



Rail Accident Investigation Branch

Rail Accident Report



Tram collision with pedestrian near Market Street tram stop, Manchester 12 May 2015

Report 06/2016
April 2016

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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Summary

At about 11:13 hrs on Tuesday 12 May 2015, a tram collided with and seriously injured a pedestrian, shortly after leaving Market Street tram stop in central Manchester. The pedestrian had just alighted from the tram and was walking along the track towards Piccadilly.

The accident occurred because the pedestrian did not move out of the path of the tram and because the driver did not apply the tram's brakes in time to avoid striking the pedestrian.

The RAIB has made one recommendation to Metrolink RATP Dev Ltd, to improve its care of staff involved in an accident. It has made one recommendation to Metrolink RATP Dev Ltd in conjunction with Transport for Greater Manchester, to review the assessment of risk from tram operations throughout the pedestrianised area in the vicinity of Piccadilly Gardens. It has also made one recommendation to UK Tram, to make explicit provision for the assessment of risk, in areas where trams and pedestrians/cyclists share the same space, in its guidance for the design and operation of urban tramways.

The RAIB has also identified the importance of regular reviews and/or appraisals for tram drivers undertaken by a line manager as a key learning point.

Introduction

Key definitions

- 1 Metric units are used in this report, except when it is normal practice on the Metrolink system to give speeds 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 about 11:13 hrs on Tuesday 12 May 2015 a tram collided with an adult pedestrian about 25 metres to the south east of Market Street tram stop in central Manchester (figure 1). The tram was running from Bury to Etihad Campus via Market Street and Piccadilly Gardens. It was travelling at 9.3 mph (15 km/h) at the time of the collision.

