RAIB

Rail Accident Investigation Branch

Rail Accident Report

Fatal collision between a tram and a pedestrian at Cleveleys, Lancashire 24 November 2021

Report 14/2022
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This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC
- the Railways and Transport Safety Act 2003
- 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.

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 RAIB has described a factor as being linked to cause and the term is unqualified, this means that RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident or incident that is being investigated. However, where RAIB is less confident about the existence of a factor, or its role in the causation of the accident or incident, RAIB will qualify its findings by use of words such as 'probable' or 'possible', as appropriate. Where there is more than one potential explanation 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 or incident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, words such as '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 accident or incident 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 RAIB, expressed with the sole purpose of improving railway safety.

Any information about casualties is based on figures provided to RAIB from various sources. Considerations of personal privacy may mean that not all of the actual effects of the event are recorded in the report. RAIB recognises that sudden unexpected events can have both short- and long-term consequences for the physical and/or mental health of people who were involved, both directly and indirectly, in what happened.

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 a pedestrian at Cleveleys, Lancashire, 24 November 2021

Contents

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Summary

At 18:11 hrs on Wednesday 24 November 2021, a pedestrian who was crossing the Blackpool tramway near Anchorsholme Park, in Cleveleys, was struck by a tram. The pedestrian, who lived locally, was fatally injured as a result of the collision. The tram involved was travelling at 32 km/h (20 mph) on a southbound journey from Fleetwood Ferry towards Starr Gate.

It was dark at the time of the accident. The pedestrian was crossing at an uncontrolled crossing which passes over both tracks of the tramway and which is situated immediately south of a road junction controlled by traffic signals.

RAIB's investigation concluded that the tram driver was unaware of the presence of the pedestrian until it was too late to take action to prevent the collision. The pedestrian who was struck was seemingly unaware of the tram's speed and proximity to him in the seconds before the collision. The layout and lighting arrangements at the crossing were factors in the accident, along with the probable distraction of the tram driver as the tram approached the crossing. RAIB concluded that the pedestrian's possible beliefs about the tram's speed and how conspicuous he was to other road users may also have been factors.

RAIB has made three recommendations. The first is that Blackpool Transport Services should review its process for identifying and assessing the risks arising from tramway activities. The second is that Blackpool Council should review its process for identifying and assessing the risks arising from tramway activities, adopting and embedding best light rail industry practice as it does so. The third is that Blackpool Council should review its assurance and audit process of Blackpool Transport Services.

RAIB also identified two learning points. The first reminds duty holders of the value of having clear and well understood processes for staff to report near misses. The second reminds tram operators of the importance of having arrangements in place to periodically check the alignment of tram headlights.

Introduction

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 which are explained in appendix A. Sources of evidence used in the investigation are listed in appendix B.

The accident

Summary of the accident

3 At 18:11 hrs on Wednesday 24 November 2021, a pedestrian using a crossing on the Blackpool tramway near to Anchorsholme Park, in Cleveleys, was struck by a tram which was travelling at 32 km/h (20 mph). The pedestrian sustained injuries that proved fatal.

4 The tram involved was travelling from Fleetwood Ferry southwards towards Starr Gate when the accident occurred. The pedestrian was crossing the tramway from the western pavement in a south-easterly direction (figure 6).

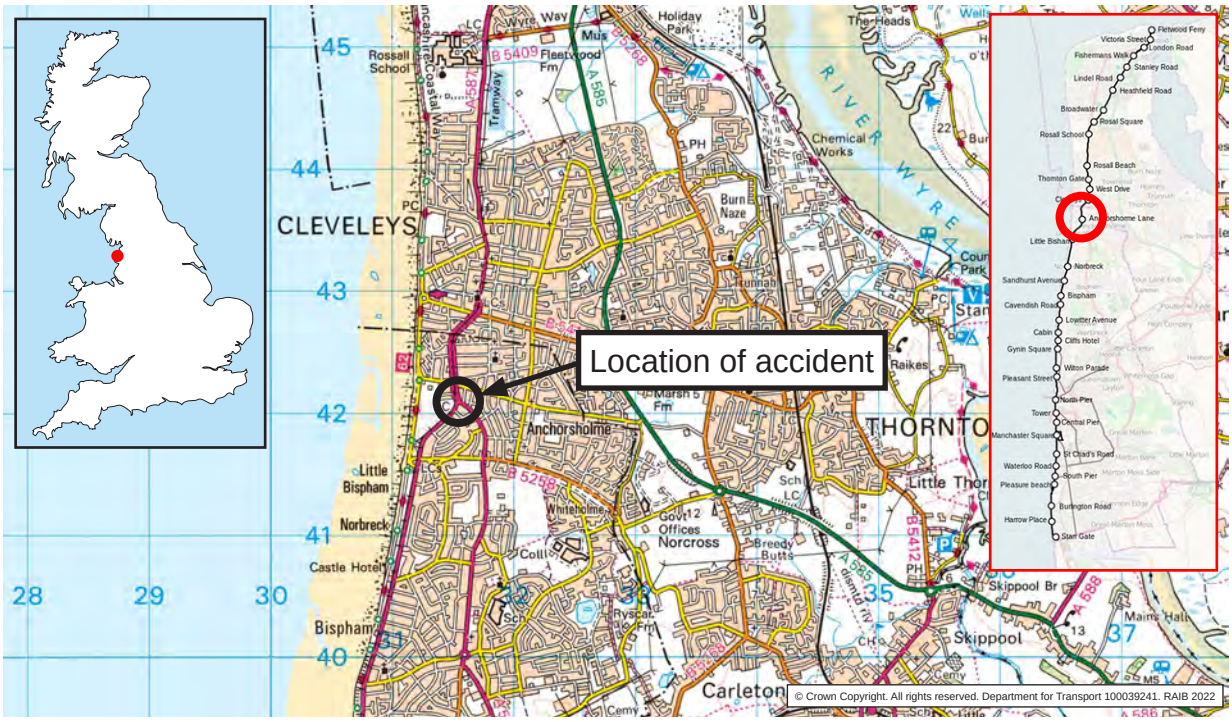

Figure 1: Extract from Ordnance Survey map showing location of accident. Inset right shows Blackpool tram network map (image courtesy of Blackpool Transport Services).

Context

Location

5 The crossing which the pedestrian was using is on the south side of the traffic-light controlled road junction where Fleetwood Road, Queen's Promenade and Kelso Avenue meet. The tramway passes through the junction on an approximately north-to-south alignment (figure 2).

6 The tramway at the location comprises two tracks, one for each direction of travel, with the southbound track on the east side (furthest from the sea). To the north of the junction, road traffic runs on two separate carriageways either side of the tramway with northbound road traffic using Fleetwood Road and southbound, Kelso Avenue. The southern end of the southbound platform of Anchorsholme Lane tram stop is approximately 70 metres north of the centre of the road junction.

