



Rail Accident Investigation Branch

# Rail Accident Report



## **Fatal collision between a tram and pedestrian at Woodbourn Road, Sheffield 22 December 2016**

Report 13/2017  
September 2017

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 2005.

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## Preface

The purpose of a Rail Accident Investigation Branch (RAIB) investigation is to improve railway safety by preventing future railway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability. Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The RAIB's findings are based on its own evaluation of the evidence that was available at the time of the investigation and are intended to explain what happened, and why, in a fair and unbiased manner.

Where the RAIB has described a factor as being linked to cause and the term is unqualified, this means that the RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident. However, where the RAIB is less confident about the existence of a factor, or its role in the causation of the accident, the RAIB will qualify its findings by use of the words 'probable' or 'possible', as appropriate. Where there is more than one potential explanation the RAIB may describe one factor as being 'more' or 'less' likely than the other.

In some cases factors are described as 'underlying'. Such factors are also relevant to the causation of the accident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, the words 'probable' or 'possible' can also be used to qualify 'underlying factor'.

Use of the word 'probable' means that, although it is considered highly likely that the factor applied, some small element of uncertainty remains. Use of the word 'possible' means that, although there is some evidence that supports this factor, there remains a more significant degree of uncertainty.

An 'observation' is a safety issue discovered as part of the investigation that is not considered to be causal or underlying to the event being investigated, but does deserve scrutiny because of a perceived potential for safety learning.

The above terms are intended to assist readers' interpretation of the report, and to provide suitable explanations where uncertainty remains. The report should therefore be interpreted as the view of the RAIB, expressed with the sole purpose of improving railway safety.

The RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of any inquest or fatal accident inquiry, and all other investigations, including those carried out by the safety authority, police or railway industry.

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# Fatal collision between a tram and pedestrian at Woodbourn Road, Sheffield, 22 December 2016

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## Summary

At 10:02 hrs on 22 December 2016, a pedestrian, who had just got off an inbound tram at Woodbourn Road tram stop, was struck and fatally injured by an outbound tram travelling from Sheffield city centre towards Meadowhall. The pedestrian was using the crossing at the northern end of the tram stop at the time. The crossing, which runs over both tracks, provides a pathway between the inbound platform and Woodbourn Road. No one was waiting at the outbound platform and no one on board the outbound tram had requested that it stop, so it was travelling non-stop through the platform at around 13 mph (21 km/h).

The tram driver did not see the pedestrian approaching the crossing. Until shortly before the collision, the tram driver's attention was focused on looking in the tram's mirrors and not on looking ahead. Consequently, the driver did not see the pedestrian in time to take action to prevent the accident. Other possible factors that might have contributed to the accident were that the driver was wearing sunglasses, which might have reduced the visibility of the pedestrian who was in a shaded area, and the driver's concentration level might have been reduced by that stage of the journey. The pedestrian was seemingly unaware that the tram was approaching the crossing and the tram did not give an audible warning to indicate that it was passing non-stop through the tram stop. An underlying cause was that Stagecoach Supertram had not assessed the risk of trams in service running non-stop through tram stops when it first introduced the system of request stops around 1999. The RAIB also found inconsistencies between the training and assessments for new tram drivers when making non-stop movements through tram stops and the operational standards that drivers are required to follow for such movements.

Since the accident, Stagecoach Supertram has reported it has taken action to mandate audible warnings for all non-stop movements through tram stops and to reduce driver distraction due to looking in mirrors. It has also updated its risk assessment to include trams in service running non-stop through tram stops and implemented measures to reduce the risk of collisions with pedestrians. These reported actions address factors which otherwise would have resulted in RAIB recommendations.

The RAIB has made two recommendations. One recommendation is addressed to Stagecoach Supertram and relates to the continuance of its work to review its training material against its operational standards so that they are made consistent. The second recommendation is addressed to UK tram operators, in conjunction with UK Tram Limited, and relates to setting up an industry working group to monitor the development and application of new pedestrian detection technology to alert drivers to potential collisions with pedestrians.

The RAIB has also identified three learning points. The first highlights the importance of tram operators actively assessing and managing the additional risk to users of foot crossings associated with trams making non-stop movements through tram stops. The second reminds tram drivers to only use driving mirrors for essential tasks related to the safe operation of the tram during non-stop movements through tram stops. The third is for tram drivers about understanding how sunglasses can affect their vision when passing from sunlit to shaded areas, particularly during the winter months when the sun is low.

## Introduction

### Key definitions

- 1 Metric units are used in this report, except when it is normal tramway practice to give speeds and locations in imperial units. Where appropriate the equivalent metric value is also given.
- 2 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report). These are explained in appendices A and B. Sources of evidence used in the investigation are listed in appendix C.

## The accident

### Summary of the accident

- 3 At 10:02 hrs on 22 December 2016, a pedestrian, who had just got off an *inbound* tram at Woodbourn Road tram stop, was struck by an *outbound* tram travelling from Sheffield city centre towards Meadowhall (figure 1). No one was waiting at the outbound platform and no one on board the outbound tram had requested that it stop, so it was travelling non-stop through the tram stop platform at around 13 mph (21 km/h).

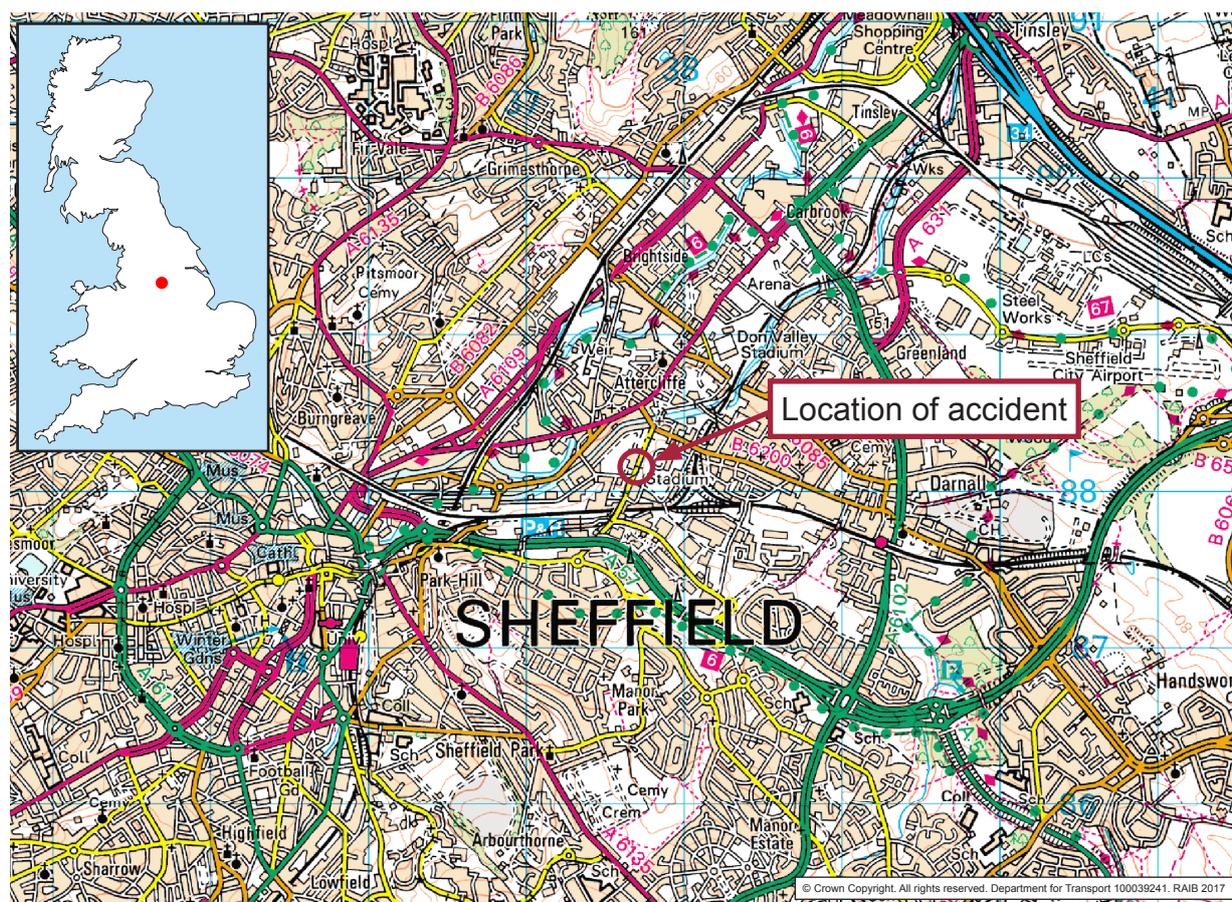


Figure 1: Extract from Ordnance Survey map showing location of accident

- 4 The pedestrian was using the crossing at the northern end of Woodbourn Road tram stop (figure 2), which provides a pathway over both tracks, between the inbound platform and Woodbourn Road (figure 3). The pedestrian was seriously injured in the collision and died in hospital the next day.

