Australian Government
Australian Transport Safety Bureau

Derailment of XPT ST23

Wallan, Victoria on 20 February 2020

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2020-002
Interim – 10 June 2021

This investigation is being undertaken under the *Transport Safety Investigation Act 2003* (Cth). The investigation is being led by the Chief Investigator, Transport Safety (CITS) and supported by the Australian Transport Safety Bureau (ATSB) and the Office of Transport Safety Investigations (OTSI).

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Addendum

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The occurrence

This Interim Report details factual information established in the investigation's evidence collection phase and ATSB interim observations of that evidence. An Interim Report has been prepared to provide progress information to the public and the rail industry, and information on safety actions so far taken. This Interim Report does not contain findings or safety factors, that will be detailed in the Final Report.

The information contained in the Interim Report is released in accordance with section 25 of the *Transport Safety Investigation Act 2003* (Cth).

Prior to the occurrence

At about 2343[1] on 3 February 2020, the Australian Rail Track Corporation (ARTC) identified that Centralised Traffic Control (CTC) signalling had been disrupted on the Somerton to Albury line between Donnybrook and Kilmore East. A subsequent investigation by ARTC determined that a road vehicle had struck overhead wiring in Wallan, impacting power supplies to the rail signalling system. A fire in the Wallan signalling hut led to extensive damage to equipment and cabling.

As a result of the damage to the signalling system at Wallan, ARTC commenced managing rail traffic through the location using Caution Orders. Under this instrument, trains were required to proceed cautiously, resulting in significant delays to rail services using this section of the standard-gauge network. As repair of the signalling system was expected to take a significant period of time, alternative train working arrangements to Caution Orders were considered by ARTC.

ARTC commenced managing rail traffic through the location using a Train Authority[2] instrument on the evening of 6 February.[3] The instrument was used for the 24 km section between Kilmore East (at about the 63.8 km[4] mark) and Donnybrook (at about the 40.2 km mark). Wallan Loop was located between these locations, from the 49.058 km mark to the 47.268 km mark.

Notification to network users of the change to the use of Train Authorities was by an ARTC Train Notice.[5] The relevant Train Notice (TN 266) was issued on 6 February, updated on 7 February and further amended on 13 February. In the arrangements established, the points at Wallan Loop had been set for the straight and locked in that position. ARTC did not impose any additional speed restrictions through the section. The maximum permitted speed for the XPT when travelling on the main line through Wallan was 130 km/h.

On 19 February, Train Notice TN 266 was supplemented with a further Train Notice (TN 367) advising of a change at Wallan Loop, with trains to be diverted through the loop for a short period on 20 February. The purpose of routing trains through the loop was to remove any contamination that may have developed on the rail head while the loop track was not being used.[6] This was in preparation for signal system testing and re-establishment of the CTC signalling system over the coming days.

[1] All times are Australian Eastern Daylight Time (AEDT) and use the 24-hour clock.

[2] An instruction in the prescribed format issued by the Network Control Officer in connection with the movement of a train. RISSB Glossary of Terms, viewed 30 March 2020, <https://www.rissb.com.au/glossary/>.

[3] The first Train Authority was issued at 2042 on 6 February.

[4] Rail-km from Melbourne.

[5] Operational information issued by or on behalf of the Rail Infrastructure Manager. RISSB Glossary of Terms, viewed 30 March 2020,< https://www.rissb.com.au/glossary/>

[6] Residues such as iron oxides can hamper electrical connection between wheel and rail and impact performance of signalling systems.

Between 1453 and 1536 on 20 February,[7] the points at either end of Wallan Loop were manually reconfigured from their Normal position to their Reverse position.[8] This change meant that rail traffic travelling in either direction after this time would be diverted from the main line into the crossing loop track (No.2 Road). Train Notice TN 367 reflected this change and also specified a 15 km/h speed limit for entry into the loop, and a limit of 35 km/h when exiting the loop. Between 1600 and 1837, Track Force Protection[9] for the laying of conduit was also in place near Wallan, between the 46.3 km and 45.4 km marks.

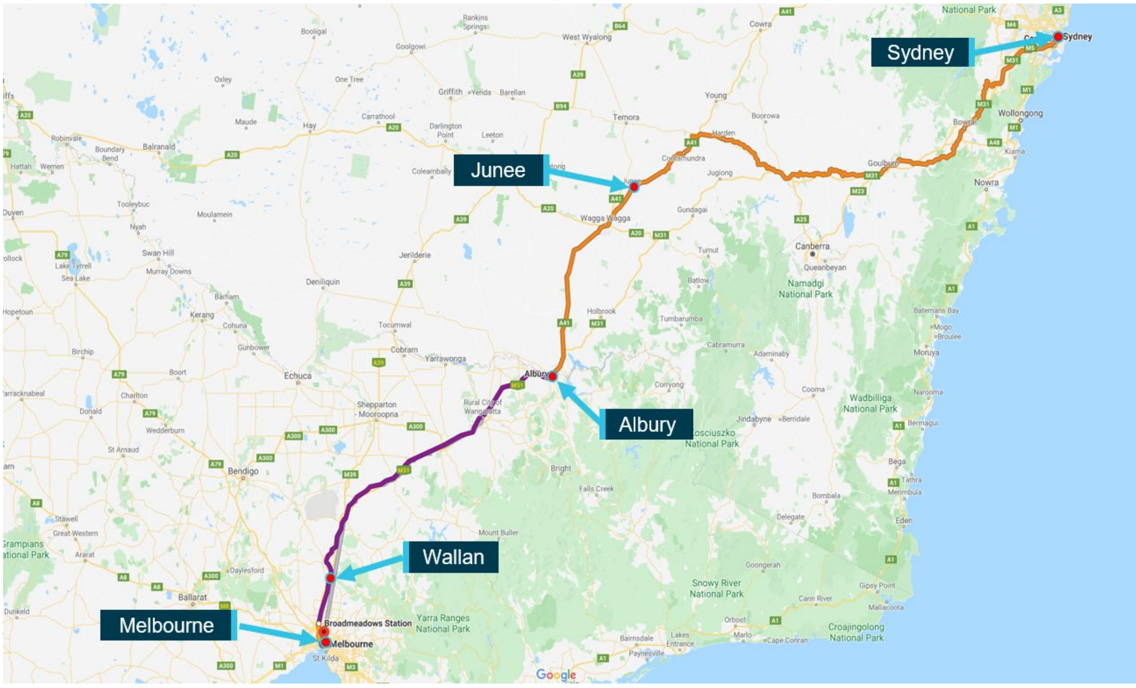
The first train to pass through Wallan Loop in this altered configuration was southbound V/Line train 8620. Immediately prior to train 8620 departing Kilmore East, the train controller advised the driver that they were going to be the first train through Wallan Loop in the past 72 hours. It departed Kilmore East at about 1623 and the Train Authority was cancelled at 1647 for its arrival at Donnybrook.

The second train through the loop was northbound V/Line train 8625. When stopped at Donnybrook and during exchanges between the driver and the network controller, there was no mention by either party of transiting through Wallan Loop. The train departed Donnybrook at about 1857. Train ST23 operated by NSW TrainLink was to be the third train through the loop.

Train ST23 from Sydney to Albury

On 20 February 2020, passenger train ST23 departed Central Station in Sydney, New South Wales (NSW) at 0741, just after the scheduled departure time of 0740. ST23 was to travel through NSW, and into Victoria to its destination in Melbourne (Figure 1).The service was scheduled to stop at several stations en-route to arriving at its final destination at Southern Cross Station (Melbourne) at 1830 that evening. ST23 comprised leading power car XP2018, five passenger cars of varying configuration, and a trailing power car.

Figure 1: Train route from Sydney to Melbourne



Source: Google Maps, annotated by CITS

[7] A track warrant for this activity was taken between these times.

[8] The Normal position of the turnouts was for 'straight-through' traffic, and the Reverse position was for the loop.

[9] A system used to protect a worksite.

The train proceeded south and arrived at Junee in southern NSW at 1452,[10] about 85 minutes behind schedule. ST23 was a single-driver operation, and there was a change of driver at Junee. The train departed Junee at 1456 and continued south, arriving in Albury on the NSW-Victorian border at 1637. There was a change in passenger services crew at Albury. The new passenger services crew comprised a Passengers Services Supervisor (PSS), a crew member training for the supervisory role, and three passenger attendants.

Train ST23 from Albury

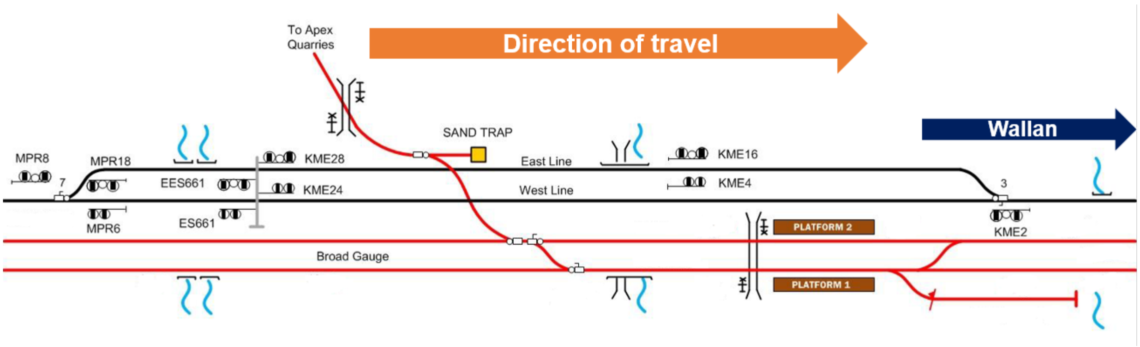
The train departed Albury at 1644, about 89 minutes behind schedule, and entered the Victorian section of its journey. After departing Albury, the PSS made an announcement covering a welcome, the delay, and emergency procedures. Tickets were checked and crew walked through the passenger cars checking door locks and equipment. Later, the driver was provided with a snack while stopped at Wangaratta Railway Station and the train departed that station at 1722.[11] Beyond Benalla, the focus of several attendants was on meal activities in the buffet car. The crew described the journey as normal although passengers were reported to be frustrated with the delays.

At about 1840, ARTC Network Control[12] contacted the driver of ST23 regarding a network alarm that had been received.[13] Later in the communication, the network controller advised the driver that due to the altered train working, ST23 would come into Kilmore East and wait until a V/Line train had passed. As part of this communication, the controller mentioned that 'you're going via the loop there at Wallan'. The response from the driver did not reference the train's route via the Wallan crossing loop.

Train ST23 at Kilmore East

The service continued south before coming to a stand at Intermediate Home[14] signal KME28, that was at Stop. It was about 1856. There was a standard-gauge passing lane at Kilmore East, with designated East and West Lines, and ST23 had been routed via the East Line (Figure 2).[15]

Figure 2: **Kilmore East standard-gauge passing lane (shown in black)**



The schematic shows the track at Kilmore East including the passing lane. Only the signalling for the standard-gauge track is shown.
Source: ARTC, modified and annotated by CITS

[10] Stopping times at stations are as recorded by NSW TrainLink.
[11] 87 minutes behind schedule.
[12] The ARTC Network Control office for this section of track is located in Junee in NSW.
[13] An alarm had been received by network control for a possible signal passed at danger (SPAD) at Tallarook, 23 km NE of Kilmore East. The network controller indicated that there had been power outages at this location, that may have showed up as a SPAD. The driver indicated that all signals had been 'clear' through Tallarook.
[14] This signal protected the broad-gauge crossover going into the Apex ballast quarry. It is called an 'Intermediate Home' because it is in an intermediate location along the passing lane.
[15] The passing lane was about 7 km in length. A 'passing lane' is an extended crossing loop long enough to be considered a short section of bi-directional double track.