Figure 2: Google Earth image of site showing geographical relationship of important features.

7 Between Anchorsholme Lane tramstop and the junction the tramway begins to curve towards the west. At the junction, Fleetwood Road turns to the southeast and the tramway runs on a section of track segregated from road traffic. This leads along the western side of Queen's Promenade next to Anchorsholme Park and towards Little Bispham.

8 The crossing is defined by a pair of parallel dotted white lines which cross the tramway at an angle of 57 degrees to the perpendicular (see paragraph 82). The crossing is 17 metres long, measured between the edge of the western pavement and the tactile paving on the eastern side.

9 At the time of the accident, southbound trams were permitted to travel at 30 km/h (19 mph) across the junction and the crossing, while northbound trams were restricted to 20 km/h (12 mph) (see paragraph 88). The crossing is uncontrolled, which means that there are no signals for crossing users indicating when it is safe to cross. Crossing users are required to judge for themselves if it is safe to cross the tramway by looking for approaching trams. Signs warning crossing users of the tramway and to 'look both ways' are present at either end of the crossing (figure 4).

Figure 3: The tram signal (circled) and road traffic signals on approach to the junction, with pedestrian crossing indicated (image courtesy of Lancashire Police).

Figure 4: The warning sign on the western end of the crossing and the direction of the pedestrian.

Figure 5: Google Earth image showing detailed view of site showing geographical relationship of important features.

Organisations involved

10 Blackpool Council is the owner of the tramway infrastructure and the associated overhead line equipment used to power trams.

11 Blackpool Transport Services (BTS) operated and maintained the tram involved. They employed the driver and conductor on board. Although managed as a separate business, BTS is wholly owned by Blackpool Council and provides both bus and tram services in the Blackpool area.

12 All parties freely co-operated with the investigation.

Tram involved

13 The tram involved was number 007, one of 18 trams supplied to Blackpool by Bombardier Transportation. The tram is of a type known as a 'Flexity 2'. The tram is fitted with a CCTV system which includes cameras that monitor the area ahead of and behind the tram (forward-facing CCTV, or FFCCTV), and the interior of the tram's passenger saloon. The interior of the driving cab is not monitored by CCTV. Flexity 2 trams can sound two different audible warnings, a bell or a horn. BTS drivers are trained to be aware of pedestrians and other road users (see paragraph 64) and to use these audible warnings as a means of alerting other road users to the approach of a tram. BTS tram drivers are not required to routinely sound warnings on approach to pedestrian crossings.

14 In addition to the service brakes which retard the tram using its wheels, the tram involved is fitted with a 'hazard brake'. When the hazard brake is commanded by the driver, normal service braking is enhanced by the application of electro-magnetic track brakes which provide additional braking force through brake shoes which act directly on the railhead. Commanding the hazard brake also automatically applies sand to the railhead, which is intended to improve the friction between the railhead and the tram's wheels and track brakes, potentially increasing the rate at which the tram can decelerate. Using the hazard brake automatically sounds the bell.

15 In addition to the driver and a conductor, the tram was lightly loaded with approximately 15 passengers when the accident occurred.

16 RAIB has concluded that the design, condition and performance of the tram were not a factor in this accident. Post-accident testing confirmed that the tram's headlights were working correctly, although the alignment of the headlamp beam pattern was not checked and is not part of the tram maintenance programme (see paragraph 61).

Staff involved

17 The tram driver had previously worked as a bus driver and tram conductor for BTS before he started training to drive trams in November 2019. He qualified as a tram driver in late December 2019. At the time of the accident, although he had been qualified for nearly two years, he had spent about half of that time furloughed due to the COVID-19 pandemic. BTS records indicate that the driver had undergone regular assessments of his competence and that a BTS assessor judged his driving as being at the required standard in every area assessed when he returned to driving duties in July 2021.

18 The driver habitually wore glasses to correct his vision when driving trams. BTS requires its drivers to successfully complete a medical examination to the standards set by the DVLA[1] for drivers of large goods vehicles and passenger carrying vehicles (often referred to as 'Class 2' vehicles). This medical examination includes an assessment of driver's eyesight by an optician, optometrist or doctor.

[1] The Driver and Vehicle Licensing Agency is a government agency which maintains the registration and licensing of drivers and vehicles in Great Britain.

19 The tram driver had previously undergone surgery to his right eye to remove a cataract.[2] A cataract was also forming in his left eye but was not yet serious enough to require surgery. The driver's eyesight had been routinely tested by a local optician seven weeks before the accident and no changes were recommended to his existing prescription. Three weeks before the accident, the driver underwent a DVLA 'Class 2' vehicle medical, conducted by a doctor, which he passed. No adverse impact of the cataract on the driver's vision was noted by either the optician or the doctor.

The pedestrian

20 The pedestrian, Mr Robert Dawson, was 69 years old and lived locally to the crossing. Witness evidence indicated that he was familiar with it, having used it many times. For this reason, RAIB considers it highly unlikely that the pedestrian did not know he was crossing a tramway at the time of the accident.

21 The pedestrian usually wore glasses, and CCTV evidence shows that he was wearing them around four minutes before the accident. His glasses were also found at the scene of the accident. On this basis, RAIB has concluded it was likely that he was wearing them at the time the collision occurred. Witness evidence indicates that he had no significant health issues of relevance to this accident.

22 On admission to hospital a sample of blood was taken from the pedestrian. Analysis of this sample found that no alcohol or commonly misused drugs were present. Three medicines were detected in the sample. One was prescribed to the pedestrian to manage hypertension and was found in a concentration consistent with the correct management of this condition.

23 The two other medications were detected in very low concentrations. Despite seeking the opinions of experts on the possible effect of these drugs, RAIB is unable to conclude if the presence of these drugs had any effect on the pedestrian's ability to safely cross the tramway.

External circumstances

24 Police officers and an RAIB Accredited Agent[3] who initially attended the accident noted the weather conditions to be calm and cold, but not freezing. Weather stations in the area, including one located at Blackpool airport, approximately 7 miles away, corroborate these observations. The carriageway was noted to be damp, although it was not raining at the time of the accident. Sunset was at 16:01 hrs that day,[4] just over two hours before the accident.

25 During site visits RAIB noted the presence of some moderate ambient noise associated with passing road traffic. However, since pedestrians rely principally on seeing approaching trams (because trams are not required to sound an audible warning before crossing the junction, paragraph 13), RAIB does not believe that the noise levels near the crossing played a role in this accident.

26 The lighting at the location is discussed in paragraphs 54 and 84.

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[2] Cataracts occur when the lens inside an eye develops cloudy patches. These patches can expand causing blurry, misty vision and eventually blindness.

