and Operating Procedures* (revision 7), *Safety Critical Communications Protocol*, and the training unit provided generic advice and allowed for a broad range of scenarios. They did not provide specific instructions on communicating with multiple trains in an emergency. The V/Line *Verbal Safety Critical Communications Protocol* stated that Rail Safety Workers must use the principle of safety critical communications being accurate, brief, and clear.

The signaller promptly commenced a radio broadcast to the driver of train 8156 on observing CCTV of train 8239 approaching signal SST535 and anticipating that the train would not stop at

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[37] Rail Safety Standards Board (2000), Railway Group Standard RGS GK/RT/0064 Issue 1, Provision of overlaps, flank protection, and trapping, London.

[38] Signal SST500 was analysed around the same time as SST535, and despite being assign a lower 'Likelihood Ranking Score', it achieved a higher 'Consequence Ranking Score' on account of being assigned a potential collision type of 'Head-on'. It was subsequently given a 'Potentially Severe' risk ranking and equipped with TPWS.

[39] This V/Line SPADAM analysis considered the risk of a side-on collision.

the red signal. This broadcast was heard by train 8239 and resulted in the trains receiving enough warning time to stop short of each other.

Other options were available to the signaller including a broadcast directed at both trains simultaneously, or a broadcast for all trains to stop. V/Line procedures do not provide specific advice on the preferred option in such a scenario.

The signaller stated later at interview that they were aware of the requirements concerning an emergency message, though during the incident used the word ‘urgent’ rather than ‘emergency’ to warn the driver of train 8156.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition, 'other findings' may be included to provide important information about topics other than safety factors.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to passenger train 8239 passing signal SST535 at danger and near collision with another passenger train at Docklands, Victoria, on 23 November 2020.

Contributing factors

- The driver of train 8239 was probably distracted when approaching ground-mounted signal SST535 and did not notice it displaying a stop indication. The driver probably noticed a gantry-mounted stop signal located further along the track and continued past signal SST535.
- **The absence of authority-overrun protection (such as TPWS) at signal SST535 increased the potential consequences of a SPAD.** (Safety issue)
- The V/Line risk assessment for signal SST535 that was conducted in 2014 did not consider a head-on or side-on collision as a credible scenario. As a result, TPWS was not considered a necessary control at the time of commissioning.

Other factors that increased risk

- Signal SST578 did not restore to danger when train 8239 SPAD signal SST535. With signal SST578 at proceed, the opportunity for the signalling to provide a warning to train 8156 of a potential conflict condition was not available.
- V/Line signalling standards did not identify flank-track protection as a control to prevent collision because of a SPAD, and none was installed at the incident location. The absence of flank-track protection increased the risk of side-on collision at the junction of track SST416T.
- RISSB signalling standards did not identify flank-track protection as a potential control to prevent collision because of a SPAD.

Other findings

- The signaller promptly broadcast a warning to the driver of train 8156 to stop their train, preventing a potential collision.
- There was no specific advice in the V/Line radio communication directions for a signaller to direct multiple trains in an emergency.

Safety issues and actions

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues. The ATSB expects relevant organisations will address all safety issues an investigation identifies.

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

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of these safety issues and actions are provided separately on the ATSB website, to facilitate monitoring by interested parties. Where relevant, the safety issues and actions will be updated on the ATSB website as further information about safety action comes to hand.

Absence of authority-overrun protection

Safety issue description

The absence of authority-overrun protection (such as TPWS) at signal SST535 increased the potential consequences of a SPAD.

Issue number:	RO-2020-019-SI-01
Issue owner:	
Transport function:	Rail: Passenger – regional
Current issue status:	Open - Safety action pending
Issue status justification:	Work is planned to install TPWS at signal SST535 in 2022.

Proactive safety action taken by V/Line Corporation

Action number:	RO-2019-019-PSA-01
Action organisation:	V/Line Corporation
Action status:	Monitor

V/Line Corporation has advised that a funding submission to fit TPWS to SST535 and other similar signals in the Southern Cross area was approved on 30 July 2021. Plans are underway to complete this installation during 2022.

Additional safety actions

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Additional safety action by V/Line Corporation

Coaching and a return-to-work plan has been implemented for the driver of train 8239, and the signaller has undertaken additional communications training.

Additional safety action by RISSB

RISSB advised that flank - track protection has been recorded for inclusion when the signalling principles standard AS 7711 is next under review.

General details

Occurrence details

Date and time:	23 November 2020 – 1635 EST	
Occurrence category:	Incident	
Primary occurrence type:	Signal Passed at Danger	
Location:	Docklands, Victoria, about 700 m north-west of Southern Cross Station	
	Latitude: 37°48'49.7"S	Longitude: 144°56'58.2"E

Train details

Track operator:	V/Line	
Train operator:	V/Line	
Train number:	8239	
Type of operation:	Loco-hauled regional passenger service	
Departure:	Southern Cross Station	
Destination:	Melton	
Persons on board:	Unknown	
Injuries:	Crew – 0	Passengers – 0
Damage:	None	

Train details

Track operator:	V/Line	
Train operator:	V/Line	
Train number:	8156	
Type of operation:	DMU regional passenger service	
Departure:	Wendouree	
Destination:	Southern Cross Station	
Persons on board:	Unknown	
Injuries:	Crew – 0	Passengers – 0
Damage:	None	

Glossary

AS	Australian Standard
CCTV	Closed-circuit television
DMU	Diesel Multiple Unit
EWRM	Enterprise-Wide Risk Model
LED	Light-emitting diode
LRS	Local Radio System
ONRSR	The Office of the National Rail Safety Regulator
RFR	Regional Fast Rail
RISSB	Rail Industry Safety and Standards Board
RRL	Regional Rail Link
SMS	Safety Management System
SPAD	Signal Passed at Danger
SPADAM	Signal Passed at Danger Assessment Model
SRRT	SPAD Ranked Risk Tool
TCS	Train Control System
TPWS	Train Protection and Warning System
UK	United Kingdom of Great Britain and Northern Ireland
VDU	Video Display Unit

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- V/Line
- V/Line personnel
- Telstra
- Event recorders from trains 8156 and 8239
- Signalling event logger
- Radio broadcast recordings
- Bureau of Meteorology
- CCTV footage from Southern Cross Station
- Photographs taken on the day of the incident

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V/Line (2020) *Signalling principles, NIST-12.0.*

V/Line (n.d.) *Professional Driving Booklet MSR01345*

Submissions

Under 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. That section 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 the following directly involved parties:

- V/Line
- Driver of train 8239
- V/Line signaller on duty at Southern Cross at the time of the incident
- ONRSR
- RISSB

Any submissions from those parties will be reviewed and, where considered appropriate, the text of the draft report will be amended accordingly.

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- 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, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

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

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining 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. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

An explanation of terminology used in ATSB investigation reports is available on the ATSB website. This includes terms such as occurrence, contributing factor, other factor that increased risk, and safety issue.