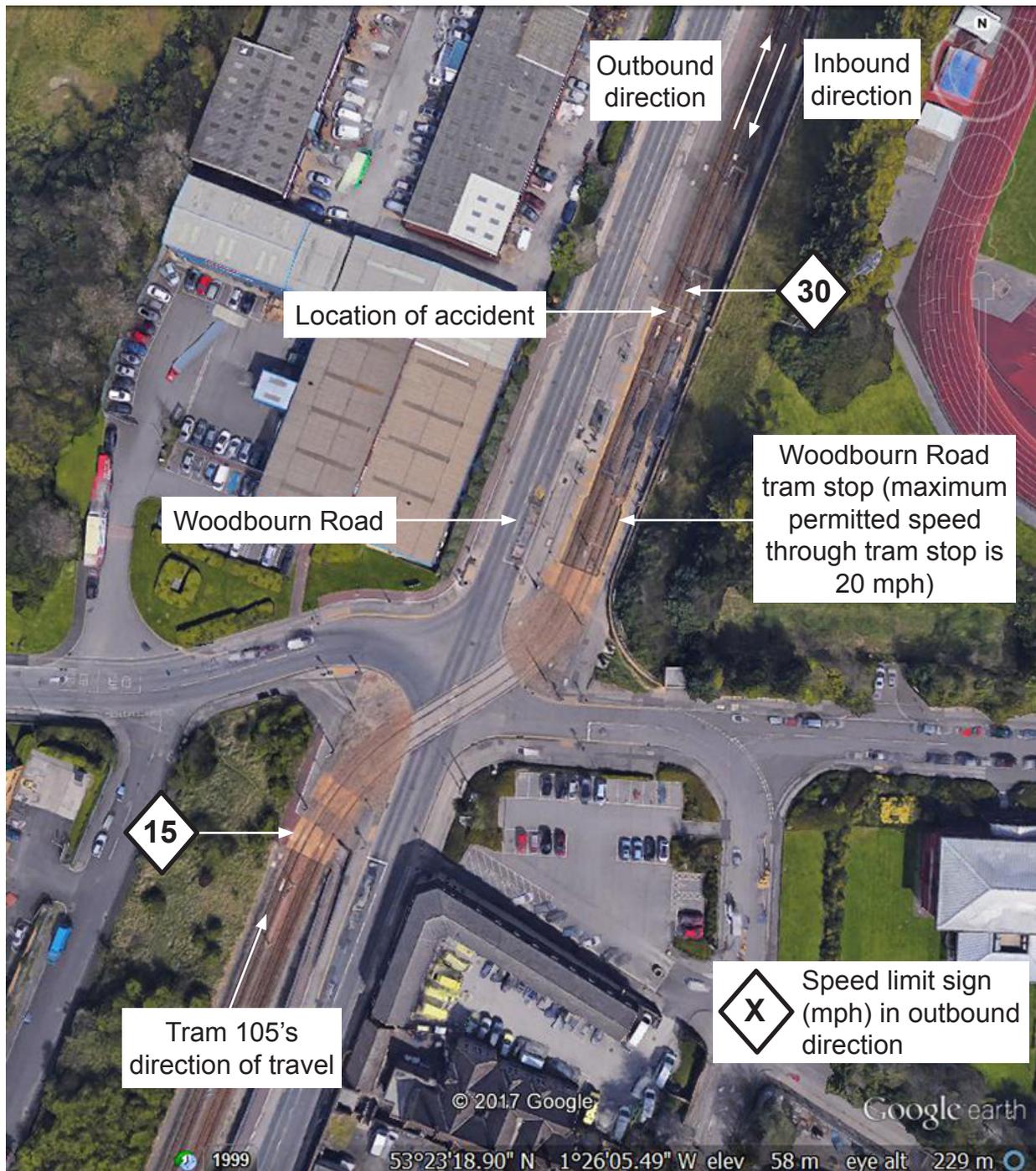


Figure 2: Google Earth overview of Woodbourn Road tram stop and surrounding area

## Context

### Location

- Woodbourn Road tram stop is located on a two track *segregated section* of tramway with *750 V DC overhead electrification*. It has two side platforms (figure 3). The track is level through the tram stop. The tram stop is on the 'Yellow' line of the Sheffield tramway network, which runs from Middlewood, via the city centre, to Meadowhall Interchange (figure 4).

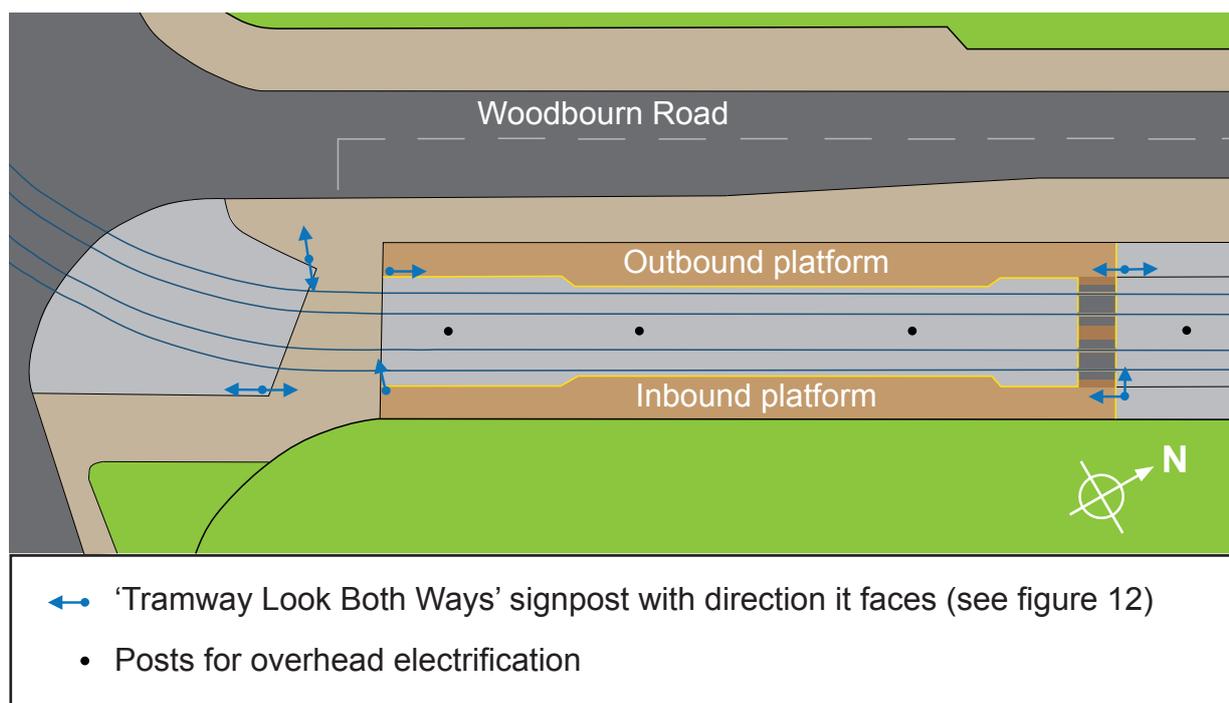


Figure 3: Layout of Woodbourn Road tram stop

- 6 The maximum permitted speeds for trams travelling in the outbound direction (towards Meadowhall) are 15 mph (24 km/h) across the road junction prior to the tram stop and 30 mph (48 km/h) just beyond the crossing on which the accident happened (figure 2). The maximum speed non-stop through the tram stop was 20 mph (32 km/h).

### Organisations involved

- 7 Stagecoach Supertram is the operator of the Sheffield tramway network and is responsible for all tram and infrastructure maintenance. It was also the employer of the tram driver.
- 8 South Yorkshire Passenger Transport Executive owns the Sheffield tramway infrastructure and the trams. It lets the concession for system operation to Stagecoach Supertram.
- 9 Both organisations freely co-operated with the investigation.

### Tram involved

- 10 The tram that collided with the pedestrian was tram 105 (figure 5), one of a fleet of 25 that was built in 1992 for this tramway by Siemens-Duewag (now trading as Siemens). Each tram comprises three articulated passenger carrying sections, supported on four bogies. A tram is 35 metres long and weighs 52 tonnes when empty.

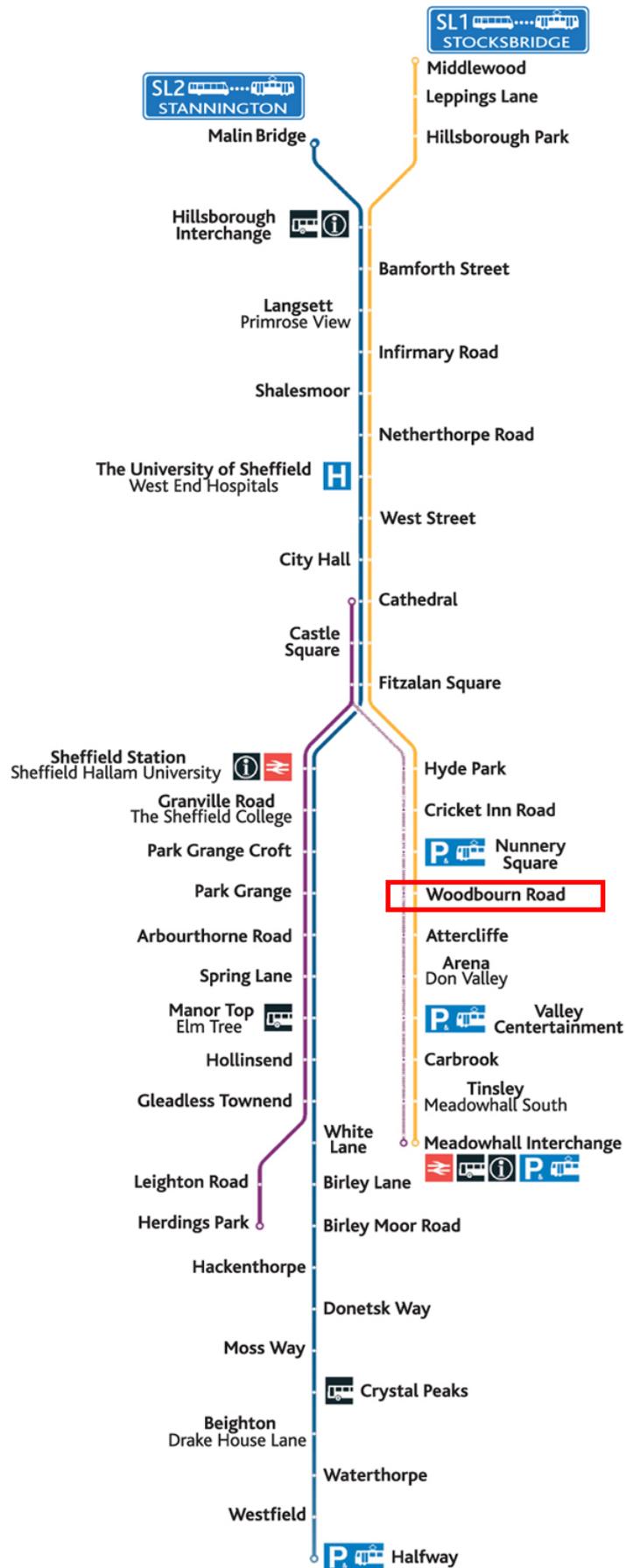


Figure 4: The Sheffield tramway network (courtesy of Stagecoach Supertram)



Figure 5: Tram 105

- 11 At the time of the accident, tram 105 was operating the 09:33 hrs service from Middlewood to Meadowhall (journey number 0648).