[3] Accredited Agents are industry professionals trained and approved by RAIB to gather evidence at accident sites on its behalf.

[4] www.timeanddate.com.

The sequence of events

Events preceding the accident

27 On the day of the accident, the tram driver booked on for duty at 16:24 hrs at Starr Gate depot (figure 1). This was his third shift since his last rest day and it was scheduled to end at 00:07 hrs that night. The preceding two shifts had started at about the same time and were of a similar duration of just under eight hours. The driver drove tram 007 north to Fleetwood Ferry (figure 1) and was partway along the return journey to Starr Gate when the accident occurred.

28 The pedestrian left his home and walked to a supermarket located approximately 200 metres north of the junction, arriving there at 17:58 hrs. He bought a few small items and CCTV shows him leaving the shop at 18:07 hrs and walking towards the crossing along the western pavement of Fleetwood Road. CCTV images show that he was wearing a dark thigh-length coat, dark trousers and dark shoes.

29 As he approached the crossing, the pedestrian walked past a petrol station forecourt located opposite Anchorsholme Lane tram stop. Although there is no direct evidence of the pedestrian's route after he passed this petrol station, the most obvious route towards the crossing is to continue along Fleetwood Road passing the entrance to Anchorsholme Park (figure 7).

30 At 18:10:42 hrs, the tram stopped at Anchorsholme Lane tram stop to allow a passenger to alight. After being stationary for 15 seconds, the tram moved away from the stop towards the road junction. During this time, road traffic was passing through the junction so the tram signals were showing a 'stop' aspect to the approaching tram. The tram driver drove the tram slowly away from the stop in the knowledge that, when the tram's presence was detected (see paragraph 40), the signal would change to allow the tram to proceed.

31 The tram driver controlled the speed of the tram to between 6 km/h (4 mph) and 9 km/h (6 mph) for 23 seconds before commanding the tram to accelerate across the junction. Witness evidence, corroborated by CCTV evidence of road traffic movements, is that this acceleration was made in response to the tram signal changing to show a proceed aspect.

Events during the accident

32 The FFCCTV on the tram shows the pedestrian for approximately one-and-a-quarter seconds before the collision. However, during that time, the pedestrian is visible walking steadily across the tramway from the tram's right to left (in the direction of travel). The pedestrian was walking between the dotted lines defining the crossing (figures 4,5 and 6) and is first visible on reaching the right-hand rail of the southbound track just ahead of the tram. The pedestrian did not look towards the tram during the time he can be seen on the tram's FFCCTV.

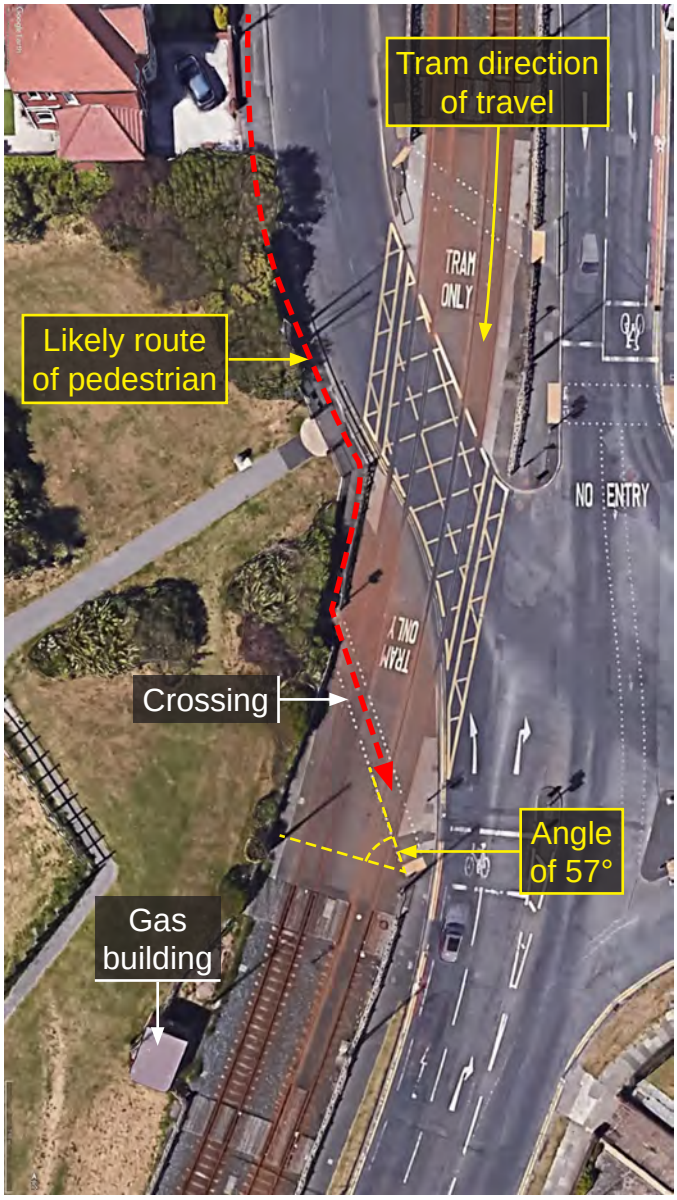

Figure 6: Google Earth image showing the likely route taken by the pedestrian.

33 The pedestrian was struck by the tram's front left corner and projected ahead, and to the left, of the tram. The on-tram data recorder (OTDR) recorded the tram's speed as 32 km/h[5] (20 mph) when the collision occurred. The same data also shows that the driver applied the tram's hazard brake approximately one-and-a-quarter seconds after the impact. Measurements taken at the scene show that it came to a stop 25 metres after the collision.

34 Data from the OTDR confirms that, when used, the hazard brake worked as designed (paragraph 14) and the tram decelerated in line with expectations for such a brake application. The presence of sand at the scene also shows that the sanding system was automatically activated. The OTDR does not show that the horn or bell were sounded before the collision, which is consistent with witness evidence that neither were used. It also shows that there was no brake application in the seconds before the collision with the pedestrian.

[5] Although 2 km/h above the maximum permitted speed for that section, it is below BTS' threshold for any formal action.

Events following the accident

35 The tram driver, conductor and members of the public travelling on the tram went to help the pedestrian. The emergency services were informed which resulted in Lancashire Police and the North West Ambulance Service attending. The pedestrian was taken to a local hospital where he died during the following day.

36 Following the accident, the tram driver was screened by the police for alcohol and commonly misused drugs, which returned negative results. An eyesight test[6] was also conducted by the police, which the driver passed.

[6] A test conducted in daylight where the ability (with glasses or contact lenses, if necessary) to read a car number plate from 20 metres is tested.

