Collision Between Two Trams
Intersection of Bourke and Spencer Streets
Melbourne City
1 March 2007
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THE CHIEF INVESTIGATOR

The Chief Investigator, Transport and Marine Safety Investigations is a statutory position established on 1 August 2006 under Part V of the *Transport Act 1983*.

The objective of the position is to improve public transport and marine safety by independently investigating public transport and marine safety matters.

The primary focus of an investigation is to determine what factors caused the incident, rather than apportion blame for the incident, and to identify issues that may require review, monitoring or further consideration. In conducting investigations, the Chief Investigator will apply the principles of ‘just culture’ and use a methodology based on systemic investigation models.

The Chief Investigator is required to report the results of investigations to the Minister for Public Transport and / or the Minister for Roads and Ports. However, before submitting the results of an investigation to the Minister, the Chief Investigator must consult in accordance with section 85A of the *Transport Act 1983*.

The Chief Investigator is not subject to the direction or control of the Minister(s) in performing or exercising his or her functions or powers, but the Minister may direct the Chief Investigator to investigate a public transport safety matter or a marine safety matter.
1. EXECUTIVE SUMMARY

On 1 March 2007 at about 1245\(^1\), two trams travelling in opposite directions along Spencer Street collided at the intersection of Bourke Street. The northbound tram was positioning to take up a service and was running without passengers. The southbound tram was running a scheduled service. The collision resulted from the northbound tram suddenly diverting into the side of the other tram at the intersection points.

Weather conditions were fine and the rail condition was good.

The driver of the northbound tram received a head injury requiring clinical treatment. The other driver and his passengers were not injured.

The investigation found that the driver of the northbound tram approached the *points direction selection area* at excessive speed and did not stop as required prior to transiting the points. The points were incorrectly set and allowed the northbound tram to turn towards Bourke Street instead of continuing along Spencer Street.

The report makes recommendations to Yarra Trams relating to the review of:

- training documentation;
- options for the provision of a basic interlocking system at tram junctions;
- management of tram driver monitoring; and
- researching an improved solution to mounting the Tram Driver Key Pad in the driving cabs of W Class trams.

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\(^1\) All times are denoted in Australian Eastern Daylight Saving Time (UTC + 11 hours).
2. CIRCUMSTANCES

At about 1245 on 1 March 2007, W Class tram № 1022 (W7 variant) collided with B Class tram № 2017 (B2 variant) at the intersection of Bourke and Spencer Streets, Melbourne.

Tram № 2017, operating Route No 75 from the corner of La Trobe and Spencer Streets to Vermont South, was being driven from the No 1 end and was proceeding south on Spencer Street. Tram № 1022 was being driven from its No 2 end and was running ‘out-of-service’ and proceeding north on the parallel track prior to taking up the operation of inter-peak Route No 30 between Newquay Docklands and St Vincent’s Plaza.

As the two trams passed each other at the intersection, № 1022 unexpectedly took the right-hand turnout at the facing points\(^2\) for the curve into Bourke Street, striking the side of tram № 2017 with its front right-hand corner in an oblique-angle collision. The contact caused moderate damage to off-side body panelling on the B Class tram (i.e. the right-hand side in direction of travel), particularly the protective trim strip and the under-gear safety valance swing panel. The leading bogie of the W Class tram was derailed and rotated about 40 degrees to the left (anti-clockwise). As a result the lead axle wheelset was displaced laterally from the track, the left and right-hand wheels being located some 490 mm to the left of their applicable flangeways. The W Class tram sustained extensive off-side panel damage, floor distortion, and possible frame damage.

There were four passengers on the B Class tram and neither they nor the driver suffered any injury.

The driver of the W Class tram suffered a laceration to the head when the Tram Driver Key Pad (refer to Section 3.4, p.13), having been dislodged from its mounting above the right-hand front driver’s cabin window by the impact of the collision, fell on his head. The driver required hospital treatment.

\(^{2}\) *Facing points* are the movable switch rails facing an approaching rail vehicle by which that vehicle can be directed via one route or another – usually either straight ahead or onto a diverging path. The term ‘facing’ refers to the situational relationship between moveable switch rails (the points switch) and the approaching vehicle. Facing points can divert a rail vehicle from one line to another. The opposite is ‘trailing points’; the points switch is approached from the opposite direction, whereby two lines converge to become one.
3. FACTUAL INFORMATION

3.1 Operating personnel

The driver of the W Class tram was a 35 year old male with approximately four years and 11 months experience driving trams.