The driver of ST23 contacted ARTC Network Control at about 1904 and inquired when they might receive permission to proceed. ST23 was required to wait until the V/Line train 8625 had cleared the single-line section.

At around this time, several rail workers were preparing for the arrival of ST23 at signal KME16. These rail workers were to assist with the alternate train working that had been implemented between Kilmore East and Donnybrook. Amongst these rail workers were an in-field signaller and an Accompanying Qualified Worker (AQW).[16] The AQW would board the train and accompany the driver from Kilmore East to Donnybrook. Both the signaller and the AQW had just started their shift and ST23 was the first train they were assisting that evening.

At about 1915 while ST23 was stopped at signal KME28, the in-field signaller positioned near signal KME16 contacted ARTC Network Control to advise that he had come on shift and taken over from the previous in-field signaller. During this call, Train Authority number 17 (TA17) for ST23 to proceed between Kilmore East and Donnybrook was issued to the on-ground signaller by the network controller. The controller read TA17, describing that the authority was issued in accordance with Train Notices 266 and 367, that the points at Wallan Loop were set and secured for number 2 track, and that there was a maximum speed entering the loop of 15 km/h, and a maximum speed exiting the loop of 35 km/h. There was then a full read back of TA17 by the in-field signaller. The network controller noted the time of the read back as 1920. A Condition Affecting Network[17] number 7 (CAN7) was then completed by the signaller under the instruction of the controller. This notice was to warn train crew of the condition of the Wallan-Whittlesea level crossing protection, and that the protection was being manually operated. The read-back of CAN7 by the in-field signaller was noted by the controller as being completed at 1921.

ST23 was held at signal KME28 on the East Line until the northbound V/line passenger train 8625 had transited the Donnybrook to Kilmore East single-line section, passed signal KME2 and was travelling along the West Line through Kilmore East. The V/Line train was clear of the single-line section by about 1925 and, soon after, ST23 was given permission by the network controller to proceed to Home Departure signal KME16,[18] still on the East Line within the Kilmore East location.

ST23 arrived at signal KME16 at about 1931. The train was met by several rail workers that included the in-field signaller and the AQW. The AQW boarded the lead power car and joined the driver at the head of the train. It was intended that the AQW would accompany the driver of ST23 for the 24 km section to Donnybrook. The XPT cab was not fitted with a cab voice recording facility (and was not required to be), and there is no record of the conversation between the AQW and driver.[19]

At about 1932 while the train was stopped at signal KME16, the driver and ARTC Network Control communicated via the train radio. This exchange included confirmation by the driver that he was in possession of 'authority 17 and CAN number 7 filled out the same way it has been'.

During this communication between the network controller and driver, the controller did not read the content of TA17 to the driver and there was no read back of the content of TA17 by the driver.[20] The controller commented 'points all set for the loop'. The driver's response to the controller did not reference transiting via the crossing loop or number 2 track at Wallan. There was no communication between the controller and driver regarding the maximum speed of 15 km/h for entering the crossing loop.

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[16] The term used in Train Notices for the worker that would accompany the driver between Kilmore East and Donnybrook.

[17] A Condition Affecting Network is a warning provided of an unsafe condition affecting, or potentially affecting, the network.

[18] Home Departure signal KME16 was protecting the turnout at the end of the passing lane. Permission for passing this signal at Stop was included in the Train Authority.

[19] Currently in Australia, locomotive and train operating cabs are generally not fitted with voice recording devices.

[20] In the extant version of Train Notice TN 266, read back of the Train Authority by the driver was not required.

The derailment of train ST23

The train departed signal KME16 at about 1934 and entered the single-line section towards Wallan. The line speed for the XPT between Kilmore East and Donnybrook was 130 km/h.[21] After departing from signal KME16, the speed of the train was increased and maintained between 100 km/h and 120 km/h.

The AQW was to ensure that the level crossing protection[22] at Wallan–Whittlesea Road in Wallan was in place for the passage of the train.[23] A Level Crossing Keeper (LCK)[24] was located at the crossing to perform the manual activation. The AQW contacted the LCK at approximately 1941, when the train was at about the 52 km mark. The LCK reported activating the crossing protection at Wallan–Whittlesea Road, and confirmed its activation to the AQW. This phone call lasted about 53 seconds and the LCK did not recall anything unusual about the communications with the AQW. The call had been completed when the train was about 4.5 km from the level crossing and 2.7 km from the entry to Wallan Loop.

At about 1943, ST23 was approaching the northern end of Wallan Loop at about the track's line speed. A brake application was made a short distance before the turnout, probably between 50 and 153 m from the points. This slowed the train a small amount before it entered the turnout travelling at a speed probably between 114 and 127 km/h. The train was not able to negotiate the turnout to the crossing loop track at this speed and derailed. The leading power car rolled onto its left side. All vehicles derailed excepting the rear power car (Figure 3).

Figure 3: **Aerial photograph of derailment site**

Source: ATSB

Emergency response

At the time of the derailment, there were 155 passengers,[25] six train crew and the AQW aboard the train. The driver and AQW were in the driver's cab, four passenger services crew were in the buffet car (the third passenger car) and another passenger services crew member was in the second passenger car.

After the train came to a stop, the PSS called the train crew on a hand-held radio and received responses from the other members of the passenger services crew. However, the driver did not respond and the AQW was not in possession of a NSW Trains issued radio.

Around this time, members of the train crew attempted to report the emergency using their radios. A V/Line signaller based at Wallan heard and responded to one of the emergency calls. The Wallan signaller contacted Centrol[26] and, at about 1945, Centrol contacted ARTC Network

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[21] Within this section, there were 115 km/h speed restrictions applied to some sections of track.

[22] Boom barriers and flashing lights at this location.

[23] Active protection on the other level crossings on the Kilmore East-to-Donnybrook section were working normally and it was only the Wallan-Whittlesea Road level crossing that required local operation.

[24] The person who activated the level crossing protection locally at the crossing, colloquially referred to as the bellhop.

[25] Passenger numbers based on available data from the operator.

[26] V/Line's network train control centre located in Melbourne.

Control at Junee relaying the information that the XPT may have derailed. In this conversation, Centrol also advised ARTC that V/Line would stop trains on the broad-gauge tracks that ran parallel to the standard-gauge. In response to the Centrol call, ARTC initiated its response.

Emergency services recorded the first '000' call for assistance from a train passenger, time-stamped 19:45:06.[27] This was followed by a series of calls from other passengers, members of the train crew, and members of V/Line and ARTC.

Around this time or soon after, some passengers started to self-evacuate from the train. A member of the train passenger services crew was allocated to manage passengers on the track, and two services crew members remained on the train to attend to passengers. The other two passenger services crew went to the lead power car. Here, they entered the power car through its the right-side cab door, accessible from the 'top' of the car laying on its left side. Finding it difficult to assist from within the cab, they then went to the outside and attempted to gain ground-level access by breaking the windscreen of the driver's cab.[28] However, attempts by the passenger services crew to gain this ground-level access were unsuccessful.

The first emergency services to arrive on site was Victoria Police at about 2003, followed by further emergency, medical and fire services. However, both the driver and the AQW did not survive the accident.

As a result of the movement of the passenger cars during the derailment, eight passengers were seriously injured and 53 received minor injuries. The five passenger services crew located in the passenger cars also received minor injuries.

[27] The emergency services call centre time stamp.
[28] Using tools sourced from the train's emergency breakdown kit.

Context

Train operator

ST23 and the XPT fleet was operated by NSW TrainLink, the operating name of NSW Trains, an agency of Transport for NSW (TfNSW).[29] NSW Trains provided passenger services in regional NSW and between the east coast capital cities of Melbourne (Victoria), Sydney (NSW) and Brisbane (Queensland).

Train crew

The driver

The driver of ST23 had been associated with the rail industry for about 40 years, employed in a range of roles including driving, training, and management. They returned to driving in mid-2016 as a Regional Driver with NSW Trains and were assessed as competent on the Junee - Melbourne route in July 2019.The driver had been medically assessed as fit-for duty (unconditional) in accordance with requirements for a Category 1 Safety Critical Worker.[30]

The driver regularly drove the XPT services between Junee and Melbourne. They would run the Junee to Melbourne leg and, following a period of rest in Melbourne, the return leg to Junee. After the commencement of alternate train working through Wallan on 6 February 2020, the driver ran the Junee–Melbourne–Junee round trip (including a rostered rest period in Melbourne) four times between 8 and 19 February. On 20 February, the driver's shift commenced at Junee at 1315 and the scheduled sign-off time in Melbourne was 1845.[31]

The accompanying qualified worker

The Accompanying Qualified Worker (AQW) aboard ST23 was employed by Programmed: a labour-hire organisation that provided skilled workers across a range of industries including transport. Programmed supplied several personnel to ARTC from 4 February for the management of rail traffic between Kilmore East and Donnybrook.

The AQW had been with Programmed since 2006. Records[32] indicate that the worker had been engaged by several rail operators in Victoria in various roles, in recent years primarily as a Track Force Protection Coordinator or hand signaller. The AQW was certified to Track Protection Coordination level 3.2, most recently renewed in March 2019. They had been medically assessed as fit-for duty (unconditional) in accordance with requirements for a Category 1 Safety Critical Worker.

The AQW had been engaged at Wallan from 4 February, primarily in the role of Level Crossing Keeper at the Wallan–Whittlesea Road crossing. All shifts from February had been night shifts that mostly commenced at about 1900. On 20 February, the AQW had just commenced the night shift. This was their first shift providing AQW services through Wallan, and this was their first train that evening.

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[29] A NSW Government agency constituted by the Transport Administration Act 1988 Part 1A Section 3C.

[30] Health and fitness requirements for Rail Transport Operators and Rail Safety Workers were governed by the Rail Safety National Law (RSNL) and associated Regulations.

[31] Due to the delay in the service on this day, arrival in Melbourne would have been significantly later than the rostered end-of-shift.

[32] Detailed work-placement records were available from 2014.

Passenger services crew

There were five passenger services crew aboard ST23, one more than the normal complement of four. The passenger services crew consisted of:

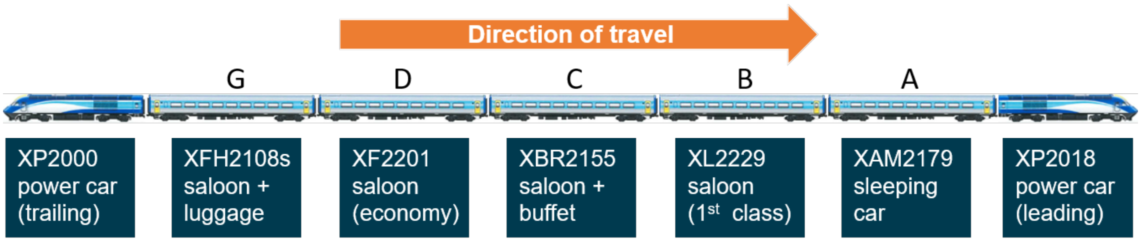
- A Passenger Services Supervisor (PSS) responsible for overall supervision of the passenger operations
- A Senior Passenger Attendant (SPA) responsible for the buffet operations and ticket sales
- A Passenger Attendant 2 (PA2) responsible for general passenger duties along the train
- A Passenger Attendant 4 (PA4) responsible for assisting the SPA in the buffet, and assisting with general passenger duties along the train
- An additional crew member designated acting Passenger Services Supervisor (aPSS) who was shadowing the PSS as part of on-the-job training.