Background information

37 Electric tramways have been a feature of Blackpool and the surrounding area for over 135 years. The current tramway was rebuilt from 2012 and extends for 18 km (11 miles) between Starr Gate and Fleetwood Ferry. Blackpool Council explained that modification of uncontrolled crossings was outside the scope of the 2012 project. Consequently, the rebuilding did not cover aspects such as lighting (see paragraph 54) at the location of the accident.

38 On the western edge of the tramway, approximately 30 metres south of the crossing, is a small building (figure 5) associated with the provision of mains gas to the area. The proximity of this 'gas building' to the tramway on the inside of the curve means that it restricts the view of the western end of the crossing from the south. Because the eastern end of the crossing is towards the outside of the curve and further south, the gas building does not affect the view at the eastern end of the crossing (see paragraph 88). It has no effect on visibility of the crossing from trams approaching from the north as was the case in this accident.

39 The movement of road traffic across the junction is controlled by road traffic light signals, while tram movements are controlled by dedicated tram signals. Road traffic has priority across the junction until the traffic signal system is alerted to an approaching tram by a transponder. At Anchorsholme Lane, the transponder for southbound trams is located approximately 7 metres beyond the tram stop and approximately 50 metres before reaching the next tram signal.

40 The tram signals at the junction will normally exhibit a 'stop' indication (which trams must not pass). On detecting a tram, the traffic signal control system initiates a sequence which stops road traffic. It then changes the appropriate tram signal to show a 'proceed' aspect, which allows trams to pass.

41 Tram signal heads contain two discreet additional lamps (figure 7) that give tram drivers information about the status of the traffic light system. A single lamp in the top left corner of the signal head tells tram drivers that the transponder has correctly detected their tram and is working to change the tram signal to show a 'proceed' aspect. A second lamp in the top right corner tells drivers that the tram signal is about to change to a proceed aspect. On seeing the first lamp, drivers will normally drive their trams slowly up to the junction because, although they must be in position to stop at the signal, they are aware that the system is working to change the aspect to allow them to proceed.

42 Transponder equipment in the junction detects when trams have begun to pass through the junction and reverses the process, allowing the junction to be used by road vehicles again. This system is intended to keep trams moving while minimising delays to road traffic.

43 BTS trams are driven in accordance with the 'line of sight'[7] principle. This requires drivers to be prepared to stop before reaching a reasonably visible obstruction by using the service brake in a similar way to road vehicles being driven on the highway.

[7] As defined in Tramway Principles and Guidance (TPG) document produced by Light Rail Safety and Standards Board (LRSSB).

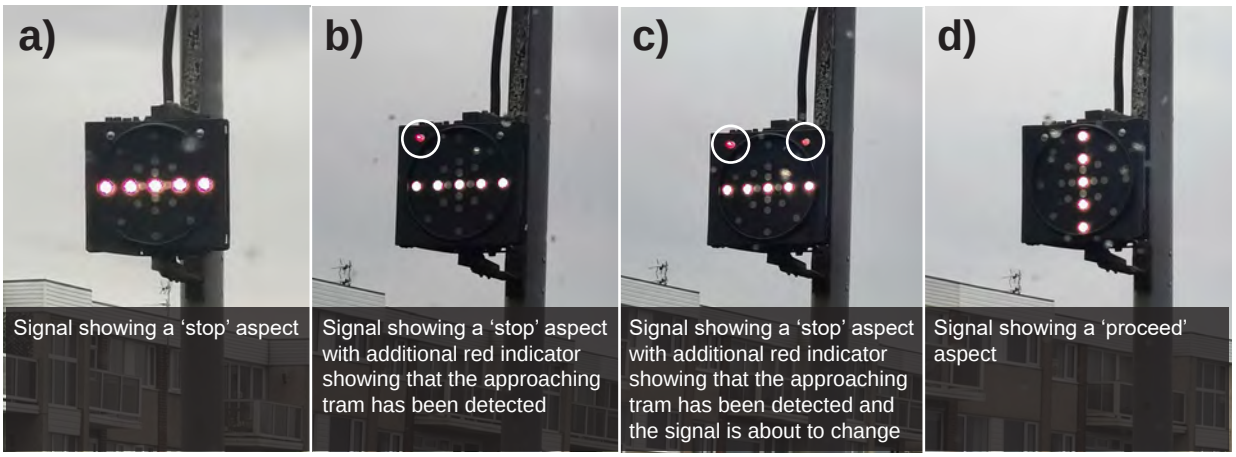

Figure 7: Tram signal showing a ‘proceed’ aspect and the indications given to tram drivers that the approach of their tram has been registered by the signalling system.

Analysis

Identification of the immediate cause

44 The pedestrian crossed into the path of the tram as it passed over the crossing.

Identification of causal factors

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

a. The tram driver did not take action to avoid the collision because he was unaware of the presence of the pedestrian on the crossing as the tram approached it (paragraph 46).

b. The pedestrian did not take action to avoid the tram (paragraph 69).

Each of these factors is now considered in turn.

The tram driver's awareness of the pedestrian

46 The tram driver did not take action to avoid the collision because he was unaware of the presence of the pedestrian on the crossing as the tram approached it.

47 When the tram left Anchorsholme Lane tram stop, the tram signal was showing a stop aspect for the junction. This was because the traffic signal control system had not yet reacted to the presence of the tram (paragraph 40). The driver was controlling the speed of the tram to between 6 km/h (4 mph) and 9 km/h (6 mph) during this period so he could stop or proceed as required when the tram got to the signal.

48 The tram maintained this low speed for 23 seconds after leaving the tram stop, before the driver commanded the tram to accelerate, almost certainly in response to a change in the tram signal aspect. Analysis of the OTDR data shows that the tram did not start to accelerate until around seven seconds before the collision with the pedestrian. Given the likely walking speed of the pedestrian (see paragraph 63), this acceleration took place after the point at which he had started to cross the tramway.

49 Witness evidence, supported by OTDR and FFCCTV, indicates that the tram driver was unaware of the presence of the pedestrian until it was too late to take any action to avoid the collision. He did not use the tram's warning devices or brakes before the collision.

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

a. It would have been difficult for the tram driver to see the pedestrian as he approached and started to use the crossing (paragraph 51).

b. The tram driver was probably distracted as the tram approached the crossing and this may have affected his awareness of the presence of the pedestrian (paragraph 62).

Each of these factors is now considered in turn.

Conspicuity of crossing users at night

51 It would have been difficult for the tram driver to see the pedestrian as he approached and started to use the crossing.

52 The pavement on the western side of the crossing (used by the pedestrian in this accident) ends as the tramway enters a segregated section of track. This section of tramway is fenced on either side and protected from unauthorised access by anti-trespass devices. A fence also separates the pavement from the adjacent Anchorsholme Park. This means that, once anyone walking south on the pavement has passed the entrance to the park, they can only continue onto the crossing which passes over the tramway (figure 6). This potentially gives a tram driver who sees people walking on this stretch of pavement an early indication that they are about to use the crossing.