Information from his driver assessments dating from March 2006 indicates a history of deficient driving technique and general non-compliance with speed control. No remedial action was taken by Yarra Trams beyond continued reminders to the driver of the corporate standards required.

The driver of the B Class tram was a 47 year old male also with four years and 11 months tram driving experience. He was uninjured as a result of the collision. Both drivers had prior experience with the tram operator in other capacities.

As required by company rules, both drivers were subject to post-occurrence breath testing with a negative result in both cases.

3.2 Passenger information

The W Class tram was working ‘out-of-service’ to take up the running of the inter-peak service on Route 30. It was not carrying passengers.

The B Class tram was working the Route 75 service and was carrying four passengers at the time of the collision, none of whom were injured.

3.3 Vehicles involved

3.3.1 W7 class tram

№ 1022 is a W7 class tram, built by the Melbourne Metropolitan Tramways Board (chassis & running gear) and bus manufacturer Ansair (bodywork), and placed into service in December 1955. Much of the body cladding and superstructure frame is of timber construction. The tram is 14.17 metres long, has a tare weight of 18.7 tonnes and a maximum service speed of 35 km/h. A driver’s cabin is located at an extreme forward position at each end of the tram. These cabins are of almost full width and of shallow dimension. The driver’s seat consists of a small folding squab attached to the rear cabin wall and the limitations of this workspace place the driver in a relatively erect position with an excellent forward view.

The tram was in serviceable order with scheduled maintenance, including Brake Check Minor Tasks, having been last undertaken on 06 December 2006 per the applicable Tram Work Module. The operation of all brake and sanding equipment was verified as serviceable and a chart depicting the correct operation of brake equipment and interlocks was produced from post-incident testing at the Southbank Tram Depot. There were no outstanding brake-related defects recorded by drivers for tram № 1022

The W7 Class tram variant utilises a revised Westinghouse air brake system incorporating Service, Safety and Emergency braking plus a Failsafe Park Brake.
Four brake actuators (one per axle) comprising brake cylinder, slack adjuster and spring park brake assemblies are attached to brake beams and by means of force applied through these beams provide the friction braking at each wheel.

Service and Emergency air brake applications are initiated by the driver via manipulation of a Westinghouse Type W brake valve, applying a pneumatic control pressure (value proportional to position of handle) to a relay valve. This relay valve functions, in turn, to supply a main reservoir operating pressure to the brake actuator cylinders (value proportional to control pressure supplied - maximum 60 psi).

The revised Westinghouse brake system retro-fitted to this tram variant includes a vigilance control system that will apply the Safety Brake as a result of input from any one of seven separate status cues. The Seratec TRAS event recording system previously fitted has been retained.

3.3.2 B2 class tram

№ 2017 is a B2 class two-unit, triple-bogie articulated tram. Built by Comeng and placed in service in mid-1989, it is 23.63 metres long, has a tare weight of 34 tonnes and a maximum service speed of 65 km/h. There is a driver’s cabin located at each end, with the driver’s position being to the right (in the direction of travel) adjacent to the forward passenger door.

There is nothing about either this tram or its operation at the time that is considered to have materially affected the development and results of this occurrence. This tram has been repaired and returned to service.
3.4 Tram Driver Key Pad

The Tram Driver Key Pad (TDKP) is a self-contained, externally-mounted, electronic device used by tram drivers to record trip and route details as well as information about ticket sales and validations. It also imparts information into the Ticket Vending Machines and Validators (Validators are the on-board devices that passengers use to check the validity of magnetic-striped tickets and Touchcards). The TDKP will also display error messages to the driver.

Measuring 300 mm by 268 mm and weighing 4.08 kg the unit has three brass mounting lugs on its underside which lock into a fixed base, called the BTI (Bus Ticket Issuer) cradle, from which it is detachable. Connection to or separation from the BTI cradle is by use of a key that rotates a cam that, in turn, drives a locking plate to simultaneously secure or release the three mounting lugs. Secondary securement is provided by two retaining clips that serve to clamp the TDKP against the BTI cradle and ensure good contact for the integral electrical connector.

The TDKP is designed to be located on a horizontal surface and to be used in a manner similar to a desk calculator. This is the manner of its installation on city buses and other tram classes. However, on the W Class tram there is no such suitable surface in the driver’s cab and for this reason it is mounted vertically in a position above the right-hand timber-framed windscreen pane.