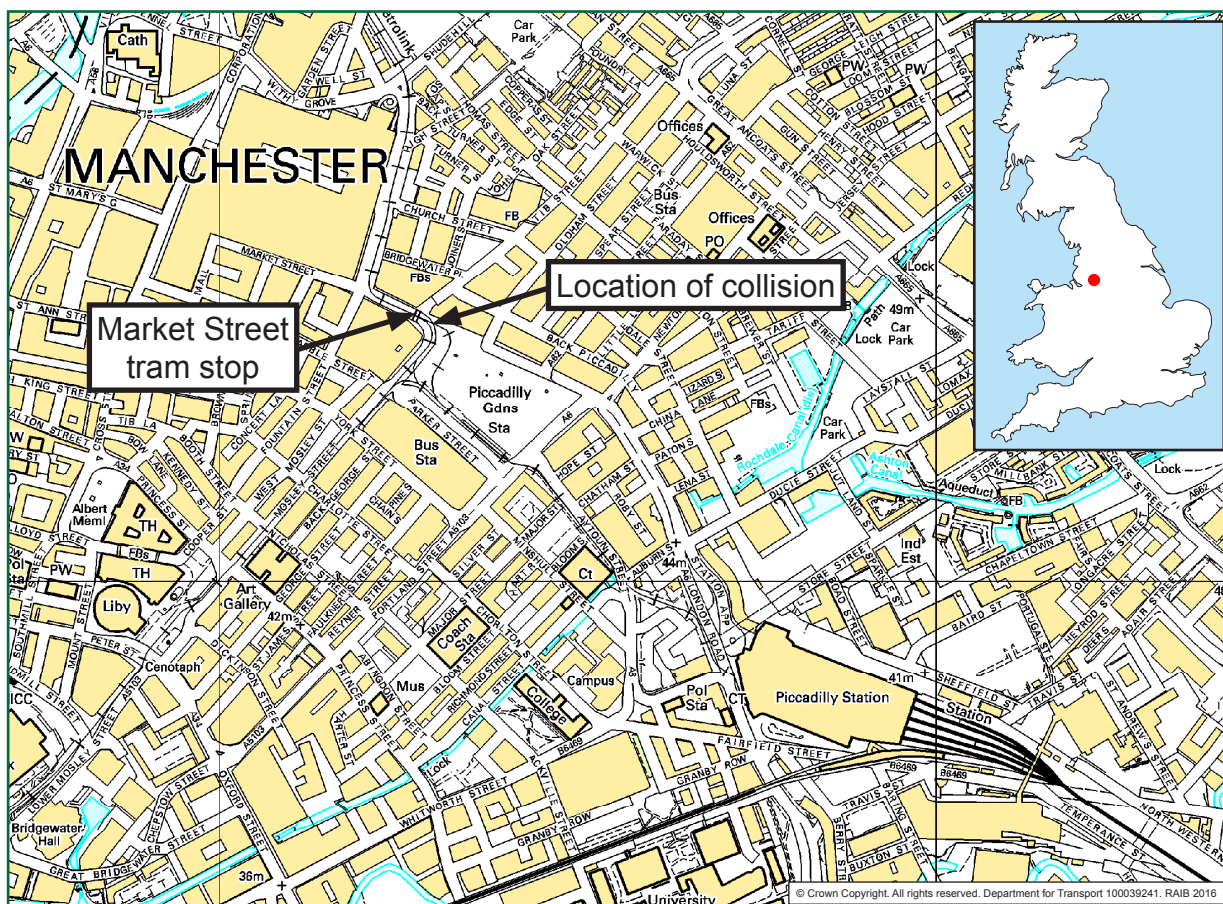


Figure 1: Extract from Ordnance Survey map showing central Manchester and the location of the accident

- 4 The pedestrian had alighted from the same tram at the Market Street stop and was walking along the track towards Piccadilly (figures 2 and 3). He suffered serious injuries as a result of the collision; no-one else was injured.
- 5 Tram services were suspended for approximately 45 minutes following the accident.



Figure 2: Market Street tram stop showing initial route of pedestrian after alighting from the tram

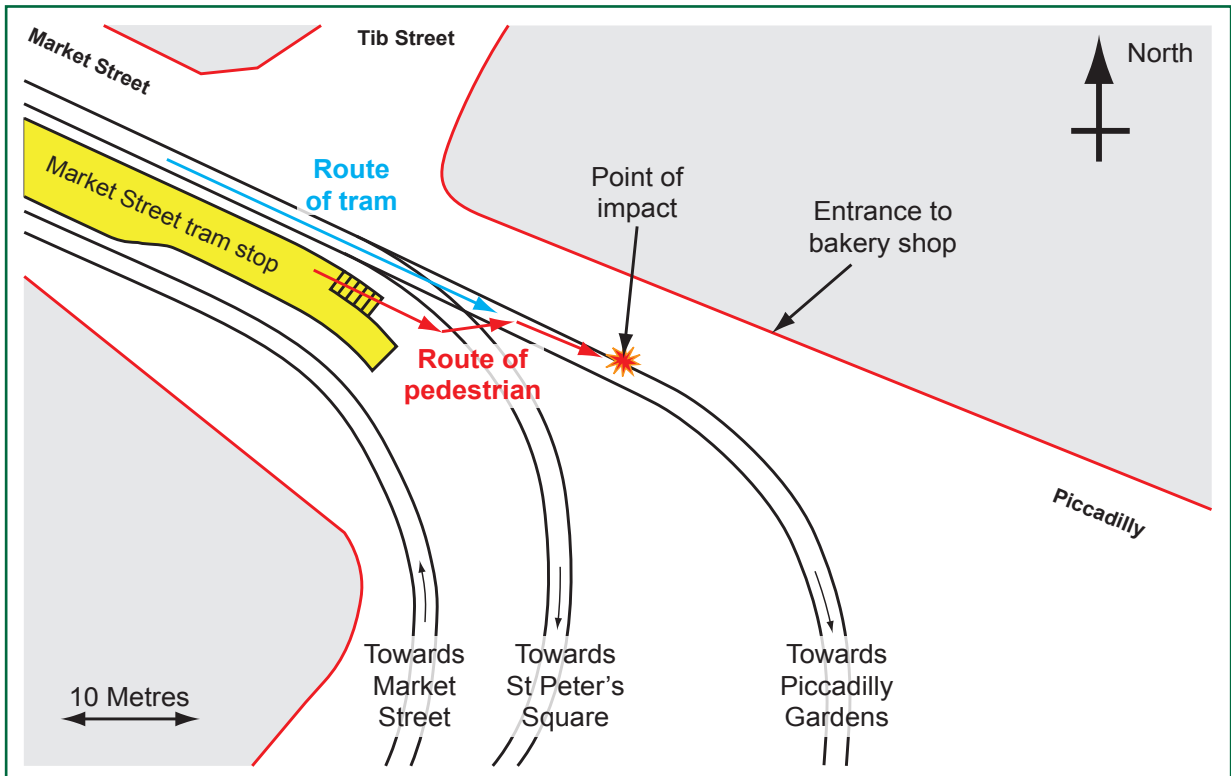


Figure 3: Plan view of Market Street

Context

Location

- 6 The Piccadilly Gardens area in Central Manchester is at the hub of the Metrolink system¹. Tramway infrastructure in this area includes North, South and West junctions, the 'Delta' and the Market Street and Piccadilly Gardens tram stops (figure 4). Piccadilly Gardens and the section of Market Street in which the tram stop is situated in a pedestrianised area (closed to motor traffic except trams and vehicles requiring access).