#### Staff involved

- 12 The driver of tram 105 had driven trams on the Sheffield tramway network for about 23 years having qualified to drive trams in January 1994. Stagecoach Supertram's last assessment of her driving was on 27 November 2016 with no issues noted (paragraph 67).

#### Pedestrian involved

- 13 The pedestrian was an 81 year old man. He had arrived at Woodbourn Road tram stop on a tram from Meadowhall, getting off onto the inbound platform less than a minute before the accident.

#### External circumstances

- 14 The local weather at the time of the accident was dry, with a temperature of about 2°C, a clear sky and sunshine. The sun was low in the sky and shining from a south-easterly direction. This created a mix of sunlit and shaded areas around the tram stop, with the inbound platform and the northern crossing in shadow at the time of the accident.

## The sequence of events

### Events preceding the accident

- 15 At 06:54 hrs on 22 December, the driver booked on for duty at the depot next to Nunnery Square tram stop (figure 4) and then went to tram 105 which was in the depot sidings. At 07:04 hrs the driver departed from the depot in tram 105, driving it to Cricket Inn Road where it formed a service to Cathedral (figure 4).
- 16 During the journey to Cathedral, the driver was alerted to a brake defect which was reported on a display in the tram's cab. The driver reported this defect to the *operations control centre*. After arriving at Cathedral, the driver changed ends to form a service to Meadowhall and when she enabled the rear cab, the reported brake fault cleared. The tram did not indicate the defect again during any of the subsequent journeys it made that morning (paragraph 81).
- 17 From 07:12 hrs to 09:30 hrs, the driver made four journeys with tram 105 between Meadowhall and Middlewood (figure 4). At 09:33 hrs, tram 105 departed Middlewood on journey 0648 to Meadowhall. At 10:01 hrs, it departed Nunnery Square, the stop prior to Woodbourn Road.
- 18 In the meantime, the pedestrian arrived at Meadowhall tram stop at 09:51 hrs. He got onto an inbound tram that was waiting in the platform, and the tram departed at 09:53 hrs. It arrived at Woodbourn Road tram stop about nine minutes later. The pedestrian stepped off the tram and onto the inbound platform at 10:01:56 hrs. He was the only person to get off the tram there. Once on the platform, the pedestrian began walking along the platform towards the crossing at the northern end, as the tram he had arrived on departed.
- 19 At 10:02:12 hrs, the inbound tram and tram 105 passed each other on the junction with Woodbourn Road beyond the southern end of the tram stop. Six seconds later, at 10:02:18 hrs, the front of tram 105 entered the tram stop (figure 6) 52 metres from the point of collision, while travelling at a speed of 13 mph (21 km/h). The tram's data recorder showed that at this time the driver was applying traction power to maintain this speed. Meanwhile, the pedestrian had begun walking down the inbound platform ramp towards the crossing (figure 6).
- 20 As tram 105 entered the outbound platform, the driver noticed there was no one waiting on the platform to catch the tram, and did not see the pedestrian at the far end of the inbound platform. Inside the tram, none of the passengers had requested the tram to stop at Woodbourn Road (passengers request a stop by pressing one of the stop request buttons that are found throughout the saloon area within the tram). Consequently, the driver decided she would drive non-stop through Woodbourn Road tram stop (this was permitted by the tramway's rules).

### Events during the accident

- 21 At 10:02:23 hrs, the front of tram 105 was at about the middle of the outbound platform and 24 metres from the point of collision. By now, the pedestrian had begun to cross the tramway and was walking over the inbound track. Figure 7 shows the sequence of events from 10:02:24.2 hrs, when the tram was about 17.5 metres from the point of collision, through to when the collision happened.



Figure 6: Forward facing CCTV footage from tram 105 as it was entering the tram stop (courtesy of Stagecoach Supertram)

### Events following the accident

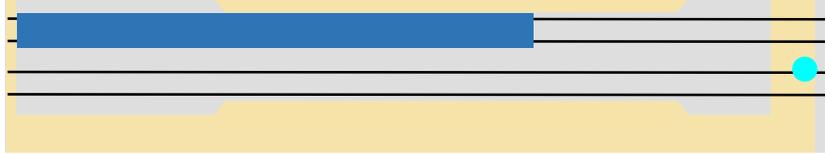
- 22 At 10:02:28 hrs, less than half a second after the collision, the driver made a brake application, and then sounded an audible warning<sup>1</sup> which lasted for two seconds. During this time the tram travelled 13 metres and its speed slowed to 10 mph (16 km/h). At 10:02:31 hrs, the driver applied the tram's *hazard brake*, releasing it one second later. After a further second, at 10:02:33 hrs, the tram stopped 22 metres from the point of collision. After being struck, the pedestrian fell underneath the front of the tram and was pushed forward by equipment underneath the tram for about 18 metres.
- 23 The driver used the tram's radio to report to the operations control centre that the tram had struck a person at Woodbourn Road tram stop. Staff in the operations control centre made a 999 call asking for the emergency services to attend. At 10:05 hrs, paramedics passing by in an ambulance on Woodbourn Road noticed there had been an accident and stopped. They immediately began to attend to the pedestrian.

<sup>1</sup> Trams on Sheffield tramway can sound a bell or a horn to give an audible warning. The tram's data recorder will record when an audible warning is given but it does not record which type of audible warning it is. The driver reported that she sounded the tram's horn after seeing the pedestrian.

**Time: 10:02:24.2 - Tram distance to collision: 17.5 metres**

The tram is now straight in the tram stop and it is braking. Its speed is between 13 and 11 mph (21 and 18 km/h).

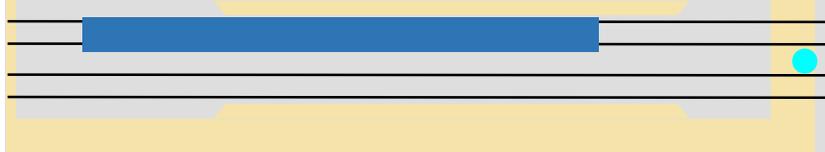
The pedestrian is nearing the halfway point of the crossing.



**Time: 10:02:25.0 - Tram distance to collision: 13.5 metres**

The tram stops braking and traction power is applied. Its speed is 11 mph (18 km/h).

The pedestrian is halfway across, in the centre of the crossing.



**Time: 10:02:26.0 - Tram distance to collision: 9.0 metres**

The tram is nearing the front edge of the crossing with traction power applied. Its speed is between 11 and 13 mph (18 and 21 km/h).

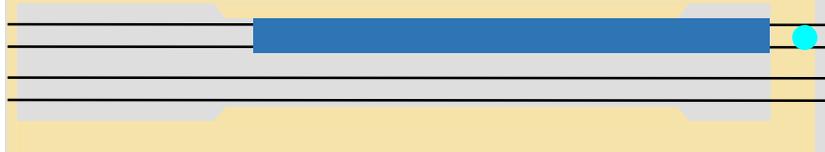
The pedestrian is moving onto the outbound track.



**Time: 10:02:27.2 - Tram distance to collision: 2.0 metres**

The tram reaches the front edge of the crossing with traction power applied. Its speed is between 11 and 13 mph (18 and 21 km/h).

The pedestrian is in the centre of the outbound track.



**Time: 10:02:27.6 - Tram distance to collision: 0.0 metres**

The tram collides with the pedestrian. Traction power is removed and braking is applied. Its speed is 13 mph (21 km/h).

The pedestrian is knocked to the ground in front of the tram.

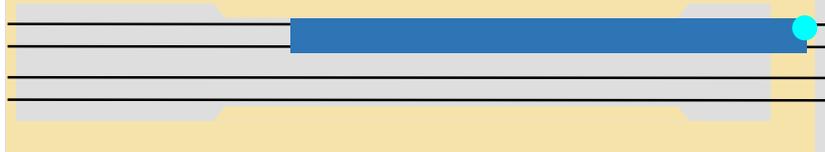


Figure 7: The sequence of the events during the accident (images courtesy of Stagecoach Supertram)

- 24 During the next 15 minutes, the South Yorkshire Fire and Rescue Service, South Yorkshire Police and Stagecoach Supertram staff all arrived at the scene. The pedestrian was transferred to the ambulance and taken to hospital. The tram driver was very distressed and was also treated by paramedics at the scene. With the assistance of the Stagecoach Supertram staff, all of the passengers had left the tram by 10:29 hrs. At 13:15 hrs the police released the tram and at 13:25 hrs Stagecoach Supertram staff took it back to the depot at Nunnery Square. The tramway reopened through Woodbourn Road at 13:30 hrs.