In the case of this occurrence the impact of the collision appears to have momentarily distorted the BTI cradle, relative to the TDKP unit itself, so that the mounting lugs have disengaged from the locking plate, dislodging the unit and allowing it to fall. It is apparent that at the same time the retaining clips have either released or not been employed prior to impact. The tram driver was unable to recall whether or not the retaining clips had been correctly applied prior to the impact.
Evidence from the manufacturer indicates that under certain circumstances the TDKP units can be detached from the BTI cradle by artificially distorting the locking plate such that its locking mechanism is freed permitting the locking plate to release the three mounting lugs. In such circumstances the retaining clips, if applied, would first have to be manually released.

### 3.5 Interview information

In his interview, the driver of W Class tram № 1022 told investigators that he carried out the normal brake tests on the tram prior to departing the depot, with no faults being evident.

He was familiar with the intersection at Spencer and Bourke Streets and operated through the location almost on a daily basis. He looked at the Bourke Street points as he approached the *points direction selection area* and his recollection is that they were set for the desired straight-ahead route. He said his speed would have been approximately 15-20 km/h and that he did not operate the points selection switch on the drivers operating console.

The driver was asked about the indication displayed on the triple-aspect points signal lantern\(^3\). He could not recall and said that he was partly preoccupied with checking the intersection for road traffic and usually did not bother with observing this indication, preferring instead to physically sight the points themselves. In his view the points signal lanterns were unreliable in that they sometimes worked (i.e. were illuminated) and at other times did not.

When he returned his attention to the points ahead he saw that they were set for the turnout. He said that he made an ‘Emergency’ brake application that resulted in the wheels locking up and the tram sliding, uncontrolled, through the points and into collision with the other tram. Under further questioning the driver conceded that in fact he didn’t make an ‘Emergency’ brake application but rather a ‘Full Service’ application. However he insisted that under certain adverse rail conditions a ‘Full Service’ application will also induce wheelslide.

The driver was also of the opinion that correct operation at auto points locations could not be assumed and that drivers were alert to this. He said that if drivers chose to report faulty points operation the verbal advice was relayed via the Fleet Operations Centre to Carlton Control.

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3 This signal is located on a pole approximately one tram-length before the compulsory stop. It indicates that the points to which it applies are set either for the straight-ahead route or the turnout (curve), or that there is a preceding tram and the points may not have reset correctly. The signal lantern is located prior to the compulsory stop as it is intended to be used by drivers of trams that are following a preceding tram and thus cannot view the condition of the points ahead.
In a separate consultant’s report produced for Yarra Trams, the driver of tram № 1022 states:

- That at the commencement of the points direction selection area (i.e. the area between the first and second track stud markers in which the detection loop is located) he looked at the facing points for Bourke Street and thought they were set for the straight [this being his intended route].
- That at this location he estimated his speed would have been 10-15 km/h because, “…if you go too fast the automatic points won’t pick you up and (the points) won’t change.”
- That he next looked at the points from about three metres away and saw that they had ‘flipped over’ [reversed] and that he “…jammed the brake full on….” going to ‘Emergency’ braking and that the wheels locked up and slid.
- That sometimes the points selection process does not work correctly and in such circumstances the driver must get out and change the points manually. “…it’s something that happens in the network quite often, …you sort of try and get yourself ready for it, …you hope that when you approach the automatic points that they’ll work, but you can’t guarantee it.”

The driver of the opposing B Class tram had previously reported that the W Class tram was travelling ‘normally’ as they approached each other and that the driver waved to him. Seconds after the two drivers acknowledged each other, the trams passed and the collision occurred.

3.6 Infrastructure information

3.6.1 The site

The occurrence site was the intersection of Spencer and Bourke Streets on the western fringe of the Melbourne Central Business District. At this location tramway double trackage occupies the centre of Spencer Street and there are double track turnouts to-and-from both directions connecting to the double track in Bourke Street.
Yarra Trams technical staff attending on the day of occurrence (with the W Class tram still sitting in its derailed position and occupying the track circuit) observed that the system was correctly locked and the mass detector and track circuit operational. There was no significant damage to the track structure, which is encased in concrete.

3.6.2 Automatic points operation

The junction points system at the intersection comprises six sets of Hanning & Kahl automatic points and associated tangent and curved trackage providing a three-way junction. This equipment is used extensively in Europe in streetcar networks and its application in Melbourne consists of:

- A points setting detection loop (a buried antenna that accepts the turn call from the tram transponder for wire transmission to the points control receiver located in a cabinet in the vicinity).