Train information

The XPT (Express Passenger Train) was first introduced into service in 1982 and was based on the InterCity 125/Class 43 design used in the United Kingdom. The fleet of XPT vehicles were maintained by Sydney Trains.[33]

The XPT operating service ST23 on 20 February 2020 comprised seven vehicles that included five passenger cars (Figure 4). The leading three vehicles were manufactured by ABB Transportation in Dandenong, Victoria and commissioned in 1993. The trailing four vehicles were manufactured by Comeng in Granville, NSW and commissioned between 1981 and 1984.

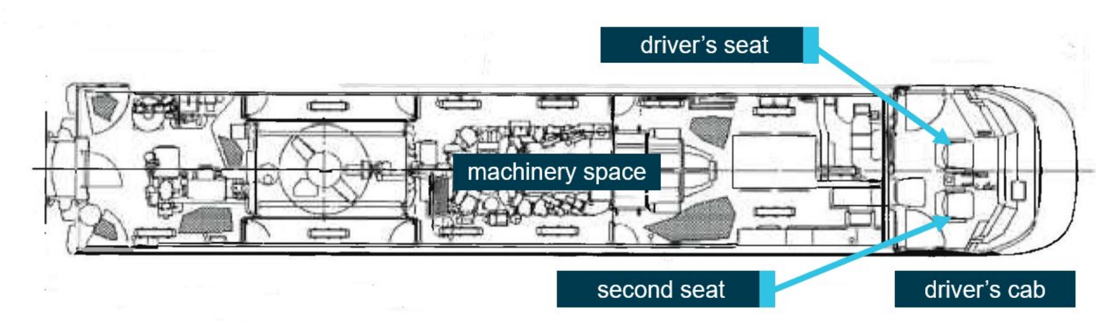
Figure 4: Train configuration



Source: Vehicle images supplied by Sydney Trains, annotation by CITS

The power car comprised a forward driver's cab with two seating positions, ahead of the compartment housing propulsive machinery (Figure 5). The primary access to the driver's cab was via its side doors.

Figure 5: Power car layout and cab seat arrangement



Source: RailCorp (NSW Transport), annotated by CITS

[33] Sydney Trains is an agency of Transport for NSW.

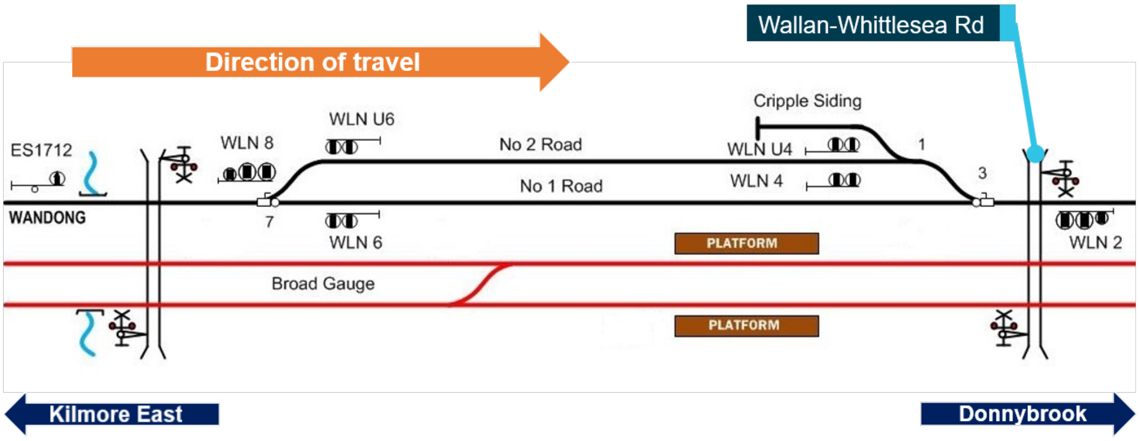
Infrastructure

Track

The XPT service was running on the standard-gauge track that connects Sydney and Melbourne. The track was part of the Defined Interstate Rail Network (DIRN) and was managed by the Australian Rail Track Corporation (ARTC).[34]

The standard-gauge track between Kilmore East and Donnybrook was a single, bi-directional line used by the XPT, V/Line passenger services and rail freight. There were passing lanes at Kilmore East and Donnybrook and a 1,550 m crossing loop at Wallan (Figure 6). The northern entry to this loop was located about 1.8 km north of Wallan–Whittlesea Road. At the southern end of the Wallan loop was Wallan Railway Station that serviced broad-gauge passenger trains.[35]

Figure 6: Standard-gauge track and signals at Wallan Loop



The schematic shows the standard-gauge track at Wallan including the crossing loop. The standard-gauge tracks are shown in black, and the adjacent broad-gauge tracks in red. Only the signalling for the standard-gauge track is shown in this figure.
Source: ARTC, modified and annotated by CITS

Wallan Loop northern turnout

The turnout at the northern end of the Wallan Loop was located at the 49.058 km mark. For southbound trains approaching the northern end of Wallan Loop, there was a downhill gradient of approximately 1:150 and the track was tangent (straight) for about the final 800 m of the approach to the turnout. The approach track was comprised of 60 kg/m rail, fastened to concrete sleepers.

The turnout design was rated for a train speed of 25 km/h and the maximum operational speed was 15 km/h in accordance with the ARTC operating code of practice.[36] It consisted of 60 kg/m rail on timber bearers, with a cast V-crossing.

Following the left turnout, the right curve (in the direction of travel) leading onto the No. 2 Road had a radius of about 422 m.[37] [38]

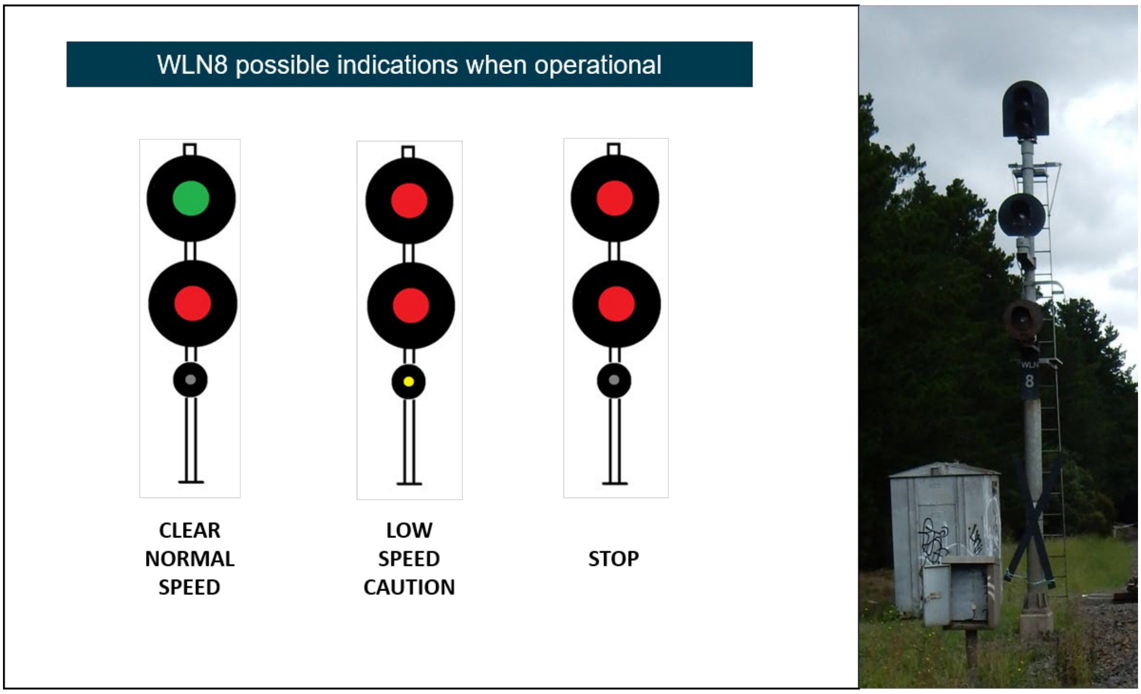
[34] ARTC is a statutory corporation fully owned by the Government of Australia.
[35] Standard-gauge trains did not stop at Wallan.
[36] TA20 ARTC Code of Practice for the Victorian Main Line Operations, Section 2, Rule 13 g.
[37] As recorded in the PTV Pass Assets database, viewed 26 October 2020
[38] A small superelevation of 8 mm was recorded at the commencement of the right-hand curve by the track recording vehicle in August 2019, indicating the left hand rail slightly higher than the right-hand rail in the 'Up' (towards Melbourne) direction.

Signals

Entry to the northern end of Wallan Loop was normally controlled by signal WLN8. Signal WLN8 was a 3-position Home signal able to authorise movement in the Up direction. When operational, signal WLN8 could provide 'Clear Normal Speed', 'Low Speed Caution' or 'Stop" indications (Figure 7). For movements into the crossing loop, the 'Low Speed Caution' indication would be used.

At the time of the derailment, signal WLN8 was extinguished and was fitted with a black cross near its base to indicate that it was not functioning (Figure 7).

Figure 7: Signal WLN8 possible indications (left) and on day of occurrence (right)

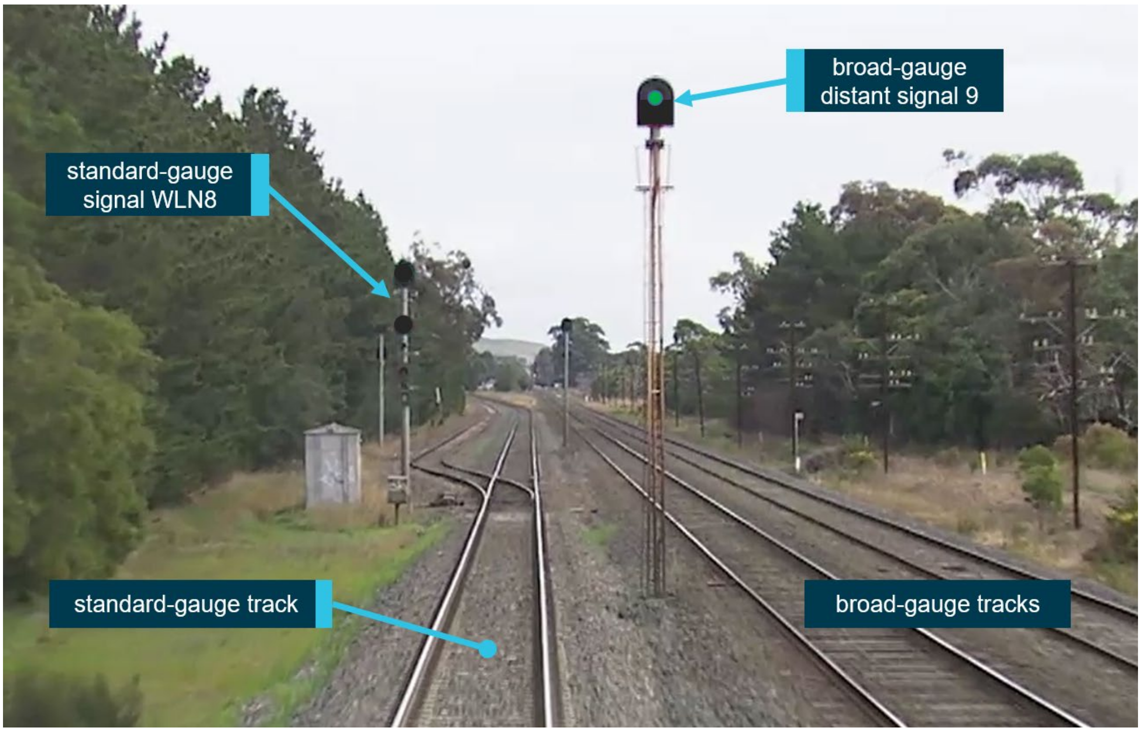


The figure shows the possible indication for signal WLN8 (when operational), and a photograph of the signal extinguished on the day of the occurrence. The photograph of signal WLN8 also shows the black cross that was attached to the signal post.
Source: CITS

A broad-gauge distant signal was located about 45 m to the north of WLN8 and was probably indicating a Proceed (green) aspect at the time ST23 passed (Figure 8).[39] This broad-gauge signal did not apply to the operation of ST23 that was running on the standard-gauge line.