53 However, in low light conditions, it is difficult for tram drivers to see crossing users who are not sufficiently lit or in contrast to their backdrop because dipped tram headlights (like all such road vehicle lights) have a limited effective range. Street lighting is used along Fleetwood Road and Kelso Avenue to make road users more visible to each other.

54 However, at the time of the accident, there was no street lighting within 20 metres of the western end of the crossing. Measurements of the intensity of lighting undertaken by RAIB after the accident indicated lighting levels of between 2 and 6 lux[8] on the ground, both on the crossing and the pavement at the western end. These values are lower than lighting levels recommended by industry guidance (see paragraph 86). These measurements were consistent with another set of readings taken on behalf of Blackpool Council.

55 To gain a better understanding of the visibility of the pedestrian, RAIB undertook testing at the crossing at night, around two hours after sunset (reflecting the timing of the accident). During these tests, a member of RAIB staff dressed in dark clothing, similar to that worn by the pedestrian, walked towards the crossing from the entrance to Anchorsholme Park. They were observed by other RAIB staff adjacent to the tram signal (figure 3) that the tram was being controlled by before crossing the junction. This test demonstrated that the person near to the park entrance was difficult to see (figure 8).

56 During this test, the member of RAIB staff walking near the crossing perceived that they would be quite visible to the observers looking towards them across the tramway. This is discussed further in paragraph 79.

57 RAIB considers that the person was difficult for the tram driver to see because the lighting levels at, and on the final approach to, the crossing were very low (see paragraph 84). This was compounded by the dark backdrop of shrubs and other foliage immediately behind the footpath which provided no discernible contrast to an individual dressed in dark clothing. The light-coloured concrete fencing between the tramway and the road on the south side of the junction, although not solid, obscured the lower half of an average-height adult pedestrian. Once on the crossing, although no longer partially obscured by fencing, pedestrians will still not be well illuminated (paragraph 54), potentially making them difficult to see.

[8] Lux is a standardised unit of measurement of light level intensity.

Figure 8: A person in dark clothing (circled) walking towards the crossing from the western pavement.

Tram lights

58 Although trams are not required to comply with provisions of the Road Vehicles (Construction and Use) Regulations,[9] the Light Rail Safety and Standards Board[10] (LRSSB) guidance recommends that tram headlights should be positioned as close as practicable to the positions prescribed within the Road Vehicle Lighting Regulations 1989.[11]

59 On the tram involved, there is a setting for both dipped beam and main beam headlights. At time of the accident, witness evidence (supported by FFCCTV images) is that the dipped beam headlight setting was in use. This means that it is likely that the light pattern was projected slightly down and to the tram's left, as is usual for road vehicle dipped headlight beams. Consequently, the tram's headlights were unlikely to fully illuminate the western end of the crossing or the pavement on the western approach to the crossing as the tram passed through the junction. However, when the pedestrian was immediately ahead of, and close to, the tram, he would have been directly lit and visible from the tram cab.

[9] www.legislation.gov.uk/uksi/1986/1078/contents/made.

[10] The Light Rail Safety and Standards Board is the safety and standards body of the tramway sector. It is a subsidiary company of UKTram, with a separate governing body, an independent chair and a board comprising of industry representatives. Further information can be found at https://lrssb.org/.

[11] www.legislation.gov.uk/uksi/1989/1796/contents/made.

60 RAIB considers that the use of dipped beam headlights was appropriate in this situation due to the position of oncoming road traffic along Queen's Promenade and the potential for the main beam to have dazzled the drivers of those vehicles.

61 Trams are exempt from the requirement to have an MOT certificate. Other road vehicles that are required to hold an MOT certificate undergo inspection annually for such a certificate to be issued, which includes an assessment of the headlamp beam pattern to ensure that they are correctly adjusted. BTS informed RAIB that it does not have an equivalent inspection for its trams (see paragraph 107).

The actions of the tram driver

62 The tram driver was probably distracted as the tram approached the crossing and this may have affected his awareness of the presence of the pedestrian.

63 The pedestrian was struck as he reached the left-hand (eastern) rail of the southbound track the tram was travelling on, having already crossed the northbound track. There is no direct evidence to show how long the pedestrian took to walk from the entrance of the crossing to the point where he was struck. RAIB inspectors took an average time of 8 seconds to walk this, corresponding to an average walking speed of 1.7 m/s. This is consistent with guidance[12] produced by LRSSB which describes the walking speed of able-bodied pedestrians as being in the range of 1.1 to 1.7 m/s. If it is assumed that the pedestrian was walking, it is unlikely that he moved more quickly than this.

64 BTS trains its tram drivers to pay particular attention to the movement and position of pedestrians. To do this effectively, drivers must be able to see pedestrians in time to anticipate their intentions, identify any hazards and decide and implement appropriate action to avoid or mitigate them, such as slowing down the tram or sounding a warning.

65 While the crossing was not well illuminated (paragraph 54), RAIB has not been able to fully determine why the driver was apprently unanware of the presence of the pedestrian on the crossing (paragraph 49) in the final seconds before the collision, when they would have been directly lit and visible from the tram cab (paragraph 59).

66 RAIB found no evidence to support the driver being distracted by factors such as mobile phone usage or fatigue. RAIB has also found no evidence of other causes that might have affected the driver's awareness such as a micro sleep[13] or an undiagnosed medical condition but is unable to discount these completely.

67 Witness evidence indicates that the tram driver was looking to his left for some of the period while the tram was approaching the crossing. This was because he was concerned about the hazard created by road traffic not complying with red road traffic lights.[14] This probably distracted the driver and may have affected his awareness of the presence of the pedestrian.

[12] Guidance on Tramway Crossings for Non-Motorised Users published by LRSSB, issue 2 July 2021.

[13] Unintentional periods of sleep lasting anywhere from a fraction of a second to a few minutes.

[14] Given the layout of the junction, the only possible conflict from road vehicles with southbound trams is from the tram's left in the direction of travel.

68 The tram driver had experience of road traffic non-compliance at both this junction and at other locations. RAIB conducted an anonymous survey of Blackpool tram drivers which included questions about their experience of motorists not complying with red road traffic lights. While the junction involved in the accident did not feature as a prime location for this type of hazard, it was reported as a common issue which drivers experienced across the Blackpool tram system.

Influences on the pedestrian's perception and decision-making

69 The pedestrian did not take action to avoid the tram.

70 At the crossing involved in the accident, pedestrians have to decide for themselves when it is safe to cross the tramway. There are no signals for pedestrians to indicate if it is safe to cross or if a tram is approaching.