- An elongated track circuit region (a low electrical voltage supplied to the rails at this point is carried through a solid-state relay to create a track circuit. When a tram occupies this region its metal wheelsets\(^4\) create a voltage discrepancy in the circuit which is interpreted by the system electronics as track occupation at this location. From this electrical state the system effectively locks the points to secure them against movement until the tram clears the region).

- A mass detector (a buried antenna situated at the facing points between, and slightly subsequent to, the facing point blades. It detects the physical presence of a tram and works in conjunction with the track circuit to ensure that only trams, rather than other vehicular road traffic, will operate the points locking function).

These components are located between the rails and buried in the road surface. The track circuit and mass detector are passive arrangements — there being no active element required on the tram to enable detection. The active element that exists on the tram is the points setting transponder. This device transmits the points setting direction call from the driver’s points selection switch.

As a W Class tram approaches the facing points at an automatically operated turnout, the points are in an unlocked state, awaiting an input command from the

\(^4\) A rail vehicle ‘wheelset’ is the wheel-axle-wheel combination, comprising two wheels fixed — one at each end, usually by ‘shrink-fit’ — to a steel axle. Unless a design feature specifically precludes it, this arrangement permits electrical conductivity between one wheel (and the rail on which it is riding) and the other, hence creating an electrical connection between the two rails.
At a certain distance before the points (approximately 25 metres at the occurrence location) the tram enters the points direction selection area and crosses the detection loop. If the driver does not operate the points selection switch the transponder will convey a default ‘straight ahead’ command via the detection loop to the points controller. If the driver operates the points selection switch for a ‘right’ or ‘left’ command, the tram will transmit that command, via the detection loop, to the points controller.

Unique to the W Class tram is a points selection ‘hold’ function by which the driver’s selection switch may be operated up to 10 seconds prior to arriving at the detection loop. Once this command is transmitted, the points controller goes into first stage locking. Note, however, that the command may not register if there is a tram in front, the transponder is faulty or the points controller has shut down. Additionally, Yarra Trams cannot state with certainty the degree to which excessive speed over the detection loop may disrupt the ability of the transponder to convey the call signal from the driver’s points selection switch. They believe, however, that travelling at excessive speed over the detection loop may result in incorrect ‘pick-up’ of the transponder call. The points setting transponder on the subject W Class tram was tested at South Bank depot following the occurrence and confirmed as functioning normally. This test also validates the functionality of the driver’s points selection switch.

A triple-aspect points signal lantern is located on a pole prior to the compulsory stop. The reason for the rear-ward location of this signal is that it is intended to be used by drivers of trams that are following a preceding tram and thus cannot clearly see the condition of the points ahead. The signal indicates the setting of the points ahead; either for the straight-ahead route or the turnout (curve). The third aspect — an illuminated horizontal bar — means STOP. It is an indication that the points may not be correctly set. Apart from the presence of a preceding tram, such an indication may result from silting of the points or fouling by a foreign object. In such an instance the resulting signal aspect is a warning indication to tram drivers and is entirely indicative of normal system operation.

Once past the detection loop the tram occupies the track circuit region, relying on the creation of an electrical voltage deviation — a result of the conductivity of the tram wheelset/s. This is the secondary stage of locking, and the key function of the points controller is now to ensure that the points cannot operate whilst a tram is over either the track circuit or the mass detector or is moving between the two. Once the tram clears the mass detector the system unlocks to permit operation of the points by a following tram. Yarra Trams technical personnel have advised that the physical characteristics of the W class tram are such that they have an excellent record at operating track circuits and that it is highly unlikely that the tram in this instance would not have been detected by the protection systems.

In his interview, the driver of tram № 1022 stated that malfunctions of automatic points, “...happen(s) in the network quite often. You expect it; you can’t guarantee the points will work correctly.” There are approximately 100 sets of automatic points on the Melbourne tram network. Data provided by Yarra Trams indicates that in the year to mid-2007 there were an average 23.75 autopoints faults recorded per month. Faults are recorded if reported by tram drivers or other staff. Such reports are subject to a ‘filtering’ process at Yarra Trams Fleet Operations Control by which the reports are validated (for example, the fault may already be known to FOC) after which the required maintenance forces are despatched if appropriate.
3.6.3 Data recording

Tram № 1022

Data from the event recorder on the W Class tram was used to determine the immediate sequence of driver’s control and tram performance events leading up to the collision. From its last stop prior to the collision the tram travelled 243.5 metres attaining a maximum speed of 31.44 km/h at a point 86 metres before impact. During this period air braking was initiated 40.5 metres and 7.8 seconds prior to the collision at a speed of 29.03 km/h. (Note: The continuity of the speed trace indicates acceptable wheel rotation: if the wheels had been locked and the tram sliding at any point during this sequence, speed during that time would have been recorded as ‘zero’)

At the points direction selection area, approximately 25 metres before the points, speed — although reducing — was approximately 24 km/h. The permitted maximum speed for passing over the points direction selection area is 15 km/h.