## Key facts and analysis

### Identification of the immediate cause

**25 The tram driver did not see the pedestrian approaching the crossing and the pedestrian was seemingly unaware of the approaching tram.**

26 The tram's data recorder showed that the tram maintained a steady speed of 10 to 13 mph (16 to 21 km/h) through the tram stop, which was less than the maximum permitted speed of 20 mph (32 km/h) non-stop through the tram stop (paragraph 6). Closed Circuit Television (CCTV) footage from cameras at the tram stop and on the tram showed that the pedestrian maintained a constant walking speed of about 0.75 metres per second (1.7 mph or 2.7 km/h) over the crossing. Neither the tram driver nor the pedestrian reacted as if they were aware of the presence of the other, and once the tram driver saw the pedestrian, it was too late to sound a warning or stop before the crossing.

### Identification of causal factors

27 The accident occurred due to a combination of the following factors:

- a. The tram driver did not see the pedestrian in time to take action to prevent the accident (paragraph 28).
- b. The pedestrian was seemingly unaware that the tram was approaching the crossing just before he crossed (paragraph 57).
- c. The tram gave no audible warning to indicate that it was not stopping at the tram stop (paragraph 61).

Each of these factors is now considered in turn.

#### Tram driver awareness

**28 The tram driver did not see the pedestrian in time to take action to prevent the accident.**

29 The data recorder on tram 105 showed that no warning was sounded and the tram's brakes were not applied prior to the collision. The driver only saw the pedestrian when he was in front of her, and by this time, it was too late for the driver to react in time to give an audible warning or apply the tram's brakes to prevent the accident. The data recorder showed that the tram's brakes were applied about 0.5 metres after the point of collision, followed very shortly afterwards by an audible warning which lasted for about 2 seconds.

30 Reaction times usually include four elements<sup>2</sup>:

- detection: something comes into the field of view of the driver;
- identification: the driver absorbs as much information as possible to aid decision making;

<sup>2</sup> Olson, P.L. and Farber, G. (2003). Forensic Aspects of Driver Perception and Response. Lawyers & Judges Publishing.

- decision: the driver makes the decision about how to react, such as sound the warning horn, apply the brake or do nothing; and
  - response: the driver carries out the action (eg makes a brake application).
- 31 Research published by the Transport Research Laboratory<sup>3</sup> shows that most car drivers involved in reaction time trials responded within about two seconds of becoming aware of an unexpected event requiring an immediate brake application. The research also identified that additional decision time is needed if there is a choice of possible actions. At Woodbourn Road, the driver needed to decide between sounding an audible warning and applying the brake. The data recorder showed that the driver chose to apply the brake first and then had to carry out this action. Adding an allowance of 0.5 seconds to the response time in the research, to account for the driver needing to decide what to do and then apply the tram's brakes, the tram driver would reasonably have reacted about 2.5 seconds after first becoming aware of the pedestrian on the crossing.
- 32 The data recorder showed that the driver acted by making a brake application at about the time of the collision. If the driver detected the presence of the pedestrian about 2.5 seconds before the collision, at this time the tram would have been about 13 metres away, when the pedestrian had just passed the centre point of the crossing.
- 33 The rate of deceleration recorded by the tram's data recorder after the collision indicates that the driver did not make a *full service brake application*. The data recorder also showed that the driver did not apply the hazard brake straight away (paragraph 22), although the driver believed that she had. The tram travelled 22 metres from the point of collision before it stopped, 5 seconds after the brakes were first applied. Stagecoach Supertram tested the tram's braking performance after the accident. The test results showed that when the hazard brake was applied while travelling at 13 mph (21 km/h), the tram's speed at the time of the collision, the tram stopped in a distance of 8 metres.
- 34 It is likely that the sudden awareness of the pedestrian in front of the tram sent the driver into a stress response<sup>4</sup>. In such circumstances, people tend to process things serially due to cognitive tunnelling. This is a phenomenon in which a person is too focused on one thing (such as instrumentation, task at hand, internal thought, etc) and not on the wider environment, the consequence of which is that the person ignores surrounding information sources or a full range of options. Automatic or well-learned routines tend to dominate and there is a tendency to take at least some immediate action in response to an emergency. This may mean fixating on a less appropriate action, rather than delaying for a more measured response. The driver's actions as recorded by the tram's data recorder are consistent with a stress-related, serial response (for example the driver only applied the hazard brake once she had finished sounding the audible warning).

<sup>3</sup> Coley G, Wesley A, Reed N and Parry I (2008). Driver reaction times to familiar but unexpected events, published project report PPR 313.

<sup>4</sup> Kahneman, D. (1973). *Attention and Effort*. Englewood Cliffs, NJ: Prentice-Hall; and Wickens, C.D., Gordon, S.E. and Liu, Y. (1998). *An Introduction to Human Factors Engineering*. New York: Longman.

- 35 The tram driver did not see the pedestrian in time due to a combination of the following:
- the driver's attention was focused on looking back in the tram's mirrors (paragraph 36);
  - it is possible that the driver did not see the pedestrian as the tram entered the tram stop as a result of wearing sunglasses, which reduced the visibility of the pedestrian who was in a shaded area (paragraph 47); and
  - it is possible that the driver's concentration levels were reduced by that stage of her shift (paragraph 51).

Each of these is now considered in turn.

#### Focus of the driver's attention

- 36 As the tram passed non-stop through the tram stop, and prior to seeing the pedestrian, the driver's attention was focused on the tram's mirrors. Stagecoach Supertram's *operational standards* define the rules that its tram drivers are required to follow and include a requirement for drivers to operate trams on line of sight. This means the 'driver must ensure that the tram can be stopped within the range of vision' and at all times drivers must 'control the tram so as to be able to stop short of any vehicle, pedestrian, or other potential hazard ahead'. However, instead of looking ahead, the driver reported that she was monitoring the external left-hand side mirror and the internal rear view mirror (figure 8).
- 37 The position of both these mirrors takes the driver's attention away from looking ahead, particularly the internal rear view mirror which is almost directly above the driver's head. Consequently, if using these mirrors the driver would not have seen the pedestrian in her peripheral vision as he crossed from the bottom right-hand corner of her view.

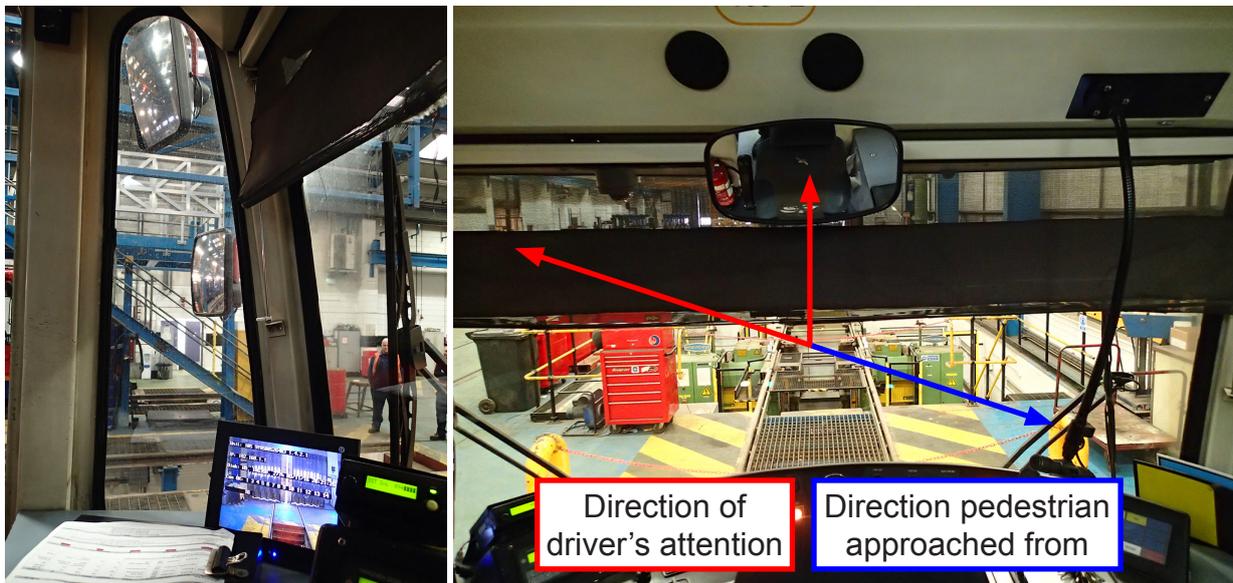


Figure 8: The location of the tram's mirrors

- 38 The driver had been prioritising her attention on the tram's mirrors and had been looking in the left-hand external mirror to check that no one suddenly approached the tram as it passed through the platform. The driver had also looked in the internal rear view mirror as she did not want to miss any passengers on the tram that might suddenly decide that they wanted to get off at Woodbourn Road, even though no one had requested the tram to stop.
- 39 The driver stated that she was focused on passengers because she was anxious to avoid any complaints. During August and September 2016, there had been three complaints against the driver by passengers. One involved some passengers transferring from a bus that were left behind, another time a passenger alleged she was trapped in the tram's doors when it departed, and the third complaint was from a passenger who said that the driver had set off despite seeing her waiting at a door. In October 2016 the driver's manager reviewed these complaints and told the driver that she needed to use her mirrors more. The manager subsequently arranged for the driver to attend a training course about using the tram's mirrors (the use of mirrors module).
- 40 The driver attended this training course in November 2016. The driver's manager referred to it as refresher training but the driver had never received this training before. The only other training on how to use the tram's mirrors that the driver could remember having was during her initial training back in 1994 when she first started working as a tram driver.
- 41 The use of mirrors module covered:
- the procedure for setting off, for example after stopping at a road junction;
  - the procedure for leaving a tram stop;
  - examples of when passengers or items have been trapped in a tram's door and then dragged when the tram has departed a tram stop; and
  - non-technical skills for drivers, which covered a driver's anticipation of risk, how to maintain concentration and the importance of attention to detail.
- 42 The driver had not received any of the latest training that Stagecoach Supertram uses to train its new drivers, including the training on a procedure called the 'tram stop drill'. This training aims to provide drivers with a systematic routine, which can be repeated and adapted, so that trams arrive at and depart from tram stops safely. It covers how to approach the tram stop appropriately, how to position the tram accurately in the tram stop, how platform duties are performed suitably, how signals are used if required, and when moving off from the tram stop how to depart appropriately. The part that covers leaving a tram stop requires a driver to look in many places before moving off. It requires a driver to first check the left-hand mirror, then the interior rear view mirror, the CCTV monitor in the cab, and a final left-hand mirror check before deciding if it is safe to close the tram's doors. Once the doors are closed, the driver should check the right-hand mirror and indicate right if necessary. The driver should then check the tram's blind spots, sound an audible warning, look forward, and check for any pedestrian hazards. After a final check in the left-hand mirror, the driver can then set off.