71 Although the FFCCTV from the tram only captures the pedestrian for approximately one-and-a-quarter seconds before the collision (paragraph 33), there is no movement or reaction in that time to suggest that he is aware of the close proximity of the tram. This suggests that he was unaware of the approaching tram as he crossed the tramway.

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

a. The pedestrian may have misjudged the speed of the tram (paragraph 73).

b. The pedestrian may have believed he was more conspicuous to road vehicle and tram drivers than he was (paragraph 78).

c. The pedestrian may have been deterred from checking to his left while crossing because of the angle of the crossing to the tramway (paragraph 81).

Each of these possible factors is now considered in turn.

Pedestrian perceptions and beliefs

73 The pedestrian may have misjudged the speed of the tram.

74 Since the pedestrian lived locally and was familiar with the area (paragraph 20), it is highly unlikely that he did not know he was crossing a tramway, or did not appreciate the hazards associated with doing so. It is therefore considered likely that he would have looked to see if it was safe to cross at some point before crossing. The distinctive appearance of the tram, its lighting and its position on the tramway meant that, if he had done so, the presence of the tram approaching the junction would have been apparent.

75 When the tram left Anchorsholme Lane tram stop, it maintained a low speed for 23 seconds, before accelerating, almost certainly as a result of receiving a proceed signal (paragraph 47). RAIB observed during site visits that a slow initial departure from Anchorsholme Lane was common practice for southbound tram drivers.

76 Analysis of OTDR data shows that the tram did not start to accelerate until after the point at which the pedestrian had started to cross the tramway (paragraph 48). This means that the decision made by the pedestrian that it was safe to cross may have been based on his perception of the tram's slower speed as it left the tram stop, rather than the faster speed at which it approached the junction and crossing.

77 Judging the speed of vehicles at night can be difficult and, even if the pedestrian had been looking towards the tram after it began to accelerate, the change of speed which occurred after he began to cross may not have been immediately apparent to him (paragraph 48)

Pedestrian perceptions of their own conspicuity

78 The pedestrian may have believed he was more conspicuous to road vehicle and tram drivers than he was. This is a possible factor.

79 During RAIB's visit to the site at night (paragraph 55), RAIB staff on the western pavement near to the start of the crossing perceived that they were more conspicuous to observers across the tramway, to the north-east, than those observing found them to be. This is supported by academic research[15] which found that pedestrians frequently overestimate the distance at which they become visible to the drivers of road vehicles in low light conditions.

80 The pedestrian's perception that he was conspicuous to road and tram traffic may have influenced his judgement that it was safe to cross ahead of the tram. Therefore, he may have believed that the tram driver could see him and would act accordingly.

Influence of crossing layout

81 The pedestrian may have been deterred from checking to his left while crossing because of the angle of the crossing to the tramway.

82 Users of the crossing walking from west to east (such as the pedestrian involved in the accident) who stay within the defined limits of the crossing will cross at an angle of 57 degrees to the perpendicular route across the tramway (figures 5 and 6). This means that, when on the crossing, they are more naturally orientated towards northbound trams than if the crossing was perpendicular to the tramway. This also means that southbound trams are both behind and to the left of crossing users and will appear in their peripheral vision later in contrast to someone crossing perpendicular to the track. As they advance further across the tramway, crossing users would, in practice, also need to turn their head or body further to see southbound trams. This may have deterred the pedestrian from looking back to his left as he was crossing.

[15] Tyrrell, R. A., Wood, J. M., & Carberry, T. P. (2004). On-road measures of pedestrians' estimates of their own night time conspicuity. Journal of Safety Research, 35(5), 483–490.

Identification of underlying factors

Risk assessments of the crossing

83 Risk assessments for the crossing undertaken by Blackpool Council did not consider all the relevant hazards.

84 Blackpool Council had been conducting risk assessments for the crossing involved in the accident (and others under its control) since at least 2012. The risk assessment for the crossing involved in the accident had been undertaken in conjunction with BTS. It was revised in 2019 and, at the time of the accident, was in the process of being further revised in line with the relatively new guidance produced by LRSSB (paragraph 63). This guidance specifically describes how crossings should be assessed to determine the conspicuity of crossing users to tram drivers during the hours of darkness, including people waiting to cross. It recommends that lighting should be at the levels recommended in the appropriate section of BS 5489[16] which, although not specifically intended for tramways, is considered good practice.

85 Part 1 of BS 5489 covers '*Lighting of Roads and Public amenity areas'*. A revised version was published in May 2020. It describes various classes of lighting for 'conflict areas' (such as pedestrian crossings) and how the selection of the class of lighting is dependent on various factors, including the speed and density of traffic.

86 BS 5489 in turn refers to BS EN 13201-2:2015[17] as the standard with which lighting schemes for 'conflict areas' should comply. This standard describes the range of horizontal illuminance provided by six classes of lighting as between 7.5 and 50 lux. It is not possible to know which class of lighting would have been chosen for the crossing if an assessment which accorded with the new guidance had been carried out before the accident. However, the levels of light found by RAIB and Blackpool Council (paragraph 54) at the crossing were less than the lowest class of lighting described in BS EN 13201-2:2015 as being appropriate for 'conflict areas'.

87 BS EN 13201-2:2015 also describes how the local lighting of pedestrian crossings is intended to attract the attention of drivers of motorised vehicles to the presence of the pedestrian crossing and '*to illuminate pedestrians in or at the crossing area'.* This is consistent with guidance found in The Institution of Lighting Professionals Technical Report 'Lighting of Pedestrian Crossings',[18] which acknowledges the importance of the adjacent footway waiting area being well lit, as well as the crossing itself.

88 The risk assessments undertaken in 2012 and 2019 had considered some risks relating to the passage of trams, such as the restriction on the view of tram drivers and crossing users of northbound trams caused by the gas building adjacent to the tramway (paragraph 38). Blackpool Council stated that this risk was well understood by both BTS and Blackpool Council and managing it was a long-standing issue for the two organisations. It was this feature that led directly to a reduced speed limit (20 km/h) (12 mph) for northbound trams.

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[16] BS5489 BS 5489-1:2020 Design of road lighting - Lighting of roads and public amenity areas, 31 May 2020.

[17] BS EN 13201-2:2015 Road lighting Performance requirements, 2015.

[18] Institute of Lighting Professionals Technical Report 12 'Lighting of pedestrian crossings' 2007.

89 However, although site visits had been made to the crossing in connection with the documented risk assessments, RAIB found no evidence that this had been done at night or that Blackpool Council had considered the risks associated with using the crossing in low light conditions. This meant that the low level of lighting in the area (paragraph 54) had not been recognised as a potential hazard or mitigated by appropriate control measures.