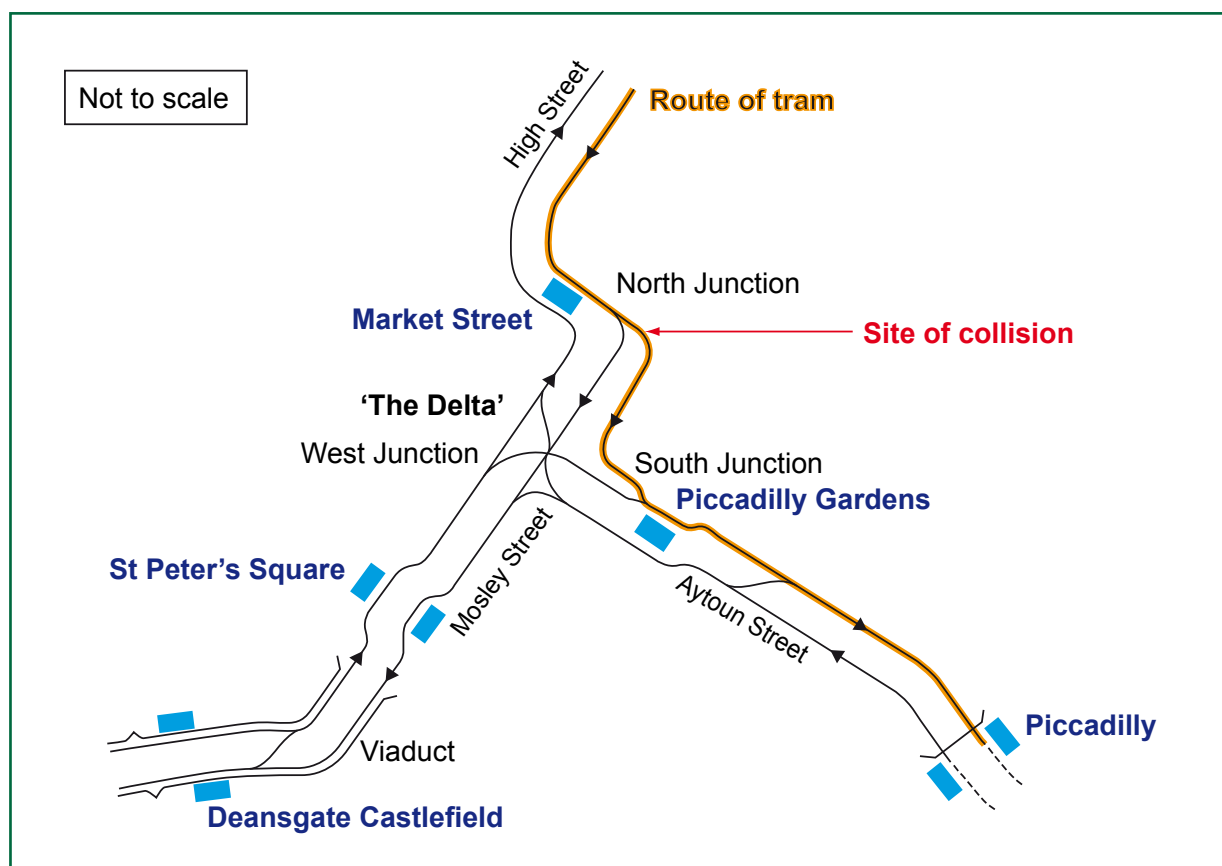


Figure 4: Track layout, Central Manchester, showing diverging routes at North Junction

- 7 The tram involved in the accident had passed from an *off-street tramway* into an *on-street tramway* at Manchester Victoria station. After travelling south along High Street, which is classed as a segregated on-street tramway (see appendix D), the tram turned left into Market Street. This area is classed as an integrated on-street tramway as, although other road vehicles are not normally present, the surface in which the rails are laid is available for use by pedestrians (figure 5).

¹ At the time this report is being written, the 'second city crossing' is being commissioned. This provides an alternative to the route through Market Street.



Figure 5: View along Market Street towards High Street, with Market Street tram stop in the centre

Organisations involved

- 8 Metrolink RATP Dev Ltd (MRDL) operates the Metrolink system under contract to Transport for Greater Manchester (TfGM). It is a wholly-owned subsidiary of RATP Dev and has held the operating and maintenance rights since 2011, when RATP Dev acquired Stagecoach Metrolink (which had been awarded a ten year contract to operate Metrolink in 2007). It employs the driver of the tram involved in the accident.
- 9 TfGM is the delivery arm for the Greater Manchester Combined Authority and its Transport for Greater Manchester Committee. TfGM owns Metrolink and is responsible for investment in transport services and facilities.
- 10 All of the organisations involved freely co-operated with the investigation.