[39] The indication of this signal at the time ST23 passed is not known with certainty, because its state was not recorded. However, broad-gauge rail traffic records indicate that the signal was more likely to be at Proceed. If not at Proceed, the signal would have been at its alternate 'Caution' indication, a single yellow light.

Figure 8: The tracks and signalling at the northern end of Wallan Loop



The photograph shows the approach to the Wallan Loop turnout. The photograph has been modified to show the extinguished state of standard-gauge signal WLN8 and the probable Proceed (green) indication of broad-gauge distant signal at the time of the derailment. The black cross that was fitted near the base of signal WLN8 at the time of the derailment is not shown in this figure.
Source: V/Line training video, with signal indications modified and annotated by CITS

Environmental conditions at Wallan

Weather

The conditions at the derailment location were dry. At 1930 at the nearest weather station at Kilmore Gap,[40] the temperature was recorded as 13°C, and the wind was from the south at 32 km/h.

Location of sun

The derailment occurred about 30 minutes before sunset. At 1943 at Wallan, the sun was at an azimuth[41] of 259°48'28" and altitude[42] of 5°02'59".[43] The direction of travel was 223° from true north, meaning the sun was about 36° to the right of the driver's direct view ahead.

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[40] 13.7 km from Wallan Railway Station
[41] Azimuth is the clockwise horizontal angle (in degrees minutes and seconds) from true north to the sun.
[42] Altitude is the vertical angle (in degrees minutes and seconds) from an ideal horizon, to the sun. An ideal horizon exists when the surface forming the horizon is at a right angle to the vertical line passing through the observer's position on the earth. If the terrain surrounding the observer was flat and all at the same height above sea level, the horizon seen by the observer standing on the earth would approximate the ideal horizon.
[43] Computed using National Mapping Division's sunmoonposn program, version 1.1.

Management of rail traffic (safeworking)

Safeworking systems and rules

Purpose

Safeworking is an integrated system of operating rules and procedures that defines the interaction between workers and engineered systems for the safe operation of a railway.[44] Of primary concern is safe operations including train separation and speed management.

Operating rules

ARTC operating rules for Victoria were defined in the ARTC Code of Practice for the Victorian Main Line Operations (TA20).[45] This Code formed part of ARTC's Safety Management System (SMS).[46] The Code described two safeworking systems, Centralised Traffic Control (CTC) and the Train Order System.[47]

Centralised Traffic Control

Prior to the signalling hut fire at Wallan in February 2020, standard-gauge rail traffic through this section was managed using the CTC system of safeworking described in section 17 of TA20. In the case of signal failure in a CTC system, this section provided for the use of Caution Orders. The Caution Order form used in conjunction with a CTC system required that traffic 'proceed cautiously' …. 'in accordance with Rule 1, Section 3'.[48]

Train Authorities

The procedures associated with Train Authorities were specified in section 25 of TA20, and also in section 17 for the CTC system. The circumstances specified for the use of Train Authority with a CTC system were:[49]

- To assist a disabled train
- Train to return to the crossing loop in the rear
- Working a train to the point of an obstruction on one or both sides.

The Code specified that 'Train Authority Working[50] must be used as specified by the individual operation of the safeworking system'.

ATSB observation

The use of Train Authorities in the circumstances that were present through Wallan in February 2020 was not provided for in the ARTC Code of Practice for Main Line Operations (TA20).

Use of Train Authority working in previous projects

ARTC advised that Train Authority working had previously been used during commissioning activities, often following signalling system upgrade.

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[44] RISSB Glossary of Terms, viewed 30 March 2020 <https://www.rissb.com.au/glossary/>
[45] At the time of the derailment, Issue 2.1, 01 July 2018
[46] A Safety Management System provides a systemic approach to managing safety risks and includes, amongst other items, codes, policies, standards, procedures and documents.
[47] The CTC system was described in section 17 of TA20 and the Train Order System in section 18.
[48] Rule 1, Section 3 specified proceeding at a speed not exceeding 25 km/h.
[49] The scope of application of Train Authorities was similar for the Train Order System.
[50] The phrase 'Train Authority Working' is used in section 25 of TA20.

Implementation of Train Authority working at Wallan

Background

Late on 3 February 2020, the Australian Rail Track Corporation (ARTC) identified that signalling had been disrupted between Donnybrook and Kilmore East. As a result of the damage to the signalling system, ARTC commenced managing rail traffic through the section using Caution Orders. To reduce traffic delays associated with Caution Orders, ARTC commenced managing rail traffic through the location using Train Authorities from 1900 on 6 February.[51]

Resourcing for altered train working arrangements

ARTC implementation of altered train working arrangements between Donnybrook and Kilmore East involved the engagement of several contractors. ActivateRail[52] was contracted to provide specialist rail project services, and labour hire firms Programmed and ARG Rail[53] supplied several rail workers.

Establishment of altered train working arrangements

A system of train working was established between Home Departure signals at Donnybrook and Kilmore East and notified by the issue of Train Notice 266. In this notice, operators were advised that rail traffic would operate by means of Train Authority. The notice included the processes that would be used and also advised that the points at either end of Wallan Loop would be clipped in the Normal position. Signage would be located at either end of the affected section advising drivers of the demarcation between CTC and Train Authority working.

Issuing of Train Authorities in the altered train working

The system used in February 2020 for issuing a Train Authority to a driver travelling between Kilmore East and Donnybrook involved the on-duty ARTC Network Control Officer (NCO) at Junee, an in-field signaller and an accompanying qualified worker (AQW). The key steps used in practice were:

- The in-field signaller was provided with partially completed Train Authority (TA) forms.
- The in-field signaller positioned themselves at whichever end of the Kilmore East – Donnybrook section that was to receive the next train.
- Prior to the arrival of the next train, the in-field signaller contacted the NCO to obtain details of the TA specific to the next train movement. The NCO dictated the details of the TA to the signaller and the signaller completed the form accordingly.
- The in-field signaller would then read back the completed TA to the NCO to verify its contents.
- A Condition Affecting Network (CAN)[54] notice was also completed by the signaller under the instruction of the controller.
- The in-field signaller would give the completed TA to the AQW (together with the CAN) and, on the train's arrival, the AQW would board the driving cab of the train. There was no contact between the in-field signaller and the driver of the train.[55]

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[51] The first Train Authority was issued at 2042 on 6 February 2020.

[52] ActivateRail describes itself as a rail interface solutions business, formed from the specialist rail project services arm of Sterling Infrastructure. It offers professional advisory services, project managers as well as worksite supervisors, site managers and track safety personnel.

[53] ARG Rail provided labour and recruitment services to the rail infrastructure sector.

[54] Issued because the Wallan-Whittlesea level crossing protection was being manually operated.

[55] TN266 specified that the signaller would deliver the Train Authority and CAN to the driver, although in practice this was done via the AQW. On one occasion (Train Authority number 20 on 14 February 2020), the driver requested that the signaller give him the Train Authority directly rather than via the AQW and the signaller complied with this request.

- Once on board, the AQW would give the TA and CAN notice to the driver. The driver would then contact the NCO to verify the TA. ARTC required the driver to verify the TA by its number. There was no expectation that the driver would read the TA to the NCO.[56]

Train Notice 266[57]

The use of Train Authorities between Kilmore East and Donnybrook in February 2020 was notified in Train Notice 266 (TN 266), issued on 6 February 2020 and commenced at 1900 on that day.

TN 266 was amended and reissued on 7 February. This amended notice advised that, in exception of a rule[58] within TA20, some disarranged signals may be lit, and that they would have a black cross affixed to the signal post.[59]

TN 266 was further amended and re-issued on 13 February 2020. Amendments included:

- Removal of the advice that signals in the section may remain lit.[60]
- Addition of text advising that 'Repeat Back of the Train Authority is not required to be undertaken by the driver of the rail movement'.
- Replacement of 'The rail movement may proceed through the section in the normal manner' with 'The rail movement may proceed through the section up to track speed as advised by the Accompanying Qualified Worker'.

Train Notice 367[61]

Train Notice 367 was issued on the evening of 19 February 2020 and contained additional instruction to TN 266. It advised that 'In addition to instructions contained in Train Notice 266 / 2020 issued on 13/02/2020 the following temporary alteration to working will apply'.

TN 367 included advice that:

- the points at Wallan Loop would be set for the No. 2 Track and that the maximum speed at entering the loop was 15 km/h and the maximum speed exiting the loop was 35 km/h.
- TN 367 also included advice that 'The Accompanying Qualified Worker must remind train crews of trains that the train will operate via No. 2 track at Wallan'.[62]

New, part-completed, Train Authority forms that included detail consistent with TN 367 were issued to the in-field signallers and ARTC Network Control, replacing the previous Train Authority forms.

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[56] On this point, the practice of drivers varied. During the period that Train Authority working was being used between Kilmore East and Donnybrook, on 30 occasions out of the 253 Train Authorities issued, the driver 'repeated back' the contents of the TA, and had that repeat back verified by the ARTC network controller.

[57] This section is limited to a brief account of notice TN266 and its amendments. The section does not include detail of the distribution of the notice, nor the receipt of the notice or awareness of its information by organisations or individuals.

[58] TA20, Section 5, Rule 5.

[59] TA20 Section 5 Rule 5 Clause b stated 'Light signals not in use are distinguished by a black cross on the front of the lights. The lamps are not to be lit'.

[60] Some V/Line drivers and the RTBU (Rail Tram and Bus Union) had expressed concern at signals remaining lit within the affected section. On 10 February, a driver refused to pass a lit signal within the section.

[61] This section is limited to a brief account of notice TN367. The section does not include detail of the distribution of the notice, nor the receipt of the notice or awareness of its information by organisations or individuals.

[62] There is no available evidence with respect to the communications between the driver and the AQW.

Risk management

Safety Management System

ARTC's Safety Management Systems (SMS) included procedures requiring risk assessments for standard and 'out-of-course' safeworking arrangements.[63] This procedure identified the potential need for a risk study or assessment for a range of activities and system changes. The procedure for risk management specified that formal risk studies were usually undertaken for complex activities where potential impact was likely to be significant. The listed types of activities where a formal risk study may be appropriate included:

- Significant civil works, such as tunnel construction, bridge construction
- Technical operational changes, such as introduction of new signal/track infrastructure
- Safety critical system changes, such as network control system changes.