- 43 The 'tram stop drill' training given to new tram drivers covers all of the information in the use of mirrors training module but in more detail (paragraph 63). The 'tram stop drill' training also includes additional information as it has a section covering how to make non-stop movements through tram stops. In this section, drivers are required to use the internal mirror for passengers who may wish to alight but have not pressed the button correctly to make a request for the tram to stop. Drivers are also required to leave the decision to continue without stopping as late as possible. These instructions are noted in the training material as being related to customer service rather than safety.
- 44 When the front of the tram entered the tram stop, the pedestrian was about 52 metres away and walking down the inbound platform ramp at the far end of the tram stop (figure 6). Posts that support the tramway's overhead electrification wiring are located between the tracks through the length of the tram stop and are likely to have interrupted the driver's view of the pedestrian (figure 9).



Figure 9: The position of the posts between the tracks through the tram stop

- 45 As the driver was not aware of anyone at the tram stop as she entered it, and with the mirrors training being so recent and in the forefront of her thinking, the driver focused her attention on the tram's mirrors. For about the next seven seconds, while travelling through the tram stop, the driver looked in her mirrors just in case she needed to stop for someone on the tram who suddenly wanted to get off or for someone who suddenly approached the tram (paragraph 38). It is possible that during this time the driver looked away from the tram's mirrors to glance ahead but did not see the pedestrian. However, the RAIB has found no evidence of this.

- 46 Once the front of the tram had reached the point where the driver was committed to not stopping at Woodbourn Road, her attention turned to looking ahead. This point in time corresponds to when the tram's data recorder shows the brakes being released and traction power being applied. This was about 2.5 seconds before the collision, when the tram was about 13 metres from the point of collision and when the RAIB calculate that the driver first noticed the pedestrian in front of the tram (paragraph 29). This is also consistent with the driver's recollection.

#### Driver's sunglasses

- 47 The low winter sun was casting long shadows that morning (paragraph 14). This meant the tram travelled through areas which were sunlit and others that were shaded and the driver's eyes would have needed time to adjust to the changes in light conditions. When the tram approached Woodbourn Road tram stop, the driver was in a sunlit area (figure 10). As she entered the tram stop, this changed to a shaded area which included the whole of the inbound platform, with the pedestrian at the far end of it (figure 6). The colour of the pedestrian's clothes did not stand out against the background of the tram stop and the wall behind it, which made him less easy to spot when in shade.

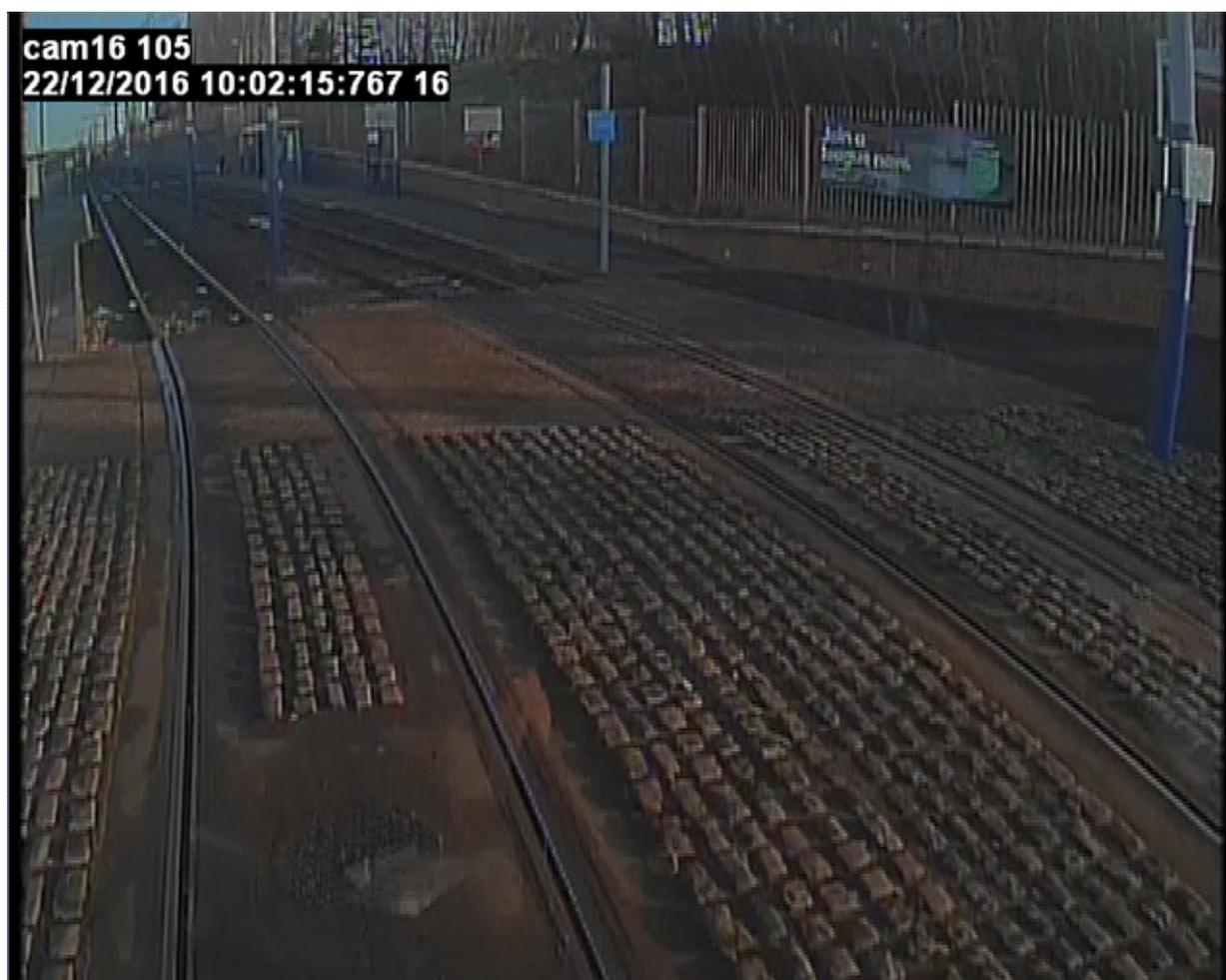


Figure 10: Forward facing CCTV images showing the approach to the tram stop in sunlight and parts of the tram stop in shade (courtesy of Stagecoach Supertram)

- 48 The driver was wearing sunglasses that morning to combat glare from sunlight reflecting off the rails and other surfaces. However, wearing them made it less likely that driver would see the pedestrian against a dark background in a shaded area when entering the tram stop. The driver was wearing prescription sunglasses, which she reported had a 70% or 75% tint (allowing either 30% or 25% of the light through to the eye). The Highway Code does not define what level of tint is acceptable for glasses or lenses that are worn when driving. However, guidance on sunglasses issued by The AA<sup>5</sup> classifies the driver's sunglasses as having category 2 lenses, which transmit between 18% and 43% of light, and which are recommended for daytime driving.
- 49 Main line train drivers are permitted to wear sunglasses to provide protection from sun glare but they should not have adverse effects on recognising the colour that a signal is displaying. Sunglasses must comply with the relevant requirements in Rail Industry Standard, RIS-3451-TOM, 'Train Drivers – Suitability and Medical Fitness Requirements', which permits train drivers to wear sunglasses with category 2 lenses. This category of lens does not impair colour perception.
- 50 During the winter months, the low angle of the sun in the sky means that there is less direct sunlight, which in turn affects the overall light level. Guidance from The Royal Society for the Prevention of Accidents on driving during winter<sup>6</sup> advises drivers to take sunglasses off whenever the sun goes in, and not to wear sunglasses in duller weather as they can seriously reduce the ability to see. Stagecoach Supertram has no policy for managing the sunglasses that its tram drivers wear. In response to this accident, Stagecoach Supertram considered introducing such a policy in January 2017 but stated that it did not do so as a result of concerns over how to enforce it.