90 Blackpool Council and BTS each have their own safety management system (SMS). Blackpool Council's SMS[19] describes how 'System Based Risk Assessments' should consider '*the effects of integrated risk on tramway operations*'. However, Blackpool Council was unable to provide any risk assessments that met this requirement and stated that the risk assessments prepared in 2012 and 2019 for the crossing involved in the accident were the only documented assessments for the location.

91 Risk assessments undertaken by BTS did not consider all the relevant hazards relating to the crossing.

92 The BTS SMS describes three types of risk assessment intended to '*assess the risks associated with the operation*' and '*demonstrate how management addresses these risks'*. These are 'Task based risk assessments', 'Specialised risk assessments' and 'System risk assessments'. However, BTS regarded the production of risk assessments for infrastructure such as crossings to be within the remit of Blackpool Council as it was the infrastructure provider. This meant that BTS did not undertake their own separate risk assessment of the crossing.

93 BTS had not undertaken a suitable and sufficient assessment of tram operations, even though it was required to do so by the relevant legislation,[20] which might have identified the hazards of crossing use from the operator's perspective. BTS explained that it relied on its longstanding history of tram operations to inform it of the risks that exist. In 2018 BTS began building a database of incidents and accidents to help improve its understanding of the risks of operating trams.

94 BTS stated that it reviewed accidents and incidents in the context of trying to reduce the risk of recurrence by considering individual accidents or problem locations and trying to reduce risk at those locations. It did not analyse or try to understand the individual causes of such accidents and where else those causes might contribute to a hazard.

95 This meant that, while BTS had recognised the risk of tram collisions with other road / tramway users (mostly vehicles and pedestrians) it hadn't sought to identify the individual causal factors that contribute to such events. BTS also hadn't identified all the specific risks that could arise from issues relating to driver performance, and relied on recruitment, driving training, assessment and maintaining medical fitness as its principal controls. Although BTS had not documented the risk of drivers losing awareness, it recognised the risk and had fitted its trams with vigilance devices.[21]

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[19] Blackpool Council Engineering (Trams) Safety Management System, Revision 6.1 dated July 2021.

[20] Regulation 3 of The Management of Health and Safety at Work Regulations 1999.

[21] Vigilance devices will safely stop trams if the driver becomes incapacitated or loses awareness for an extended period. In common with other tram systems, the vigilance device on the accident tram does not mitigate against a loss of awareness for short periods.

96 BTS was reliant on tram drivers performing as trained. Although it hadn't identified all the specific risks that could arise from driver performance, BTS strove to recruit and train the right people as drivers and had an established programme of driver training, assessment and maintaining medical fitness.

97 RAIB considers it is likely that the lighting deficiencies in the area of the crossing where the accident took place may have been identified if both BTS and Blackpool Council had put a more effective risk assessment regime in place. This may then have identified the need for improvements to the lighting or operational mitigations, such as a speed restriction across the crossing for southbound trams, as already existed for northbound trams.

Blackpool Council's oversight and assurance of BTS activities

98 Blackpool Council states in its SMS that it requires assurance that the BTS '*SMS (Trams) adequately controls all safety risks associated with the trams and their operation but also of their ability and competence to work on their infrastructure and do this work safely*'.

99 Blackpool Council and BTS explained that the two organisations met regularly at Tramway Safety Management Group (TSMG) meetings. TSMG appeared to be the main forum at which the organisations liaised regarding tramway safety. Recent minutes[22] of group meetings revealed that, while it discussed incidents, accidents and events, it did not specifically discuss risk assessment. This is reflective of the generally reactive approach to identifying hazards and assessing risks which is present within the tramway.

100 Blackpool Council explained that it has an audit programme and undertakes regular inspections of the condition of the tramway infrastructure. However, it explained that these inspections and the work of the staff undertaking audits examined the condition of the network in comparison to the previous inspection and accepted standards and were not intended to assess the suitability of the condition or arrangements as a whole. For example, with regard to street lighting or tram stop lighting, an audit would ensure that the existing lights were in good working order, not necessarily whether the lighting provided was adequate.

101 Although Blackpool Council's SMS documented that it should assure itself that BTS were adequately managing all safety risks associated with the trams and their operation, Blackpool Council has not provided RAIB with evidence that it has undertaken any activities to do this.

[22] Between September 2019 and the accident TSMG had only met four times, mostly due to the COVID-19 pandemic.

Observation

Near miss reporting at BTS

102 BTS possibly lost access to potential safety intelligence from near misses because of the way they were reported.

103 The effective reporting and analysis of near misses is a valuable means by which organisations can understand the risks of their operation. BTS use two separate systems working in parallel to collate intelligence about incidents and accidents. In addition to evidence gained from witnesses, RAIB conducted an anonymous survey of BTS tram drivers during the first three weeks of April 2022. Some of the questions in the survey were around the subject of near miss reporting, which helped RAIB to understand how BTS tram drivers approached the reporting of near misses.

104 More than half of drivers surveyed told RAIB that they only reported near misses formally if they had had to take emergency action to avoid a collision. In particular, several drivers associated a 'near miss' only with the use of the hazard brake.

105 This misunderstanding appears to have grown from a requirement for drivers to formally report use of the hazard brake to control to allow BTS to effectively investigate the consequences of its use (mostly injury to passengers).

106 RAIB considers that the need to report the use of the hazard brake and the circumstances in which a 'near miss' should be reported may have become conflated over time, probably reducing the occasions when drivers would make formal reports of such occurrences. A culture of reduced reporting may have led to BTS missing important indicators about potential hazards. This is particularly important with its reliance on operational learning to identify risk.

Tram headlights

107 The BTS arrangements for tram maintenance did not include a periodic check of tram headlight alignment.

108 The correct adjustment of the beam of vehicle headlamps helps to ensure that headlights are as effective as possible without causing undue dazzle for other road users. Trams are exempt from the requirements of statutory annual inspections (MOT, paragraph 61), which means that operators need their own arrangements to ensure that tram headlights are correctly adjusted.

Previous occurrences of a similar character

109 RAIB has previously reported on accidents in which trams have struck pedestrians crossing tramways. Recent examples include a fatal collision between a tram and a pedestrian which took place near Saughton tram stop, Edinburgh in September 2018 (RAIB report 09/2019) and a fatal collision involving a tram and a pedestrian which took place at Woodbourn Road, Sheffield in December 2016 (RAIB report 13/2017).

110 The last accident of this type on the Blackpool tramway was at Norbreck in August 2009 (RAIB report 09/2010). This accident involved an older type of tram which collided with a pedestrian on a crossing during daylight hours.