The procedure also specified that formal risk assessment was undertaken in order to identify potential risks, their causal and contributory factors, the likelihood and consequence of the risk eventuating, and controls that may be implemented to prevent the risk or otherwise minimise the impacts of the risk. It specified that a formal, documented risk assessment must be conducted in various circumstances (including when notifiable changes are planned to the SMS and/or network configuration and as directed in project management procedures). This could include the identification and assessment of risks associated with:

- Achievement of organisational objectives
- Operational activities of the organisation
- Projects
- Impending changes to the organisation, operational environment or systems.

Risk assessments associated with altered train working through Wallan

Initial risk assessment

A risk assessment for the operation of rail traffic between Donnybrook and Kilmore East by Train Authority working was reported as being conducted at approximately 1600[64] on 6 February 2020 and the associated documentation finalised on 7 February. The risk assessment involved representatives from ARTC and ActivateRail and was based on previous applications of Train Authority working by ARTC.

The risk assessment for Wallan contained 10 identified hazards and associated control measures. Hazards and risks associated with routing trains through Wallan Loop were not directly identified in the risk worksheet. Hazard number 2 (Rail Operators not aware of the altered working) was indirectly relevant to any potential train operations through the loop (Table 1).

[63] RSK-PR-001 Risk Management, version 1.4, 5 April 2019.
[64] Approximate time of risk assessment advised by ARTC

Table 1: Extracts of risk assessment for altered train working

	Hazard	Caused by	Worst Outcome	Control	Risk Rank
2	Rail Operators not aware of the altered working	Train notices not received by train crews detailing the processes in place	Train driver accepts the train authority and proceeds into the section not conversant with the altered working	Train Notices will be issued in a timely fashion. Signals at the interface of the commissioning will have change of safeworking signage to indicate the interface between CTC and Train Authority working. Disarranged signals will have black crosses affixed to them. Train are piloted through the section.[65]	Low

ARTC reported that the risk worksheet was released to V/Line and Programmed. NSW Trains and freight operators were not included in this distribution. The documented risk assessment was not updated after 7 February 2020. However, ARTC has advised that risks relating to the altered train working continued to be informally assessed as feedback was received and that changes were reflected in the amendments made to Train Notice 266.

Risk assessment for travelling through Wallan Loop

There was no documented risk assessment specific to the routing of trains through Wallan Loop on 20 February and the release of Train Notice 367. The risk controls adopted for this change included the provision of information to operators through the issue of TN 367, and a note within that notice that the AQW was to advise the driver that the train will operate via No. 2 Track at Wallan Loop and of the speed limits required (for entry to and exit from the loop).

ATSB observation

Formal risk assessment was not used to identify hazards and available risk controls to manage the risk associated with train overspeed at the entry to Wallan Loop.

Distribution of safety notices

ARTC

Procedures defined the processes to be followed for preparing, reviewing, approving and issuing Operational Notices (including Train Notices) on the ARTC Network.[66] Different processes applied to different parts of the ARTC network.

Approved operational notices for Victoria, South Australia and Western Australia were published on the ARTC WebRAMS (Rail Access Management System) portal.[67, 68] Standing Train Notices were specified as being uploaded to this portal at approximately 1800[69] each evening. Access to WebRAMS was available to ARTC customers and stakeholders via an allocated User ID system. Rail operators were required to access the safety notices through this portal.

[65] The risk assessment reference to 'piloted' is different to TN266 that refers to an Accompanying Qualified Worker.
[66] Preparation and Distribution of Operational Notices OPE-PR-001, Version Number 1.2, 31 May 2019
[67] http://webrams.artc.com.au/
[68] In procedure OPE-PR-001, the acronym NRAMS was used.
[69] Australian Central Standard Time

For the New South Wales and Queensland network, the ARTC procedures for distribution of operational notices specified direct transmission to selected internal and external stakeholders.

ARTC Distribution of Train Notice 367

Formal distribution of Train Notice 367 by ARTC to rail operators was via the WebRAMS portal. ARTC reported that TN 367 was uploaded to WebRAMS as part of an automated system update at 1815[70] on 19 February 2020.

In addition to the formal release, information regarding transit via Wallan Loop and the release of TN 367 was shared with V/Line. There was no active engagement by ARTC with, or direct release of TN 367 to, NSW Trains or freight operators.

NSW Trains

Sources of safety information for operation on the Victorian network

For its operations within Victoria, NSW Trains drew on Weekly Operational Notices (WONs) prepared by Metro Trains Melbourne (MTM) and issued each Tuesday for the week commencing the Wednesday.[71] The WONs included safety information for metropolitan and regional services. The WONs did not, however, typically include ARTC Train Notices, and reference was instead made within the WON to the ARTC WebRAMS portal.

NSW Trains did not routinely interrogate the ARTC WebRAMS portal for network operational information related to its Victorian operations. For its operations on the NSW portion of the ARTC network, it received train notices directly from ARTC.

> **ATSB observation**
>
> NSW Trains systems for obtaining network safety information for operations within Victoria did not include accessing information via the ARTC web portal.

Distribution of safety information to drivers

Each week, information considered relevant to its Victorian operations was extracted from the WON. This was used to produce an information pack for its regional drivers that would operate in Victorian territory. This information pack was then placed in the pigeon-hole of each driver at their Junee base. It was the driver's responsibility to collect information from their pigeon-hole.

NSW Trains distribution of Train Notice 367

No evidence has been identified to indicate that NSW Trains was aware of Train Notice 367 prior to the occurrence. WON Issue No. 07 that was published on 18 February 2020 did not include information from TN 367. Extracts from WON 07 were prepared for distribution by 1139 on the morning of 20 February and were reported placed in the pigeon-holes of regional drivers (at Junee) by 1247 the same day.

> **ATSB observation**
>
> NSW Trains and its regional drivers coming on shift were probably not aware of the issuing of Train Notice 367 by ARTC and the possible operation of the ST23 through Wallan Loop on 20 February 2020.

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[70] Adelaide time

[71] The WON was published by the Office of Rail Safety Manager (a part of MTM) on behalf of MTM and V/Line.

WON Issue No. 07 that was published on 18 February 2020 did contain Train Notice 266 (as amended on 13 February). This was the ongoing operational notice for the Kilmore East to Donnybrook section at the time of the release of WON 07. It's direct inclusion in the WON was not standard practice, and was the result of V/Line re-issuing ARTC TN 266 (as amended 13 February) within its own system.

V/Line distribution of Train Notice 367

Normal V/Line process entailed driver supervisors checking the WebRAMS portal after the evening publishing of ARTC notices on that portal and distributing train notices to affected drivers.

In this instance, on the evening of 19 February, V/Line also published a V/Line safe working circular (SW.0024.2020) incorporating TN 367, for distribution to all drivers including those running broad-gauge services. The V/Line drivers that ran through Wallan Loop on 20 February were also contacted by their driver supervisor prior to their shift and advised of the change.

Derailment site information

Position of leading vehicles

The derailed train came to rest in a concertinaed arrangement. The lead power car had rolled onto its left side and decelerated at a higher rate than trailing vehicles (Figure 9).

Figure 9: Leading three vehicles in the derailment

The photograph shows power car XP2018 on its left side, and first two passenger cars A and B.
Source: CITS

Of the passenger cars, the first (Car A) had the greatest tilt of about 30 degrees from the vertical. It had come to rest on a row of pine trees and its trailing end had bound with the next car, Car B (Figure 10). The row of pine trees had probably stopped Car A from rolling onto its side.

Figure 10: The derailed position of Car A (left photograph taken after removal of trees)

The left photograph shows Car A rolled to its left and supported by pine trees, and the right photograph shows the trailing end of Car A bound with the leading end of the next car, Car B.
Source: CITS

Points position and turnout

At the time of the derailment, the points at the northern end of Wallan Loop were in their Reverse position to provide entry to the loop (Figure 11). The point mechanism had been placed into hand-mode[72] and the points locked in the Reverse position. The mechanism was also padlocked.

There were a number of witness marks on rails and within the track that indicated that wheels had derailed within the turnout. There were no derailment marks identified prior to the turnout.

Figure 11: No. 7 points at the northern entrance to Wallan Loop

Source: CITS

Train recorded information

The Hasler RT recorder

Power cars XP2018 and XP2000 were each fitted with a Hasler RT data recorder. The Hasler RT is an electro-mechanical device that records data onto a waxed paper tape (roll). Data recorded included speed, distance, time, a combined power-vigilance parameter, and brake cylinder pressure. The Hasler equipment included an analogue speedometer located on the driver's console.

The Hasler tapes from the two power cars were recovered for analysis (Figure 12). During retrieval, the Hasler tape from XP2018 jammed in the recorder and was damaged. However, all information was recovered and data relevant to the investigation was not affected.

[72] No. 7 points were controlled by a dual-control point machine. They could be operated in motor (remote operation) or hand (manual operation) mode.

Figure 12: Hasler waxed paper rolls removed from power cars XP2018 and XP2000

The photograph shows the recovered waxed tapes. The centre roll is the tape from power car XP2000. The left and right rolls are the tape from power car XP2018 that jammed and was torn at one location.
Source: CITS

Data processing

Unlike modern data logger systems that provide digital information for a wide range of operating parameters, Hasler recorders provide limited information in graphical format. In addition to the limited range of information, the format can introduce a loss of precision in the presentation of recorded data.

To process the data, both tapes were scanned and examined using photographic software. The traces for each recorded parameter were assessed for alignment with key events, such as start/stop points. Some horizontal re-alignment of parameters was required and both the horizontal and vertical scales of the images were calibrated for measurement.

Wheel diameter corrections

The Hasler used a pre-set (average) wheel diameter to calculate both speed and distance from the measured revolutions of the left-hand wheel on the second axle of the power car (wheel 3).[73] Actual speed may deviate from that recorded (and displayed) due to differences between this pre-set diameter and the diameter of the actual wheel providing the feed to the Hasler system. The actual measured wheel diameter for both power cars was larger than the pre-set value, hence recorded speed and distance were lower than the actual values.

[73] An average wheel diameter is used to accommodate wear and a reducing diameter during the wheel's life.

The recorded values for speed and distance were corrected for the ratio of actual-to-pre-set wheel diameter (Table 2). The larger actual wheel diameter on the XP2018 (compared to the pre-set) meant that the recorded speed was about 2% lower than the actual train speed.