#### *The driver's level of concentration*

- 51 By the time of the accident at 10:02 hrs, the driver had been driving tram 105 for about three hours, apart from five short periods to change ends on the tram. This was once at Cathedral with a planned turnaround of one minute, twice at Meadowhall with planned turnarounds of two minutes and twice at Middlewood with planned turnarounds of four and five minutes.
- 52 The driver had not eaten or drunk anything after leaving the depot that morning at 07:04 hrs. The driver's duty for that day showed a planned rest break at 11:14 hrs, after driving for 4 hours and 10 minutes. This was within the agreed contractual maximum of 4 hours 45 minutes for Stagecoach Supertram drivers. However, after three hours of driving, along with a relatively early shift start time (paragraph 15), it is possible that the driver's ability to concentrate was reduced.
- 53 Best practice guidelines for rostering train driver duties, issued by the trade union ASLEF<sup>7</sup>, call for a rest break of not less than 20 minutes to be taken between the commencement of the third hour and the end of the fifth hour of a duty. The UK government's website for road vehicle drivers' hours states that for passenger carrying vehicles (such as a bus or coach), after driving for 5 hours 30 minutes, a driver must take a break of at least 30 minutes for rest and refreshment.

<sup>5</sup> The trading name of AA plc (originally called The Automobile Association).

<sup>6</sup> <https://www.rospa.com/rospaweb/docs/advice-services/road-safety/drivers/winter-driving-tips.pdf>.

<sup>7</sup> The Associated Society of Locomotive Steam Enginemen and Firemen, a trade union for train drivers.

- 54 *RSSB* has published a good practice guide<sup>8</sup> to assist rail industry stakeholders with understanding and complying with their duties for managing fatigue. The guide notes research that recommends a maximum of four hours of driving before taking a break. It also notes that the Health and Safety Executive recommended limit is three hours of driving before a break should be taken. The *RSSB* guide complements guidance issued in 2012 by the Office of Rail and Road (ORR) on 'Managing Rail Staff Fatigue'. The ORR guidance states that good practice for driving tasks would be to plan a short break every three hours.
- 55 Although the driver stated that she felt fine prior to the accident, a person's capacity to concentrate on a task reduces over time. It is possible that the driver had reached the stage within this driving duty where lapses in attention were more likely and she was less able to concentrate on all the tasks required for making a non-stop movement through the tram stop (paragraph 42).
- 56 It is also possible that the driver's overall level of alertness had reduced by this stage in the journey. The driver had already driven tram 105 through the city centre, which was the busiest section of the journey. The driver was now travelling in a segregated section, which was less demanding to drive through.

### Pedestrian awareness

#### **57 The pedestrian was seemingly unaware that the tram was approaching the crossing just before he crossed.**

- 58 The pedestrian had boarded an inbound tram at Meadowhall (paragraph 18). The CCTV footage from this tram indicated he was confident about using the tramway. The pedestrian pressed a button to request the tram to stop at Woodbourn Road, and when it stopped there, he got off the tram via the second set of doors on the leading vehicle. As the tram departed, he walked back along the inbound platform towards the crossing at the northern end.
- 59 At the bottom of the inbound platform ramp, the pedestrian turned left, and without stopping, began to cross the tramway using the crossing. The CCTV footage from both the tram and the tram stop does not show any sideways movement of the pedestrian's head at any time, indicating that the pedestrian began to cross without looking either way. It is possible that the pedestrian assumed that any tram which approached on the outbound line would stop in the platform, although it is not uncommon for trams to pass through Woodbourn Road without stopping.
- 60 As the pedestrian crossed, he did not look towards the tram at any point. It is possible that the pedestrian was focused on looking down at the crossing surface. Although the crossing is level throughout, the journey from the inbound platform to Woodbourn Road involves several changes in the type of surface (figure 11). Research<sup>9</sup> indicates that older people tend to spend more time than younger age groups looking down when crossing a road, particularly when the type of surface changes, as they give more of their attention to not tripping over.

<sup>8</sup> Managing Fatigue – A Good Practice Guide, Document number RS/504 Issue 1, September 2012.

<sup>9</sup> Oxley, J., Fildes, B., Ihsen E., Day R. & Charlton J. (1995). An Investigation of Road Crossing Behaviour of Older Pedestrians. Monash University Accident Research Centre.



Figure 11: Photograph showing the surface over the crossing

### Audible warning

- 61 **The tram gave no audible warning to indicate that it was not stopping at the tram stop.**
- 62 The tram's data recorder showed that no audible warning was sounded when the tram passed through the tram stop. There is no requirement in the operational standards for a driver to sound the tram's bell or horn when non-stopping through a tram stop. Section D8 of the operational standards covers giving audible warnings to other road users, pedestrians and track side workers. However, most of it is focused on giving horn warnings to track workers on segregated sections of the tramway. Although a non-stopping tram must slow down through a tram stop, it is not mandatory to sound a warning.
- 63 The training given to new tram drivers is a combination of classroom theory and practical demonstrations. The 'Tram Stop Drill' training course covers all stages of approaching, stopping at, and departing from a tram stop (paragraph 42). It also includes training on driving a tram non-stop through a tram stop, both in service and out of service. The training includes measures to manage the risks associated with making a non-stopping movement but it does not mandate that drivers give an audible warning when not stopping at a tram stop (paragraph 62). However, it does state that audible warnings should be used before passing trams or vehicles which impede the driver and pedestrian's views of each other. The RAIB noted that there are some requirements within this training, such as this one, which are not covered in the operational standards (see paragraph 69).

- 64 The in service and out of service assessments for new tram drivers also include a section on driving a non-stopping tram. Examples of what the assessor should take note of include the driver's forward observation, early hazard recognition, and reaction to hazards by sounding a warning and applying the brakes.
- 65 The driver had qualified to drive trams in 1994 (paragraph 12), before any of the current training and its associated assessments were in place. For the first five years of her driving career, trams carrying passengers always stopped at tram stops until request stopping was introduced around 1999 (paragraph 87). Although the driver was very experienced, there are no records that show Stagecoach Supertram trained the driver on making non-stop movements through tram stops, when in service with passengers on board.
- 66 The last training the driver attended that was related to driving trams was the 'Drive Safe Course' in August 2014. The driving element of the course was focused on the effects of rapid acceleration, deceleration and cornering, and how these might cause passengers on board the tram to fall over. Prior to that, the only other record of the driver receiving any training related to driving trams was in 2008.
- 67 The driver's performance when driving trams was monitored and assessed by driver managers who carried out covert and overt rides on the trams she was driving. These are known as ride checks. The form that is used to record a ride check lists many of the activities that a driver is expected to carry out. A driver manager will mark an activity when they see the driver perform it, and there is space to record comments. Assessing how a driver travels non-stop through a tram stop is not a listed activity, although the driver stated that typically she would pass through Woodbourn Road tram stop without stopping once or twice a day. Stagecoach Supertram's records showed that ride checks took place about every 6 months for this driver, but sometimes more often if an issue had been noted during a previous ride check. There were 13 ride checks recorded for this driver from December 2011 to November 2016, with the last one recorded on 27 November 2016. The driver manager noted no issues with her driving during this latest check.
- 68 Stagecoach Supertram is currently implementing a new competence management system for all of its tram drivers. At the time of the accident, the driver had not moved over to this new system. Under the new system, each driver is assessed to determine a risk ranking for their competence. This ranking then defines the content of their personal driver development plan, which identifies their training needs and any enhanced checks which are needed. Under this system, drivers' rankings and training needs are re-assessed every two years.

### *Inconsistencies in the requirements for driving trams*

- 69 The investigation noted that requirements in the training and assessments for new drivers are not consistent with the operational standards that experienced drivers are required to follow, with some requirements in the training and assessment that experienced drivers might not be aware of.

- 70 The training for new tram drivers identifies many hazards that could be encountered when approaching, stopping at, departing, or passing non-stop through a tram stop. For non-stop movements, the training material notes that there is a high degree of risk as pedestrians and other highway users are expecting the tram to stop. The training calls on new drivers to maintain full control of the tram and reduce speed so it is appropriate to the conditions, and to be extra vigilant and expect pedestrians to cross the track. It includes many requirements which mitigate the risks associated with these hazards, and compliance with these requirements is checked by Stagecoach Supertram when its new drivers are assessed.
- 71 Stagecoach Supertram has developed its training course for new drivers over the years, but its longer-serving drivers have received little or none of this latest training, unless a specific need for it was identified as part of their competence management. Experienced drivers are required to drive to the requirements which are set out in the operational standards. However, the operational standards are not consistent with the latest training material. Consequently, there will be existing drivers who are not aware of the requirements within the latest training.
- 72 One such example of this is the requirement covered within the 'tram stop drill' training for new drivers to give an audible warning at tram stops when their view is impeded (paragraph 63). This requirement is not in the operational standards. It is possible there are other inconsistencies between what new drivers are trained to do and what the more experienced drivers are required to do by the operational standards.

### Factors that were not causal to the accident

- 73 The RAIB considered the relevance of the following factors related to the driver, pedestrian, the tram and the tram stop infrastructure. Although some of these factors cannot be entirely discounted, the RAIB found no evidence to suggest that any of them were likely to have been a factor in causing the accident.

#### Driver distraction

- 74 The driver was not distracted by the passengers on the tram. The internal CCTV footage shows that the majority of passengers were sitting down, with about five passengers standing up, all of whom were standing still. No one on board the tram was doing anything unusual that would have attracted the driver's attention.
- 75 The driver was not distracted by using a mobile phone or an electronic device while driving. Stagecoach Supertram reported that the mobile telephone given to the driver when she signed on for duty was not used (this mobile phone is for use in an emergency if the tram's radio system is not working). Records for the driver's personal mobile phone showed that it was not used that morning. The CCTV camera that recorded the forward facing view from tram 105 is mounted inside the tram and its footage showed the position of the driver's hands reflected in the windscreen. The driver's hands can be seen on the controls as the tram passes through the tram stop.