At 12 metres and 3.6 seconds prior to impact, estimated to be at the facing points for the turnout, speed was 20.7 km/h and braking pressure 21.4 psi (where ‘Full Service’ pressure would be 50 psi). The driver had just waved to acknowledge the driver of the passing tram. At this location the tram should be stopped for the driver to confirm the setting of the points.

One metre and 1.26 seconds from impact, speed was still 15 km/h but braking pressure had been increased to approximately 48 psi (49.7 psi control pressure from driver’s brake valve). This is the maximum ‘Service’ air brake pressure achieved throughout the collision sequence. However, between the locations that are 12 metres and one metre distant from the impact (i.e. at approximately five metres from impact) brake cylinder pressure was momentarily reduced to around 12 psi before being increased to the 48 psi described above.

The driver of № 1022 did not apply ‘Emergency’ braking.

The automatic points system

From a site inspection conducted by Yarra Trams technical personnel on the day of the occurrence, Automatic Vehicle Monitoring data indicated that the previous tram through the intersection made a right-turn from the same direction (i.e. from Spencer Street into Bourke Street). A more thorough analysis of both the primary points protection system (mass detector and track circuitry) and the secondary input command systems involved charting and logging the operation of these elements on an event recorder for several days. The data acquired showed no evidence of improper functioning of the system. Specifically, the track circuitry performed as designed, the mass detector correctly registered the movement of trams (the system remained locked as required in all instances observed), and the points control receiver operated faultlessly. There was no evidence of primary protection system failure either at the scene of the occurrence or in post-occurrence testing.

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5 Automatic Vehicle Monitoring (AVM) is a voice & data communications system used by Yarra Trams to provide voice communications with drivers, real time position monitoring of the tram fleet, service delivery information for the Department of Infrastructure, audio information to passengers, and on-board security audio monitoring. The system functions by polling each vehicle approximately every 10 seconds, recording information such as location, route, distance, speed, door status, and alarms etc. The system records vehicle location using a combination of calibrated route information, transponders and the vehicle odometer.
The operation and indications of the triple aspect points signal lantern are not recorded by the automatic points system.

3.6.4 Rules / guidelines

Yarra Trams W CLASS TRAM DRIVERS TRAINING COURSE - Section 9 Automatic Point Procedures states:

“For curves, automatic points are operated by moving the points switch in the appropriate direction whilst the tram is travelling over the stud markings no faster than 10 km/h. To continue straight, coast through the stud markings at 10 km/h.”

The section also notes that the driver’s points selector switch has a programmed ‘hold’ feature permitting its operation up to 10 seconds prior to reaching the selection area between the studs. The instruction states that once the direction call is made, the switch must be released whereupon its spring-loaded action will return it to its central ‘straight-ahead’ position.

Yarra Trams POINTS & SHUNTING TRAINING MODULE - Section 9 Automatic Points – Operating Procedures, Step 1: Approaching and Setting a Command states:

“Every time a driver approaches the Automatic Points, the correct command must be entered. The command must be entered when the front of the tram passes between the first and the second studs, i.e. the “POINT DIRECTION SELECTION AREA.”

The section then describes the correct driver’s points selection switch settings, with that for the ‘straight-ahead’ command being, “Points selector must be left in the middle position.”

Note: The instructions include a diagram depicting the stud markings that define the ‘point direction selection area’ as well as a 15 km/h speed limit approaching the compulsory stop prior to the facing points. This speed which is mandated at Rule 79 in the Yarra Trams GENERAL OPERATIONAL RULES & PROCEDURES 2003 is inconsistent with that prescribed in the TRAM DRIVERS TRAINING COURSE, Section 9, which quotes 10 km/h.