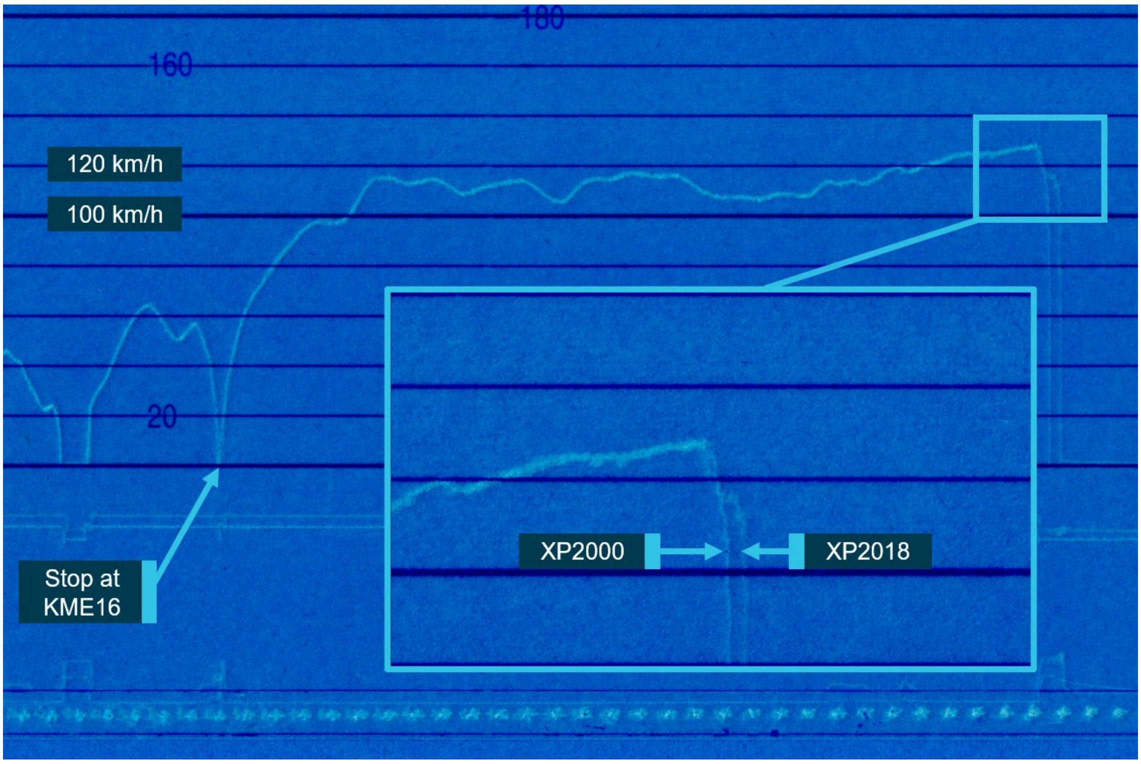
Table 2: Measurements used for speed and distance correction factor

	XP2018 – leading	XP2000 – trailing
Pre-set diameter (mm)	1000	1000
Measured diameter (mm)	1019.2	1011
Ratio (correction factor)	1.0192	1.011

Uncertainties in recorded data

An initial review identified a likely recording anomaly in the latter part of the XP2018 data. All channels recorded noise in the latter phase. An overlay of the data from the two power cars showed the discrepancy (visible as diverging speed toward the end of the data) and also confirmed that the speed data prior to this occurring was consistent (Figure 13).

Figure 13: Overlay of data recordings from XP2018 and XP2000



The image shows an overlay of speed records from power cars 2018 and 2000. It indicates consistent speed records after departing Kilmore East, then a consistent initial sharp deceleration of both cars followed by diverging speed records during the derailment.
Source: ST23 Hasler recordings annotated by ATSB

There were also potential inaccuracies in the XP2000 data in the latter stages due to uncertainty in measured wheel rotation being an accurate measure of train speed during this phase.

Other sources of train speed

GPS data from the installed ICE radio system[74] was interrogated and used as a comparator for time, speed and position information. While only coarse GPS data was available due to the system's polling frequency, it provided a source for comparison with the Hasler data and an enhanced confidence in the assessed train speed. The GPS data was also the primary source for locating the position of ST23 when stopped prior to signal KME16.

Throttle and braking events

One limitation of the fitted Hasler data recorder was that it did not record the positions of the driver's throttle and brake handles. Instead it recorded a generic power ON-OFF parameter and brake cylinder pressure.

The data from both power cars indicated that, at a point just prior to the commencement of deceleration, the power moved from ON to OFF and there was a rapid increase in brake cylinder pressure. For each recording, the points at which brake cylinder pressure began to rise and then reached a steady state were determined. The steady state pressures were noted for each record and compared with expected values. For both power cars, the recorded pressure was above that expected for a Notch 7 (Full-Service) application (345 kPa). The pressure recorded on XP2018, the leading power car, was about 378 kPa which was in line with the pressure expected for an Emergency application (375 kPa). While the pressure recorded on XP2000 was lower, about 358 kPa, it was still substantially above the Full-Service value. These results indicate that it was very likely that the brake application was an Emergency application. The speed of the train at the commencement of braking was about 129 km/h.[75]

Location of rise in brake cylinder pressure

Due to known limitations and potential anomalies in the Hasler data recording, obtaining position information from the data with respect to fixed points on track was difficult to achieve with high levels of accuracy. Therefore, the position at which brake cylinder pressure began to rise and the speed at which the train entered the turnout could not be directly read from the Hasler data.

Instead, the Hasler speed and distance data was used to calculate estimates of position considering different known stop locations. This was cross-checked using data from other sources to provide greater confidence. The different methods yielded slightly different results, however all indicated that the brake application was commenced before entry to the Wallan Loop (Table 3).

Table 3: Estimated start of braking and speed at entry to turnout

Parameter	Estimated closest braking	Estimated furthest braking[76]
Distance from brake cylinder pressure rise to No.7 points	50 m	153 m
Speed at No. 7 points	127 km/h	114 km/h

Train handling of ST23 during journey

The Hasler recordings and the GPS data were examined to evaluate any potential trend in speed exceedance by ST23 during the Victorian segment of the journey. The ARTC Route Access Standard specified a maximum speed for express passenger trains in Victoria (including the XPT) of 130 km/h in areas where no local speed restrictions applied.[77] The assessment focussed on

[74] The ICE radio GPS speed is not displayed to the driver in the locomotive cab.
[75] The speed display on XP2018 would have been reading about 127 km/h.
[76] To reduce train speed from 130 km/h to 15 km/h at the turnout would require braking at least 800 m before the turnout.
[77] ARTC Route Access Standard D53.

any identifiable trends and did not include local speed restrictions that were remote from the event.

Review of the GPS data identified 11 speed peaks of between 133 and 137 km/h in the Victorian section. These exceedances within the GPS data were cross-checked with the Hasler recordings and similar peaks identified, including a maximum actual value of about 139 km/h.[78]

None of the over-speeds identified were for a significant duration. These observations suggest that the driver was targeting line speed and occasionally overshooting. There was no evidence identified to suggest unusual train handling.

Vigilance parameter

The locomotive was fitted with a vigilance system. The installed Hasler does not record all information on driver activity associated with the vigilance system and its information is therefore of limited value.[79] However, the Hasler does record a vigilance parameter. The last point at which the vigilance parameter was recorded as active was prior to the stop at signal KME 28. There were no vigilance parameter events recorded between ST23 departure from signal KME 16 and the occurrence.

Cab video and voice recording devices

Power car XP2018 was not fitted with in-cab voice or video recording devices, nor was it required. As a result, there is no available evidence with respect to any communications or interactions that may have taken place between the driver and AQW prior to the occurrence.

Voice and video recording within the driver's cab would have assisted the investigation in ascertaining the interactions within the cab, and the potential identification and analysis of associated safety factors.

ATSB observation

Voice and video recording within the driver's cab would have assisted the investigation in the identification and analysis of potential safety factors.

Rolling stock condition assessment

Overview

Scope of condition assessment

The assessment of rolling stock condition was led by OTSI. The assessment involved vehicle inspections, oversight and review of testing conducted by Sydney Trains on behalf of ATSB, and a review of maintenance records. Specific testing was conducted on braking, vigilance and communication systems. The twist characteristics of power car XP2018 were also assessed.

Assessments were conducted at several locations and included observations at the derailment site on 21 February 2021, inspection of vehicles XP2000 and XFH2108 at the Sydenham Maintenance Centre on 6 March 2020 and inspection of vehicles XP2018, XAM2179A, XL2229, XBR2155 and XF2201 at the Auburn UGL facility on 10 March 2020. Further inspection and testing was witnessed by OTSI at the Auburn UGL facility.

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[78] Actual speed calculated by correcting the recorded speed for actual wheel diameter. The recorded speed was about 2 per cent lower than the estimated actual.

[79] AS 7527:2015 (amendment 2019) Legacy, tape based data loggers should, as a minimum record the following information that included train speed, distance, time, and brake status (i.e. brake pipe pressure or brake cylinder pressure).

Summary findings of rolling stock condition assessments

Based on post-incident testing of safety critical systems including braking, vigilance and communications systems, vehicle and component inspections, and a review of maintenance records, no rolling stock condition or defect has been identified that was likely to have contributed to the derailment.

ATSB observation

Completed post-incident assessment of ST23 rolling stock did not identify a condition or defect that was likely to have contributed to the derailment. This included braking, vigilance control and radio communications systems.

Incident site observations

General

Observations were made at the derailment site prior to the rolling stock being moved. The preliminary observations did not identify evidence of rolling stock defects or equipment failures potentially causal to the derailment. All vehicles remained mechanically coupled although some couplers had sustained damage in the derailment. All bogies remained attached.

The derailed vehicles exhibited wheel tread damage consistent with (and typical for) running on track ballast. The wheels on the leading passenger vehicle (XAM2179) exhibited significantly more wheel tread damage than those of power car XP2018, suggesting that power car XP2018 had travelled in an upright derailed state for a shorter distance than the following passenger vehicle. This was consistent with the power car overturning early in the derailment sequence.

Brake controller position

At the time the site observations were made, the brake controller in the driver's cab of power car XP2018 was in the Emergency brake position with the power (throttle) controller in OFF and the reverser direction in Forward.

Sydney Trains maintenance systems

Maintenance of the XPT fleet was managed using the Sydney Trains Enterprise Asset Management (EAM) system. Work orders were generated within EAM in accordance with the requirements of the Technical Maintenance Plan (TMP). The TMP specified the frequency of tasks required for the power cars and trailer cars. Maintenance inspections included Major Inspections and Trip Inspections (pre-release to service). In addition to the maintenance regime, heavy overhauls were conducted at specified frequencies.

The Major Inspection was typically completed at 90-day intervals and inspected the condition of the carriage in greater detail. The task list for each Major Inspection varied with the inspection cycle, with some tasks completed more frequently than others.

Review of maintenance system

Open work orders

At the time of the derailment of ST23, a number of work orders within the TMP were listed as Open. However, none of the Open orders were found to be relevant to the risk of derailment.

It was also found that vehicles of ST23 entered service with work orders for the Trip Inspection of all cars identified as Open. However, review of the task list identified that most tasks had been completed prior to the train entering service. Those tasks that were not completed were not considered potential contributors to the derailment.

Fault management

Open and closed faults for the 120 days prior to the derailment were reviewed. There were no open faults identified that would suggest the train was operating at increased risk relevant to the derailment sequence. Review of closed faults did not show any recent faults which might have been addressed incorrectly and created increased risk.

Bogies and wheelsets

Bogie overhaul and wheelset records

Review of bogie and wheel set sheets did not identify any areas of concern with the condition of the bogies at the time of overhaul or wheelset change. Assessment of bogie weights at time of overhaul were within specification. Braking components including brake levers and cylinders were within specified dimensions and clamping forces at the time of servicing.

Bogie post-incident overhaul

Overhaul of bogies from ST23 has not identified defects relevant to the derailment. Inspection and overhaul of all bogies was not yet complete at the time of finalising the Interim Report.

Condition of wheels

The last routine wheel measurement indicated flange and rim thickness were within engineering standards.

Wheel profile measurements taken following the incident were compared to the WPR2000 profile specified for these vehicles. No sharp flanges were identified, and profiles were within tolerance and generally close to the WPR2000 profile.