- 76 The driver was not likely to have been fatigued from the shifts she had worked. The RAIB reviewed the shifts the driver had worked over previous weeks. No particular issues were noted although they did include early start times (before 07:00 hrs) and, two days before the accident, the driver's shift start times rotated backwards by 1 hour 40 minutes. Guidance available from both ORR and RSSB on managing fatigue (paragraph 54) recommends that where shift start times vary, this should be in a forward (clockwise) rotation (ie subsequent shifts should not start earlier than previous shifts). The driver had no personal problems that were affecting her sleeping or distracting her at work, and she reported that she was well rested before starting her shift that day.
- 77 The driver was not impaired by medication. She had a long term medical condition which was being controlled by regular medication. The driver reported it had no side effects on her driving performance. The only reported side effect for this medication which could affect driving performance was insomnia, if in turn it caused fatigue. The driver stated that it did not affect her sleeping.
- 78 The driver was not driving under the influence of drugs or alcohol. After the accident the driver was tested by both the police and Stagecoach Supertram. All of these tests returned negative results.

#### The pedestrian's mobility and health

- 79 The pedestrian's mobility and general health do not appear to have affected his ability to use the crossing. The pedestrian's speed along the platform and over the crossing was about 0.75 metres per second (paragraph 26), and CCTV from the tram the pedestrian had travelled on shows him walking at a faster pace to catch the tram at Meadowhall. The pedestrian was not using any walking aids.
- 80 The pedestrian's family reported that there were no specific issues with his general health, including his eyesight and hearing. The pedestrian wore glasses which can be seen on the CCTV footage. There was also no evidence that the pedestrian had a medical condition that prevented him from turning his head to look towards the tram.

#### Maintenance and condition of tram 105

- 81 The driver made no allegation against tram 105's braking performance. Stagecoach Supertram investigated the brake fault that the driver had reported earlier on the day of the accident (paragraph 16), and later traced this to a defect with a contactor which it stated would not have affected the tram's braking performance. Post incident testing (in wet conditions) on the day of the accident showed that the tram's braking performance was within the stopping distances required by Stagecoach Supertram. These tests included full service and hazard brake applications at different speeds, including the speed at the time of the accident.
- 82 CCTV footage from the tram that passed tram 105 just outside the tram stop shows that the tram's headlights were correctly illuminated at the time of the accident. The headlights can also be seen illuminated in photographs taken afterwards. Stagecoach Supertram also checked the headlights were functioning as part of the post incident testing it carried out.

- 83 The maintenance condition of tram 105 was not a factor. The RAIB examined tram 105's maintenance records and defect history which showed that all of its maintenance examinations were up to date and there were no defects outstanding when it went into service that day. Stagecoach Supertram did not find any defects during its post incident testing of tram 105.

#### Infrastructure at the tram stop

- 84 It is unlikely that the signage provided at the crossing was a factor. Four 'Tramway Look Both Ways' signs were in place on the northern crossing for its users (figure 12). These signs were the same as the 'Tramway Look Both Ways' sign shown in the Highway Code. When the pedestrian approached the crossing, one of these signs, located on the inbound side of the crossing, was in the pedestrian's line of sight. Stagecoach Supertram has since placed another of these signs on the outbound side of the crossing, which faces users crossing from the inbound side (paragraph 103 and figure 13). Guidance on tramways<sup>10</sup> issued by the ORR mentions that these signs should be provided at pedestrian crossings but it does not state whereabouts on the crossing. It is unlikely that the presence of a second sign would have altered the way in which the pedestrian used the crossing because he had just got off a tram and had just walked past such a sign.



Figure 12: Example of the signage for crossing users

- 85 The condition of the crossing, including its surface, was not a factor. Stagecoach Supertram's records show the tram stop was last inspected on 30 November 2016. The only defect noted during this inspection was graffiti on some of the signs which was removed that day. The crossing surface was reported in the inspection as 'ok' and no issues could be seen with it during a visual inspection after the accident. It was level throughout its length, at the same height as the head of the rail, and tactile paving strips were present at the outer edges, denoting the start and end of the crossing (figure 11).

<sup>10</sup> Guidance on Tramways, Railway Safety Publication 2, 24 November 2006.

## Identification of underlying factors

- 86 **Stagecoach Supertram did not assess the risk of trams in service not stopping at tram stops.**
- 87 Trams began operating in commercial service in Sheffield in 1994. For about the first five years trams stopped at every tram stop until request stops were introduced in about 1999. Stagecoach Supertram could not find any evidence to show how the risk associated with making this change was assessed at the time, and it could not identify any specific risk mitigation measures that were introduced.
- 88 In its current training material and associated assessments for new drivers, Stagecoach Supertram had identified many of the hazards, risks and control measures associated with non-stop movements such as:
- ‘Pedestrians expect trams to stop at tram stops so expect pedestrians to cross the tracks’;
  - ‘Approaching passengers may try to board a non-stopping tram’;
  - ‘Be aware of other trams approaching, positioned or departing tram stops on the opposite side’; and
  - ‘Be prepared to stop as you pass through the tram stop’.
- 89 The training material and associated assessments for new drivers had developed over time, so while newer drivers received training about these hazards and risks, experienced drivers who had qualified at various times over the previous 23 years, including this driver (paragraph 65), had not. Experienced drivers might not have known about certain requirements placed on new drivers in the training material and assessments, as these were not covered in the operational standards (paragraph 69).
- 90 To understand how other tramways operate their trams non-stop through tram stops while in service, the RAIB surveyed the six other tramways operating in the United Kingdom. The responses showed that:
- Two tramways (Blackpool and Nottingham) permit non-stop movements by trams running in service (Blackpool allow non-stop movements at any tram stop, while Nottingham restrict them to specific tram stops);
  - Two tramways (Croydon and Edinburgh) do not permit non-stop movements by trams that are in service so that their trams are consistent with the expectations of members of the public that the tram will stop;
  - One tramway (Manchester) does not have a facility for its passengers on board the tram to request that it stop so trams must stop at all tram stops; and
  - One tramway (Midland Metro) is contractually required to stop at all tram stops.
- 91 Five out of the six tramways allow their trams to make non-stop movements through a tram stop when a tram is not in service. The one tramway that prohibits these non-stop movements does permit them under extremely rare circumstances, such as during security alerts or when asked to by the emergency services. In these instances, the driver must obtain prior authority from the control room and the tram’s speed must be less than 10 km/h (6 mph) through the tram stop.

- 92 All of the six other tramways have mitigations in place to reduce the risk associated with making a non-stop movement. The types of mitigation are listed below:
- All six tramways stated that their drivers are trained on how to make a non-stop movement through a tram stop;
  - All six tramways require drivers to make these movements at slow speed, three tramways require drivers to go slower if people are present, and two tramways tell their drivers to be prepared to stop if necessary;
  - On two tramways, if another tram is already present in the opposite platform, then it is mandatory to stop;
  - All six tramways require their drivers to give an audible warning on the approach to the tram stop, with two requiring the driver to give a continuous warning while passing through the tram stop; and
  - One tramway uses the public address system at its tram stops to announce when a tram is not stopping.
- 93 Since this accident, Stagecoach Supertram has instructed its drivers to give an audible warning whenever passing non-stop through a tram stop (paragraph 99).

### Previous occurrences of a similar character

- 94 The RAIB has completed six previous investigations involving trams colliding with pedestrians, four of which were collisions on a crossing over the tramway. One of these, related to a fatal accident at Norbreck ([RAIB report 09/2010](#)), involved a tram travelling non-stop through a tram stop and colliding with a pedestrian on a crossing at the far end of the stop. However, in that case the tram should have stopped to pick up waiting passengers and was exceeding the speed limit over the crossing at the time of the accident.
- 95 Another investigation related to a collision between a tram and a pedestrian close to Market Street tram stop, Manchester ([RAIB report 06/2016](#)). It is similar to this accident in that the driver probably had a loss of forward attention which resulted in him not seeing the pedestrian in time to sound a warning or apply the tram's brakes to prevent the accident. The driver's actions were also similar, as he applied the brakes at about the moment of collision, gave an audible warning one second after applying the brakes and applied the emergency brake about two seconds after that.

## Summary of conclusions

### Immediate cause

96 The tram driver did not see the pedestrian approaching the crossing and the pedestrian was seemingly unaware of the approaching tram (paragraph 25).

### Causal factors

97 The causal factors were:

- a. The tram driver did not see the pedestrian in time to take action to prevent the accident (paragraph 28, **Recommendation 2, Learning point 2**).

This causal factor arose due to a combination of the following:

- i. The driver's attention was focused on looking back in the tram's mirrors (paragraph 36, **Learning point 2**, paragraph 100).
  - ii. It is possible that the driver did not see the pedestrian as the tram entered the tram stop as a result of wearing sunglasses, which reduced the visibility of the pedestrian who was in a shaded area (paragraph 47, **Learning point 3**).
  - iii. It is possible that the driver's concentration levels were reduced by that stage of her shift (paragraph 51, **Recommendation 2**).
- b. The pedestrian was seemingly unaware that the tram was approaching the crossing just before he crossed (paragraph 57, **Learning point 1**, paragraphs 99 and 101).
  - c. The tram gave no audible warning to indicate that it was not stopping at the tram stop (paragraph 61, **Recommendation 1**, paragraph 99).

### Underlying factor

98 Stagecoach Supertram did not assess the risk of trams in service not stopping at tram stops (paragraph 86, **Learning point 1**, paragraph 101).