Tram involved

- 11 The tram involved in the accident was a type M5000 tram, No. 3034, which was manufactured by Bombardier Transportation in 2011/12. The M5000 was specifically designed for use in Manchester and has a high floor; it can operate as either a single articulated vehicle or coupled together to form a 'double' unit.
- 12 The RAIB has found no evidence that the design or condition of the tram caused or contributed to the accident.

Staff involved

- 13 The driver had approximately 12 years' experience of driving trams on the Metrolink system. His tram driving history is discussed at paragraph 43.

- 14 A *crew supervisor* acted as both incident officer and investigator on site. He subsequently completed MRDL's first and second internal investigations into the accident.

External circumstances

- 15 The day was clear and there was bright sunlight at the time of the accident (paragraph 46); this is evident from the strong shadows that are visible in the forward facing closed circuit television (CCTV) recording from the tram (figure 6). This is discussed at paragraph 46. A weather report for Manchester airport (8.5 miles / 13.7 km south of Market Street tram stop) records that there were 'scattered clouds' at this time.



Figure 6: Cropped image from the forward facing CCTV on tram No. 3034

The sequence of events

Events preceding the accident

- 16 The tram driver had been on duty for 6½ hours (his shift had started at 04:39 hrs and was due to run until 12:08 hrs). He had taken a meal break from 09:36 to 10:06 hrs.
- 17 The pedestrian boarded the tram at Crumpsall tram stop shortly before 11:00 hrs, and was travelling to Levenshulme. His route required him to change from tram to bus in the city centre.
- 18 The tram stopped at Market Street tram stop at 11:12:36 hrs². The pedestrian alighted at approximately 11:12:43 hrs and descended the steps at the Piccadilly end of the tram stop. He crossed the track that leads to St Peter's Square and headed towards a bakery shop on the far side of the track that leads to Piccadilly Gardens (figures 3 and 5). The tram was behind and to his left; it started to move as he was crossing the St Peter's Square track.

Events during the accident

- 19 On departure from Market Street tram stop at 11:13:09 hrs, the tram driver accelerated the tram towards the maximum speed permitted in the pedestrianised area of 10 mph (16 km/h). He had sounded the tram's whistle as it started to move (in accordance with standard practice for trams departing from city centre tram stops). The tram continued straight ahead at North Junction, taking the route towards Piccadilly Gardens.
- 20 Meanwhile, the pedestrian continued walking away from the tram stop, and in a direction that involved him crossing the track on which the tram was routed. After stepping over the first rail of the track, rather than immediately crossing the second rail, he turned slightly to the right and started walking along the track at 11:13:15 hrs.
- 21 The tram collided with the pedestrian four seconds later, at approximately 11:13:19 hrs, knocking him to the ground. The driver applied the tram's brakes at about the same time as the accident occurred. The tram had been travelling at 9.3 mph (15 km/h) for about one second before the collision. The driver sounded the whistle after he applied the brakes and applied the emergency brake two seconds later, at 11:13:22 hrs.

Events following the accident

- 22 A member of MRDL's operations planning department, who had been a passenger on the tram, assisted the driver in disembarking the passengers. A paramedic on a bicycle was flagged down within a few minutes by members of the public and police community support officers at the scene; a member of the public also made a 999 call to the North West Ambulance Service. The pedestrian's injuries were initially believed to have been relatively minor; it later transpired that he had been seriously injured (see paragraph 56).

² Times are based on analysis of the tram CCTV recordings and data from the on tram monitor & recorder (OTMR). They have been synchronised using the times recorded by the OTMR and are given as hh:mm:ss; they are recorded to the nearest second.

- 23 The MRDL control office despatched a crew supervisor to site in a company van. When he arrived, he acted as both incident officer and investigator (see paragraph 49).
- 24 The crew supervisor encouraged the tram driver to sit in the incident van, which was parked on the opposite side of the tram from the injured pedestrian. He subsequently asked the tram driver if he would be able to drive the van back to the depot (so that he, the crew supervisor, could drive the tram to the depot).
- 25 Tram operations through Market Street restarted approximately 45 minutes after the accident. The tram driver left site in the incident van with the other member of staff (paragraph 22) a few minutes later.