Braking and vigilance systems

Static brake testing and vigilance system

Static brake testing on power car XP2018 was conducted at Auburn, NSW.[80] The purpose of this testing was to determine whether the brakes were degraded prior to the derailment. In preparation for the static brake testing, some of the items damaged during the derailment were repaired and the testing supported by workshop services.[81]

Given the damage sustained by the rollover derailment, the performance of the braking system and the vigilance control system was better than expected. There was no evidence found that the brake system or vigilance control system on XP2018 contributed to the derailment.

Review of maintenance records for braking system

During the (pre) Trip Inspection, the braking system was required to be tested. The test consisted of a functionality check of the braking system including brake pipe pressure, automatic and electro-pneumatic brake function, driver safety system (operator enable handle and pedal) and the vigilance control unit. Sydney Trains was unable to provide brake testing capture sheets from the most recent Level 1 or Level 2 brake testing and advised that the tasks were completed and signed off within the EAM but no paper records were available. The absence of these brake testing sheets prevented a more detailed assessment of the brake condition at the time of these maintenance checks. However, a review of the fault history did not show any known faults.

[80] Static testing was conducted on XP2018 as the trailer cars immediately behind in the consist were damaged and without significant repairs could not be tested. The main areas of focus were the driver control aspects of XP2018.

[81] During the derailment and subsequent rollover, some pneumatic equipment was dislodged from the power car or damaged, while other equipment remained intact. In preparation for the static brake testing, approval was provided to Sydney Trains to repair some of the items damaged during the derailment in preparation for the test to be undertaken.

Additional to the testing, there were no known reports of issues with the braking system during the journey of ST23 prior to the derailment.

Power car XP2018 response to track twist

A twist test on power car XP2018 was conducted at Auburn, NSW. The purpose was to determine this vehicle's capacity to negotiate track twist. The twist test arrangements were in accordance with the twist (packing) described in RailCorp Standard ESR0001-200 (2013) that represented the standard current at the time of the derailment. For testing, vehicle suspension was retained in its as-derailed condition that included some contained debris, and some suspension damage.

The testing found a maximum wheel unloading of 57.3 per cent, compared to the maximum permissible value of 60 per cent. Given this result, it is unlikely the twist performance of this vehicle contributed to the derailment.

Train radio performance

Post incident function testing and log review

The radio system was function tested and logs reviewed to assess the condition of the radio system just prior to derailment. The train radio system had sustained damage during the derailment and antennas had been removed, resulting in some performance degradation during testing.

Based on results of radio function testing and the review of radio log files, the Sydney Trains specialist maintenance group responsible for the train communications concluded that there was no evidence to suggest that the on-board communications systems were non-operational or defective at the time of the incident.

Assessment of recordings of communication between the train driver and ARTC Network Control were consistent with the train radio system operating normally.

Maintenance records of communications system

The maintenance history for the communication equipment fitted to ST23 was reviewed, with the primary focus being power cars XP2018 and XP2000. The review found that the train radio system was within the required maintenance inspection timeframes and compliant at the time of the derailment. The most recent inspection of communications equipment on XP2018 was completed on 6 February 2020, and on 4 February 2020 for XP2000.

Rolling stock crashworthiness and survivability

Scope

The ATSB conducted crashworthiness and survivability inspections of the lead power car and the five passenger cars. Inspections included an examination of features pertinent to the survivability and evacuation of the train crew and passengers. The unoccupied rear power car remained upright and on track and was not inspected for its crashworthiness.

Inspections were conducted at the derailment site on 21 February. Power car XP2018 and the leading passenger (sleeper) car were further examined at the Auburn UGL facility on 10 March 2020.

Power car XP2018

General findings

Damage to the vehicle's exterior indicated that the lead power car had slid on its side for some distance (Figure 14). The driver's cab retained its structural integrity. However, the left-side cab door separated from the door frame, and the left-side engine room door at the rear of the power car was dislodged. Fuel tanks on the left side were also breached.

The car's forward windscreen remained in place during the derailment. The screen was subsequently removed by rescuers to access the driver's cab. The lower rear corner of the left-side quarter window had detached from the frame, sufficient to allow a limited amount of ground material into the cab.

Internally within the cab, equipment and fittings remained mostly intact. Instruments, control panels and interior linings contained little or no damage. The driver's side (left-side) headrest was detached from the seat back.

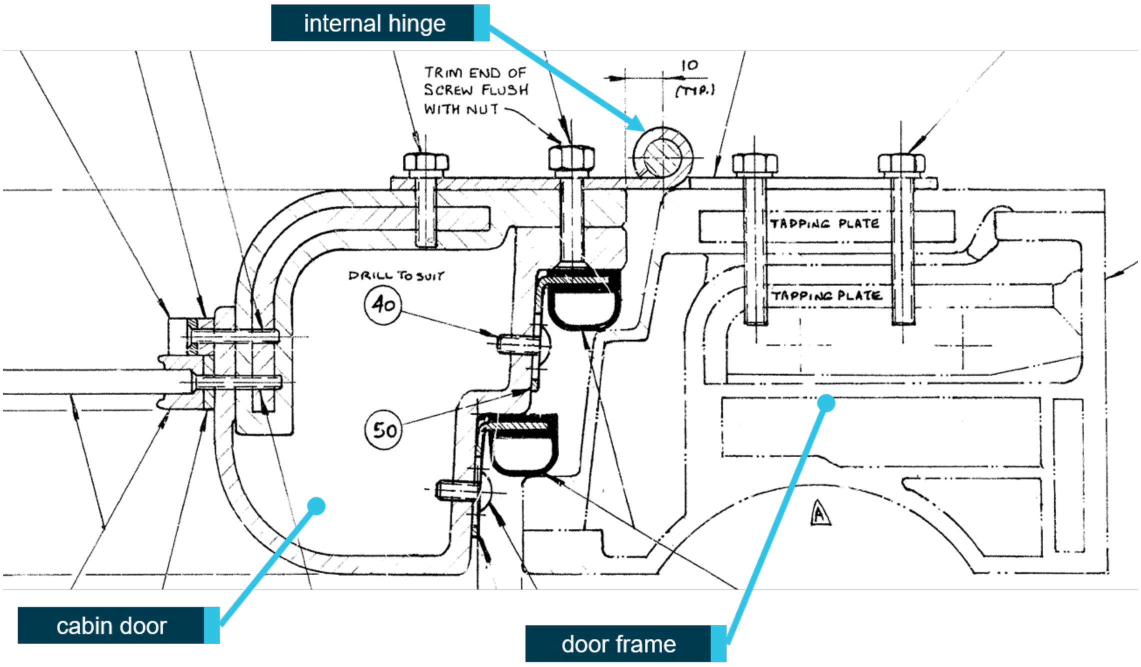
Figure 14: Power car XP2018 at Auburn workshops 10 March 2020

Source: ATSB

Driver’s left-side cab door

The most significant damage to the power car was to the left cab entry door. The cab door had been secured with two hinges on its rear edge and a single door latch on its forward edge. The glass fibre composite doors were a plug shape and rotated inward on the rear door frame. The hinges were attached to the door and frame using bolts secured to embedded plates (Figure 15).

Figure 15: Door and doorframe section drawing



Source: Commonwealth Engineering (NSW) Drawing 022010940-1 annotated by CITS.

The door hinges had failed as a result of the external loading during the sliding event. The door had become disconnected from the door frame and loose within the cabin. The door-side fingers of the upper hinge had peeled open (Figure 16) and the lower hinge had failed by the loss of fastening on the frame-side of the hinge (Figure 17).

With the door aperture open, the rear of the door frame had acted as a scoop for ballast and dirt which accumulated inside the cab. A significant amount of material was found to have entered the cab space.

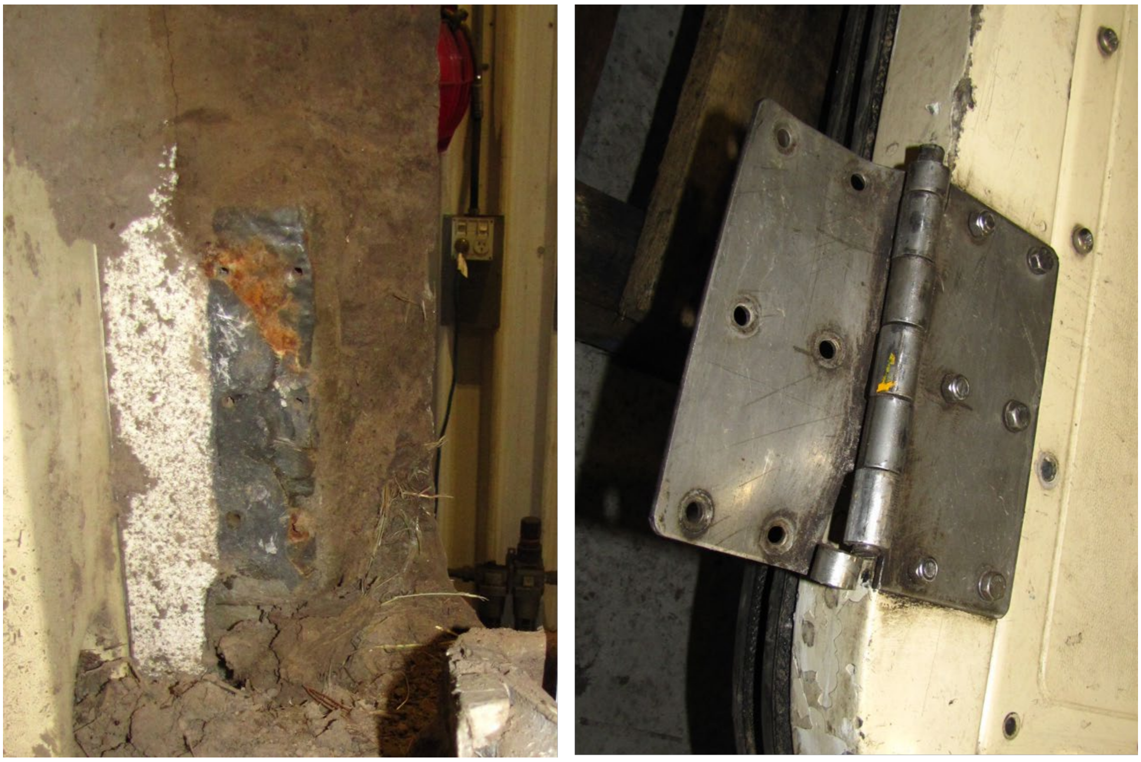
ATSB observation

The left cab door of the power car did not withstand the external loading associated with power car 2018 rolling on to its side. This resulted in materials entering the driver’s cab of the power car.

Figure 16: Upper internal hinge of left cab door of XP2018

Source: ATSB

Figure 17: Lower internal hinge of left cab door of XP2018



Source: ATSB

Evacuation routes from driver's cab

The normal access to and from the driver's cab was through the side doors. At the rear of the cab, there was an internal door to the machinery space and at the rear of that space there were a further two door exits either side of the car, and a rear central door. With the power car on its left side, the right driver's cab door was the most accessible access route to the cabin and the crew inside. The right driver's cab door remained operable and was used by members of the crew to gain access to the cab. This access route was only accessible by able bodied people climbing on top of the vehicle and there was no practical way to extricate any survivor if they themselves were not ambulatory.

ATSB observation
With power car XP2018 on its left side, there were no points of entry at or near ground-level.