Summary of conclusions

Immediate cause

111 The pedestrian crossed into the path of the tram as it passed over the crossing (paragraph 44).

Causal factors

112 The causal factors were:

a. The tram driver did not take action to avoid the collision because he was unaware of the presence of the pedestrian on the crossing as the tram approached it (paragraph 46). This causal factor arose due to a combination of the following:

   i. It would have been difficult for the tram driver to see the pedestrian as he approached and started to use the crossing (paragraph 51, **Recommendations 1 and 2**).

   ii. The tram driver was probably distracted as the tram approached the crossing and this may have affected his awareness of the presence of the pedestrian (paragraph 62, **Recommendation 1**).

b. The pedestrian did not take action to avoid the tram. This causal factor arose due to a combination of the following:

   i. The pedestrian may have misjudged the speed of the tram (paragraph 73, no recommendation).

   ii. The pedestrian may have believed he was more conspicuous to road vehicle and tram drivers than he actually was (paragraph 78, no recommendation).

   iii. The pedestrian may have been deterred from checking to his left while crossing because of the angle of the crossing to the tramway (paragraph 81, **Recommendation 2**).

Underlying factors

113 The underlying factors were that risk assessments for the crossing did not consider all the relevant hazards (paragraphs 83 and 91, **Recommendations 1 and 2, Learning point 1**), and that audit and assurance arrangements did not identify this (paragraph 98, **Recommendation 3**).

Observations

114 Although not linked to the cause of the accident on 24 November 2022, RAIB observes that:

a. BTS possibly lost access to potential safety intelligence from near misses because of the way they were reported (paragraph 102, **Learning point 1**)

b. The BTS arrangements for tram maintenance did not include a periodic check of tram headlight alignment (paragraph 107, **Learning point 2**)

Actions reported as already taken or in progress relevant to this report

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

115 Following the accident, Blackpool Council commissioned a review of the design of the crossing and undertook works to implement a revised design.

116 The new layout (figures 9a and b) removed foliage and extended the western approach to the crossing to make the crossing perpendicular to the tramway. New ornamental fencing was moved back into Anchorsholme Park and two additional streetlights have been ordered for installation on either side of the tramway near to the crossing. A traction pole adjacent to the western end of the crossing has also been relocated to improve sighting.

Figure 9a: The revised crossing layout, photographed from the western end of the previous crossing, with remains of previous crossing markings visible.

Figure 9b: The revised crossing layout looking towards the western end.

Other reported actions

117 Following the accident, BTS briefed its drivers on the value and importance of reporting near misses, in accordance with the relevant BTS procedure, to address any misunderstanding about what type of incidents should be reported.

118 Blackpool Council reported that it has reviewed its tramway governance structures. As a consequence, it has established a Tramway Infrastructure Improvement Committee, comprising three subgroups, including one dedicated to Infrastructure/Health & Safety.

119 BTS delivered a two-day tram driver refresher training programme for all of its tram drivers from February 2022. This included engaging a consultant to deliver emergency response training for its drivers including an appreciation of issues such as perception response times, why things are seen or not seen, sensory overload and lighting conditions.

120 Blackpool Council has prepared risk assessments for all its tramway crossings using the guidance provided by LRSSB in its Non-Motorised Users Crossings guidance (paragraph 63). All tramway road crossings now have a mandatory maximum speed limit of 20 km/h (12 mph).

121 Blackpool Council has begun developing a new Tramway Asset Management Strategy and has begun the recruitment of a Health & Safety specialist focused on Highways and Tramway Services. These actions are intended to improve Blackpool Council's oversight of tramway operation and support Blackpool Council's Track Services team.

122 In RAIB report 13/2017 (Fatal collision between a tram and pedestrian at Woodbourn Road, Sheffield) RAIB made a recommendation concerning the fitment of pedestrian detection technology for trams. BTS had been trialling collision avoidance technology[23] on a tram before this accident. In February 2022 Blackpool Council's Shareholder Committee agreed to purchase an obstacle detection and collision avoidance system for all of its trams. The fitment of this technology will mitigate the risk of drivers not detecting or reacting to potential imminent collisions with other road users. RAIB has not remade the recommendation.

[23] Such technology uses sensors to detect the presence of obstacles, such as pedestrians, in the path of a tram. Should an obstacle be detected, systems of this type can automatically apply the tram's brakes.

Recommendations and learning points

Recommendations

123 The following recommendations are made:[24]

1 *The intent of this recommendation is to ensure that Blackpool Transport Services adequately identifies and manages risks arising from its tramway activities*.

Blackpool Transport Services, working in conjunction with Blackpool Council, should review its process for assessing and controlling the risks arising from its tramway activities to ensure it is effective, incorporates industry best practice and is updated at appropriate intervals. Blackpool Transport Services should develop a timebound plan to implement any changes identified (paragraphs 112a.i, 112a.ii and 113).

2 *The intent of this recommendation is to ensure that Blackpool Council adequately identifies and manages risks arising from its tramway activities*.

Blackpool Council, working in conjunction with Blackpool Transport Services, should review its process for assessing and controlling the risks arising from its tramway activities to ensure it is effective, incorporates industry best practice and is updated at appropriate intervals. Blackpool Council should develop a timebound plan to implement any changes identified (paragraphs 112a.i, 112b.iii and 113).

3 *The intent of this recommendation is to ensure that Blackpool Council has an assurance process that provides an effective oversight of the activities of Blackpool Transport Services*.

Blackpool Council should review the processes it uses to provide assurance and audit of Blackpool Transport Services to ensure that it has visibility of ongoing safety performance and a clear understanding of how risks are being managed. Blackpool Council should develop a timebound plan to implement any changes identified (paragraph 113).

[24] 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.

Learning points

124 RAIB has identified the following important learning points:[25]

1 RAIB reminds duty holders of the value of having a clear and well understood process for staff to feedback intelligence on incidents and safety-related concerns based on near misses and their operational experience (paragraph 102).

2 Tram operators should have adequate arrangements to satisfy themselves that tram headlights are providing effective illumination of the road ahead and are compliant with the Road Vehicle Lighting regulations with regard to causing undue dazzle (paragraph 107).

[25] 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where 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

BTS	Blackpool Transport Services
CCTV	Closed-circuit television
LRSSB	Light Rail Safety and Standards Board
MOT	Ministry of Transport
ORR	Office of Rail and Road
OTDR	On-tram data recorder
RAIB	Rail Accident Investigation Branch
SMS	Safety management system

Appendix B - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- information taken from the on-tram data recorder (OTDR)
- closed-circuit television (CCTV) recordings taken from the tram involved and commercial premises local to the accident site
- site photographs and measurements
- weather reports and observations at the site
- a lighting assessment of the crossing undertaken by RAIB
- expert reports on the interpretation of toxicology reports commissioned by RAIB
- evidence provided by BTS and Blackpool Council
- an anonymous survey of BTS tram drivers undertaken by RAIB
- a review of previous reported accidents near the accident site
- a review of previous RAIB investigations that had relevance to this accident.

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