## Actions reported that address factors which otherwise would have resulted in a RAIB recommendation

### Audible warnings

99 Stagecoach Supertram reports it has taken action to mandate that its drivers give an audible warning when making a non-stop movement through a tram stop. At the start of January 2017, it issued an instruction to its drivers to give an audible warning whenever making a non-stop movement through a tram stop, irrespective of whether or not anyone was in the vicinity of the tram stop. This notice, which expired in February 2017, was followed by the issue of an amended section in Stagecoach Supertram’s operational standards for audible warnings. This section now requires drivers going non-stop through a tram stop to give a long audible warning on the approach to, and exit from the tram stop. It also requires drivers to be alert to the possibility of pedestrians anticipating that the tram is stopping and stepping into the path of the tram. The amended section also includes a requirement for drivers to give an audible warning when their line of sight is obstructed, so it is now consistent with the training given to new drivers (paragraph 63).

### Use of mirrors

100 Stagecoach Supertram reports it has taken action to review the instructions and training it gives to tram drivers about how and when to use the tram’s mirrors while making non-stop movements through tram stops. This is so that the use of mirrors is limited to essential tasks related to the safe operation of the tram, and not extended to customer service tasks such as monitoring passengers through the rear view mirror (paragraph 38). It has amended its training material for new drivers about using the tram’s mirrors when making a non-stop movement and has removed the references to drivers using the internal rear view mirror for customer service related tasks. The training material now explains that drivers must only use this mirror when the tram is stationary. Stagecoach Supertram has also issued an instruction to its drivers that they should not use the internal mirror when the tram is moving. Stagecoach Supertram is planning to brief all of its drivers on this change by the end of September 2017. The revised training material will also form part of the driver refresher training scheduled during 2018.

### Assessing risk of non-stop movements

101 The risks associated with making non-stop movements through tram stops when in service were not assessed when request stopping was introduced in about 1999 (paragraph 87). After this accident, Stagecoach Supertram reports it has updated the risk assessment which applies to all of its tramway so that it now includes an entry that assesses the risk of trams making non-stop movements through tram stops and references the control measures it has put in place.

102 Stagecoach Supertram reports it has implemented three control measures to reduce the risk to pedestrians when its trams make a non-stop movement through a tram stop. It has reassessed the permitted maximum speed for making this type of movement and the outcome was to reduce the maximum permitted speed through a tram stop from 20 mph (32 km/h) so that the speed of a non-stopping tram, when its front reaches the exit end of the platform, is no more than 10 mph (16 km/h). This change was communicated to its drivers via an instruction and a briefing in July 2017. Other control measures it has introduced are mandatory audible warnings (paragraph 99) and minimising driver distraction due to looking in mirrors (paragraph 100).

### Other reported actions

103 Stagecoach Supertram placed an additional ‘Tramway – Look Both Ways’ sign on the outbound side of the northern crossing (paragraph 84). As a result, two of these signs are now visible when crossing from the inbound to the outbound side, which is consistent with the signage for pedestrians crossing in the opposite direction (figure 13).



Figure 13: The additional signage placed at the crossing

104 Stagecoach Supertram reported that it has reviewed and updated its documentation for pedestrian crossing audits. The changes include capturing more data about its level crossings during the audits, such as more detail on the number of controls in place. For example, data from existing audits stated that signage was in place at a crossing but did not indicate whereabouts these signs were located and how many there were. The revised level crossing audits will capture data on what signage is installed, what type it is, where it is located and which way it faces. A programme of work to capture data for all tram stops was due to be completed in July 2017.

- 105 Stagecoach Supertram has reviewed and updated its risk assessments for each of the routes on the tramway. The following changes are relevant to this accident:
- The risk assessments for each route now include an entry for the risk associated with trams passing non-stop through tram stops.
  - Instead of having one generic entry in an assessment for all of the pedestrian crossings along a route, Stagecoach Supertram has added entries in the risk assessments for each pedestrian crossing. This allows each crossing to be subject to its own assessment. The results from the pedestrian crossing audits (paragraph 104) will be used to give a risk ranking for each crossing.
- 106 Stagecoach Supertram has drafted a new procedure to better manage the content of its operational standards, risk assessments and training material. The draft procedure calls for any changes made to the operational standards to be risk assessed and also included in relevant training material. An output of the procedure will be a summary document that lists paragraphs from the operational standards, together with references to its associated risk assessment and where it is covered within the driver training. Any paragraphs without an associated risk assessment or training reference can then be identified and addressed.
- 107 Stagecoach Supertram is working to update its driver training material to include references to the relevant section in its operational standards. Where Stagecoach Supertram identifies a requirement in the training material which has no associated reference in the operational standards, it will carry out a review to identify whether changes need to be made to its training material or to the operational standards.

## Recommendations and learning points

### Recommendations

108 The following recommendations are made<sup>11</sup>:

- 1 *The intent of this recommendation is that all tram drivers drive to the same set of requirements, irrespective of when they were initially trained.*

Stagecoach Supertram should continue and complete its work to review the requirements in operational standards against its current training material to identify any inconsistencies, use the review findings to update its operational standards and training material as necessary so that there is a consistent set of requirements for drivers to comply with, and update its drivers on the changes made (paragraph 97c).

- 2 *The intent of this recommendation is to reduce the risk of a collision between a tram and a pedestrian in the event that a driver has a loss of attention.*

UK tram operators, in conjunction with *UK Tram Limited*, should set up a working group to monitor the development and application of pedestrian detection technology for trams, with a view to future fitment on new build trams and retro-fitment to existing tram fleets where practicable, as and when a practical and reliable application of such technology becomes available (paragraph 97a and 97a.iii).

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<sup>11</sup> Those identified in the recommendations have a general and ongoing obligation to comply with health and safety legislation, and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail and Road to enable it to carry out its duties under regulation 12(2) to:

- (a) ensure that recommendations are duly considered and where appropriate acted upon; and
- (b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 200 to 203) can be found on RAIB's website [www.gov.uk/raib](http://www.gov.uk/raib).

## Learning points

109 The RAIB has identified the following key learning points<sup>12</sup>:

- 1 It is important that tramways assess the additional risk to users of foot crossings associated with trams making non-stop movements through tram stops. The purpose of this assessment should be to identify and evaluate potential additional control measures, such as the use of audible warnings, reduced speeds, minimising driver distraction and raising public awareness of non-stopping trams (paragraphs 97b and 98).
- 2 Drivers are reminded that, during non-stop movements through tram stops, driving mirrors should only be used for essential tasks related to the safe operation of the tram. They should not be used for checking if passengers are waiting to get off the tram since this is likely to distract the driver from looking ahead (paragraphs 97a and 97a.i).
- 3 This accident highlights the importance of tram drivers understanding how sunglasses can affect their vision when passing from sunlit to shaded areas, particularly during the winter months when there is less direct sunlight due to the low angle of the sun in the sky. Drivers are advised that guidance from The Royal Society for the Prevention of Accidents on driving during winter calls on drivers to take sunglasses off whenever the sun goes in, and not to wear sunglasses in duller weather as they significantly reduce the ability to see. Similarly, drivers are reminded of the Highway Code (Rule 94) which states that in poor visibility, do not use tinted glasses, lenses or visors if they restrict vision (paragraph 97a.ii).

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<sup>12</sup> 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when the RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where the RAIB has not identified management issues that justify a recommendation) and the consequences of failing to do so. They also record good practice and actions already taken by industry bodies that may have a wider application.

# Appendices

## Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed Circuit Television
ORR	Office of Rail and Road
RAIB	Rail Accident Investigation Branch

## Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (\*), have been taken from Ellis's British Railway Engineering Encyclopaedia © Iain Ellis. [www.iainellis.com](http://www.iainellis.com).

750 V DC overhead electrification	A general term used to cover the type of electrification that involves the supply of a 750 V DC traction current to trams by means of a system of posts, insulators and wires suspended above the track.
Full service brake application	A full (non-emergency) brake application.*
Hazard brake	On trams, a braking system for use in emergencies which applies an electro-magnet to the rails to slow down the tram. It provides a high rate of retardation which is higher than would normally be acceptable to passengers.
Inbound	On the Sheffield tramway, this refers to a tram journey travelling towards Sheffield city centre.
Operational standards	A Sheffield tramway publication detailing the general responsibilities of staff engaged on operating the tramway system, and the specific duties of certain types of staff such as tram drivers.
Operations control centre	The control centre, based at the Nunnery Square depot, manages the operation of all trams on the network. A radio based system provides a communication link between control and each tram driver.
Outbound	On the Sheffield tramway, this refers to a tram journey travelling away from Sheffield city centre.
RSSB	A not-for-profit company owned and funded by major stakeholders in the railway industry, and which provides support and facilitation for a wide range of cross-industry activities. The company is registered as 'Rail Safety and Standards Board', but trades as 'RSSB'.
Segregated section	A section of track on the tramway where the route is not shared with road vehicles or pedestrians. The track is normally mounted on sleepers sitting in a bed of ballast.
UK Tram Limited	A not for profit organisation which is the trade body for all light rail and other guided transport systems in the British Isles. The company is registered as 'UK Tram Limited', but trades as 'UKTram'.

## Appendix C - Investigation details

The RAIB used the following sources of evidence in this investigation:

- information provided by witnesses;
- information taken from the tram 105's on-tram data recorder;
- site photographs and measurements;
- weather reports and observations at the site;
- closed circuit television (CCTV) recordings taken from tram 105, the tram the pedestrian travelled on and the tram stop;
- voice recordings for the radio communications between the driver and control room after the accident;
- maintenance records for tram 105;
- results of post incident checks and tests carried out on tram 105;
- inspection records for Woodbourn Road tram stop;
- the risk assessment for the route to Meadowhall;
- records for the driver's training, assessment and history of previous incidents;
- documents showing Stagecoach Supertram's competency management system for its drivers;
- Stagecoach Supertram's operational standards;
- training course material for new tram drivers;
- information about the management of non-stop movements by trams through tram stops on other UK tramways; and
- a review of previous RAIB investigations that had relevance to this accident.

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