Rear left door

The rear external machinery space entry door on the left side of the power car had also been dislodged but the top hinge did not fully part from the frame (Figure 18). There was a build-up of ballast and dirt at the base of the door.

Figure 18: The rear left-side door of power car XP2018

The left photograph shows a full view of the rear left-side door of XP2018, and the right photograph the base of the door pushed-in by track ballast and dirt.
Source: ATSB

Passenger cars

Overview

Inspections did not identify any structures that would have generated injuries by their design. In the lead passenger car, some windows had been shattered introducing a hazard. It was also reported that luggage had fallen from overhead racks, some of which struck passengers and service staff causing injury.

Most injuries to passengers were a result of people being unprepared for the sudden deceleration or losing their balance when their car lurched or tilted. Passenger injuries were more prevalent and more severe in the forward passenger cars.

Passenger car XAM2179 (Car A)

XAM2179 was the leading passenger car and had a cabin/sleeper configuration. It consisted of nine cabins which could seat three passengers each. Some cabins had forward facing seats while others were rear facing. This sleeper car came to rest rolled to about 30 degrees to its left. External damage included four broken exterior windows on the left (passenger aisle) side of the carriage and exterior damage to the roof line above the windows from the passenger car striking pine trees adjacent to the track. The trailing end had also bound with the leading end of the following car, XL2229.

Damage within the sleeper car included collapsed interior lining in the passenger aisle. Two cabins had cracked glass partitions most likely from being struck by luggage or passengers (Figure 19).

Figure 19: Passenger car A, left-side corridor (left) and fractured glass partition (right)

Source: ATSB

Being the most widely spaced seats in the train, these occupants had the largest free-flight distance available that can lead to more serious injuries. The injuries in this car were most likely the result of passengers being thrown a significant distance before impacting structures and fittings. Injuries occurred to people sitting in both forward- and rearward-facing seats.

Passenger car XL2229 (Car B)

This was a first-class car with 56 forward-facing passenger seats in a single open cabin. It was seating an estimated 52 people at the time of the derailment. It was the car with the most reported injuries and the most reported serious injuries. The injuries were most likely the result of passengers being thrown from their seats or being hit by luggage falling from the overhead racks. The car came to rest at an angle of approximately 17 degrees to its right.

There was no evidence of structural failure or dislodged internal fittings acting as projectiles. The only significant damage to the cabin was exterior binding at the front right corner with the car ahead, Car XAM2179. This prevented the use of the exits at this location.

Passenger car XBR2155 (Car C)

This car was half first-class forward-facing seating with the other half being the buffet section. It was near upright when it came to a stop. The car suffered no interior damage of consequence.

Passenger car XF2201 (Car D)

This was an economy-class car with 68 forward facing passenger seats in a single open cabin. It was the most heavily populated car in the set with an estimated 57 passengers in this car at the time of the derailment. Comparatively fewer injuries were reported in this car. It was near upright when it came to a stop. The car suffered no interior damage of consequence.

Passenger car XFH2108 (Car G)

This car was half economy class forward facing seating with the other half being the baggage section. The baggage section was locked meaning there was only one pair of exits (forward) immediately obvious to passengers. A key to the baggage compartment was available behind breakable glass. This would have permitted a second set of exits to be used through the baggage compartment, however in this instance these rear exits were not used. This car was at an angle of about 10 degrees when it came to a stop and had the least number of reported injuries and the lowest injury rate. The car suffered no interior damage of consequence.

Evacuation routes from passenger cars

The majority of exits in passenger cars were available. Six of the 18 exits for passengers could be considered freely available. A further eight exits were operable and available but with some hindrance to their free use due to the distance from the ground, the angle of the access ladder, or some other hazard. Four exits were deemed not to be available, either due to obstruction, jamming or excessive height off the ground.[82]

Most people reported, and general evidence suggests, that the majority of passengers were able to evacuate without or with limited assistance. Some special needs passengers were assisted out of the carriages.

While not obstructing the evacuation, the angle of two carriages slowed some people getting off. The longitudinal angle of most cars was negligible, however the lateral angle (roll) of the front two passenger cars was significant.

Passenger information

Passenger numbers and injuries

Based on information supplied by the rail operator and Victoria Police, the total number of passengers on board ST23 at the time of the derailment was 155.[83]

Available injury information from the operator and police was combined with ATSB passenger survey response data to estimate a total number of passenger physical injuries of 61.[84, 85] This total figure was comprised of 8 serious injuries and 53 minor injuries.[86]

[82] Considered not usable in cases where the bottom rung of ladder was more than 1.5 m from the ground.
[83] Based on available information.
[84] Some passenger information was incomplete, and this reported data represents a summary of available information.
[85] There were also reports of psychological impacts including instances of post-traumatic stress disorder (PTSD) that are not included in the injury total.
[86] A serious injury is an injury that required, or would usually require, admission to hospital within 7 days of the event.

Passenger survey

Overview

The ATSB conducted a survey of passengers that were aboard train ST23 at the time of the derailment. From 155 passengers reported to be on board, 83 responses to the survey were received: a response rate of 54 per cent. The survey included questions on:

- passenger demographics
- passenger seating location
- safety information and briefings
- experiences during and after the event
- the nature of injuries.

Safety information

On questions pertaining to safety information:

- Seventy per cent of passengers who responded to the question about the provision of safety information reported that they either did not receive any safety information or could not recall receiving any.
- Of the 63 responses about the format of the safety information provided, eight passengers reported that they received the information from a briefing card.
- Of the 74 responses to a question related to paying attention to the safety information provided, 57 per cent of passengers reported that they did not pay attention. Some passengers mentioned that the reason for not paying attention was that there was no information provided.
- Seventy per cent of survey respondents reported that, prior to the event, they did not know how to get out of the train in an emergency.

In response to questions on suggestions for improvement in safety information:

- Ten passengers referred to the way in which safety information is provided by airlines.
- Some passengers mentioned that better signage on the seat in front of them or at the end of carriages may have been helpful.
- Other comments included increasing announcements.

The evacuation

There were varied responses about the communication received from crew members following the derailment. This was at least in part due to the distribution of the crew, with four of the five crew being in the buffet car at the time of the derailment. There were no crew members in three of the cars at the time of the derailment. Most of the passengers who responded advised that initial crew instructions were to remain on board the train. Others reported being unsure about what to do. There was no report of any announcements being made via the public address system or the use of loud hailers.

Responses indicated that some passengers self-evacuated before receiving instructions from the crew. Passengers were asked to estimate how long it took to exit the train. The responses ranged from a ‘few minutes’ to up to 30 minutes, supporting other evidence that some passengers self-evacuated prior to being instructed by train crew. About half of the respondents indicated having difficulty exiting the train due to carriage orientation and/or difficulty with getting down to the ground.

Once passengers were out of the train, crew members were observed instructing passengers to move off the adjacent tracks (due to concern of possible rail traffic).

In response to questions on areas for improvement in emergency response, suggestions included:

- a greater number of staff members to manage an emergency
- crew training in emergency management
- leadership and direction, including more information being provided to passengers
- consistency in the information provided.

Sixteen respondents utilised the free text question to provide praise for the handling of the event by members of the train crew and first responders.

Safety actions

Australian Rail Track Corporation

ARTC advised[87] that, since the incident, it had taken the following steps to improve the safety of its operations, that are relevant to two ATSB Observations:[88]

1) ARTC has developed an amendment to TA20 to facilitate an “Alternative Proceed Authority”. Once implemented, TA20 will provide for a new form of safeworking, similar to Train Authority Working, that can be implemented in circumstances where Centralised Traffic Control (CTC) is not operational for an extended period of time. The proposed amendment to TA20 has been the subject of initial user consultation including internal briefing sessions with operational areas within ARTC’s business and external briefing sessions with rail operators. A Human Factors assessment is scheduled to be undertaken in relation to the proposed amendment in Quarter 4 of Calendar Year 2021. The proposed amendment will then be subject to further formal stakeholder consultation and ARTC’s management of change processes prior to implementation.
2) ARTC is developing a new risk assessment tool for abnormal circumstances, to be known as an Event Flow Work Tool, with a focus on risk scoring and authority escalation requirements. A prototype has been developed and is to be further work shopped with Network Controllers prior to implementation.
3) Until the steps referred to in 1) and 2) above have been completed, ARTC has implemented an interim requirement that the implementation of any altered method of safeworking, other than Caution Orders, requires a formal Risk Assessment and approval by ARTC’s Executive Risk Committee.
4) ARTC has developed an amendment to TA20 to include a new rule titled “Train Notices”. Once implemented, the new rule will clarify the manner and circumstances in which the operation of TA20 may be amended through the issue of Train Notices. Implementation of the new rule is subject to consultation with rail operators and internal approvals.

NSW Trains

NSW Trains advised[89] that, since the incident, it had undertaken a number of safety actions. Safety actions taken included:

1) The development of new procedures for the daily access of the ARTC WebRams system
2) Amendment of procedures to include confirmation of receipt of safety critical information by train crew prior to them starting their day of operations
3) Additional resources to ensure that NSW Trains has 24/7 frontline leader coverage across the network
4) The review of interface agreement risks from all rail infrastructure managers (RIMs) to identify and assess NSW Trains' systems and procedures for managing interface safety risks with the relevant RIMs

[87] 22 April 2021
[88] ATSB Observations:
- The use of Train Authorities in the circumstances that were present through Wallan in February 2020 was not provided for in the ARTC Code of Practice for Main Line Operations (TA20)
- Formal risk assessment was not used to identify hazards and available risk controls to manage the risk associated with train overspeed at the entry to Wallan Loop.

[89] 22 April 2021

5) A range of initiatives to enhance safety critical communications including:
    a) the development of a new program to strengthen safety critical communication across NSW Trains (TrainLink) rail safety workers
    b) international benchmarking against safety critical communication systems used by other rail operators
    c) risk workshops with key internal and external stakeholders to identify opportunities to strengthen safety critical communications
    d) the development of a business case for future digital solutions for safety critical communications.

Ongoing investigation

The investigation is continuing and will include further consideration of the following:

- management of train operations, including implementation of altered train working, risk management and communications
- distribution of safety critical operational information
- train operations and further human factors analysis
- survivability and crashworthiness standards relevant to this type of event
- finalisation of derailment sequence analysis
- finalisation of rolling stock and track condition assessments
- passenger services crew training and preparedness for a derailment event
- passenger safety information
- similar occurrences.

Relevant parties are notified of critical safety information identified during the course of the investigation so that appropriate and timely safety action can be taken.

A final report will be released at the conclusion of the investigation.

General details

Occurrence details

Date and time:	20 February 2020 – 1943 AEST	
Occurrence category:	Accident	
Primary occurrence type:	Derailment	
Location:	Wallan, Victoria	
	Latitude: 37º 24.500' S	Longitude: 145º 0.823' E

Train details

Track operator:	Australian Rail Track Corporation (ARTC)	
Train operator:	NSW Trains (TrainLink)	
Train number:	ST23	
Type of operation:	Passenger	
Departure:	Sydney	
Destination:	Melbourne	
Persons on board:	Crew – 6 +1	Passengers – 155
Fatalities	Crew: 1+1	Passengers: 0
Injuries:	Crew – 5	Passengers – 61
Damage:	Substantial, to train and track	

Submissions

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:

- Australian Rail Transport Corporation and their directly involved contractors
- NSW Trains
- Sydney Trains
- V/Line
- Office of the National Rail Safety Regulator.

Submissions were reviewed and, where considered appropriate, the text of the report was 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.