Yarra Trams POINTS & SHUNTING TRAINING MODULE - Section 9 Automatic Points – Operating Procedures, Step 2: After the Command Is Selected states:

‘Drivers should proceed slowly to the Provisional Stop mark, check the points signal light (referred to elsewhere by Yarra Trams as a ‘triple-aspect points signal lantern’), and follow the requirements conveyed by the indication thereon.”
Yarra Trams’ braking performance data for the W class tram indicates that in ‘Full Service’ braking (assuming good rail conditions), the vehicle is capable of a deceleration rate of at least 1.7 m/s². If this degree of braking had been applied at the facing points at the speed recorded at the time (20.7 km/h), the tram would have stopped within approximately 9.72 metres, some 2.3 metres short of the eventual impact point. By comparison, in ‘Emergency’ braking (which also activates the track brake and rail sanding) the W class tram will decelerate at or better than 3.0 m/s². In this scenario, an ‘Emergency’ brake application would have stopped the tram within 5.51 metres. Again, the collision would have been avoided – this time with an even greater margin.

Once the driver of the W class tram had approached in close proximity to the facing points and was still travelling at approximately 15 km/h where he should have been stopped, there was little time available to him in which to take avoiding braking action. Nonetheless, either Full Service or Emergency braking could have stopped the tram prior to the impact were it applied immediately the nature of the emergency became apparent. The event recorder, however, shows a brief but significant reduction in brake cylinder pressure approximately five metres from impact, before braking is again restored to a value of just under 50 kPa as the collision occurs. This momentary reduction of braking effort so close to the point of collision would have extended the braking distance of the tram at a vital time and was probably the last critical factor in the development of the collision sequence.

The comment by the driver of tram № 1022 that the points signal lanterns were unreliable in that they, “…sometimes worked and at other times did not…” could not be substantiated. Yarra Trams engineering staff stated that they have no data indicating unreliable performance of these signals; in their view the opposite is the case. The only major abnormality that could conceivably occur would be for a failure condition to exist concurrently on all three aspects of the signal. Excepting from a general power failure, this could only transpire if all three globes in the signal head failed at the same time (in which case none of the three aspects could illuminate), and such a coincidence would be extremely unlikely. Yarra Trams technical personnel could not recall this ever having occurred.

Regardless, in this instance the tram driver has stated that he chose to concentrate his attention on the traffic situation at the intersection and did not observe the signal indication. In addition, company rules specify the following:

- All compulsory stops must be obeyed.
- It is always the tram driver’s responsibility to ensure the points are correctly set prior to moving over them.
- Tram drivers must not attempt to travel over any points that are not set correctly.
- The tram must travel at no more than 15 km/h until clear of the points.

The investigation determined that there is no basis in fact for the belief that the triple aspect points signal lanterns are unreliable or for any implication that they may convey an erroneous indication. Neither the signal at the occurrence location nor its operation are considered material to the development of this incident.
The driver of tram № 1022 had a history of transgressing against Yarra Trams requirements for good tram operation, especially on the issue of speed. These violations would appear to have been considered by the company to be of relatively minor consequence as the only sanctions applied in each case were warnings and reminders of the company’s expectations. Despite this history of non-conformance, the driver of tram № 1022 continued to be approved for normal rostered operations.
5. CONCLUSIONS

5.1 Findings

1. The driver of W class tram № 1022 was qualified for his duty and had been assessed as competent at his most recent appraisal.

2. The driver of W class tram № 1022:
   • Approached the facing points for the Bourke Street intersection at excessive speed.
   • Failed to stop as required at the facing points.
   • Did not apply the degree of braking effort that was available to him and that would have been sufficient to have prevented impact.
   • Had a record of non-compliance with company requirements for the correct operation of trams.
   • Was injured when the Tram Driver’s Key Pad dislodged from its mounting and fell on his head during the collision.

3. The facing points were not set for the intended route, but were set for an alternative direction that conflicted with an opposing tram on the adjacent track.

4. Post-occurrence testing found no fault with either the automatic points system or the tram brake system. Both were in proper working condition and operating correctly.

5.2 Contributing factors

1. The management of the tram driver following previous instances of inappropriate driving practices was inadequate.

2. Tram № 1022 was not operated in accordance with prescribed procedures.

3. An appropriate level of braking was not applied in time to prevent the collision.
6. SAFETY ACTIONS

6.1 Recommended safety actions

It is recommended that Yarra Trams:

RSA 2008014
Review and assess driver training course material for accuracy in technical and factual detail as well as consistency in terminology.

RSA 2008015
Review the management of tram driver monitoring and assessment as well as protocols for the application of sanctions for non-compliance.

RSA 2008016
Research an improved solution to mounting the Tram Driver Key Pad in the driving cabs of W Class trams.

RSA 2008017
Consider the provision of a basic interlocking system at tram junctions to prevent points and signal operation that will permit conflicting movements.