Key facts and analysis

Background information

- 26 Guidance on the design and construction of tramways, including the general principles for signing and marking tramways³, is provided in 'Railway Safety Publication 2 – Guidance on Tramways' (referred to as RSP2), which was published by the Office of Rail and Road (ORR). The ORR also published 'Tramway Technical Guidance Note 2 – Pedestrian Safety' (referred to as TTGN2). Responsibility for both these documents has now passed to UK Tram⁴, and they are due to be revised.
- 27 Trams in the UK operate in a number of different operating categories, usually switching between them in the course of a journey. The different categories are defined in RSP2, appendix D. In summary, these are:
- a. integrated on-street tramways;
 - b. segregated on-street tramways; and
 - c. off-street tramways⁵.
- 28 The Piccadilly Gardens area in Manchester, including Market Street, is a pedestrianised area in which trams share the space with pedestrians (figure 5). As such, it falls within the definition of an integrated on-street tramway as well as being a form of *shared space*.
- 29 The measures adopted by MRDL to mitigate the risk in the pedestrianised area are consistent with the guidance contained in RSP2 (see paragraphs 31 and 72), and are aimed at both drivers and pedestrians. They include:
- a. *line of sight* driving;
 - b. driver training (*defensive driving*);
 - c. a speed limit of 10 mph (16 km/h);
 - d. trams are equipped with a hazard brake with a retardation rate of at least 2.5 m/s² for a stop from the maximum permitted speed of operation;
 - e. use of the whistle (see paragraph J5 of MRDL's Rule Book, appendix F)⁶; and
 - f. demarcation of the tramway.
- 30 Tram drivers in Manchester, in line with those driving for other operators in Britain, have no warning systems to assist them in detecting hazards such as pedestrians while driving in pedestrianised areas. Trials have been carried out in various European cities with 'driver assistance systems' (also referred to as 'tram collision avoidance systems'), although predicting the behaviour of pedestrians has so far proved to be too difficult for inclusion in such systems.

³ Detailed guidance on the use of road markings for street-running tramways is provided in Chapter 5 of the Traffic Signs Manual published by the Department for Transport, while mandatory requirements are set out in the Traffic Signs Regulations and General Directions 2002.

⁴ An umbrella body bringing together organisations with an interest in the current operation and future development of tramways in the UK.

⁵ Off-street operation is often referred to as segregated running, as the track is separated from any highway

⁶ Metrolink trams are equipped with a horn, which is predominantly used during segregated running, and a whistle for street use.



Figure 7: Demarcation of tramway (view in opposite direction from figure 5)

31 With respect to a pedestrian’s awareness of the tramway, RSP2 states that ‘the path of an on-street tramway should be marked where it is not apparent from the carriageway or kerbs, and where it would be useful either to tram drivers or other road users to do so.’ It also states that, to help visually-impaired people, ‘the preferred method of marking the tramway path in pedestrian zones is for it to be slightly lower than that of the surrounding area, and for there to be a suitable colour contrast between surfaces. The tramway path and the surrounding areas should be demarcated using a battered kerb.’ Figures 5 and 7 show that, while the design of the tramway near the location of the accident conforms with some aspects of the guidance, there is no effective colour contrast to assist with demarcation. For reference, a 1984 artist’s impression showed a clear colour contrast between the tramway and the surrounding area (figure 8).

32 The RAIB has observed that, in the vicinity of the Market Street tram stop:

Drivers

- a. have a clear and unobstructed view from the cab;
- b. have to check the *points position indicator* before moving off, as well as the actual lie of the points and the monitors providing the driver’s view of the passenger doors;
- c. need to anticipate pedestrian movements;
- d. must be ready to whistle and sometimes stop for pedestrians; and
- e. have to monitor their speed.



Figure 8: Artist's impression showing the proposed design of Market Street in 1984⁷ (courtesy Museum of Transport, Greater Manchester)



Figure 9: View from Market Street tram stop showing shortest routes between areas of tactile paving

⁷ From a brochure published by Greater Manchester Passenger Transport Executive. The artist's impression differs from the actual design and does not show the Market Street tram stop (figure 5).

Pedestrians

- f. may be inattentive to trams due to the use of mobile devices (eg phones or music players) or conversations with other pedestrians;
- g. tend to move freely across and along the tracks (figures 5 and 9), ignoring the areas of tactile paving on either side of the tracks (see paragraph 73);
- h. often do not appear to respond to tram whistles; and
- i. stand close to trams while waiting to cross.

Identification of the immediate cause

33 The pedestrian was in the path of the tram as it approached.

- 34 The pedestrian was walking along the track and facing away from the tram when it struck him.

Identification of causal factors

- 35 The accident resulted from a combination of the following causal factors:
- a. the pedestrian did not move out of the path of the tram as it approached (paragraph 36); and
 - b. the driver did not apply the tram's brakes in time to avoid striking the pedestrian (paragraph 41).

Each of these factors is now considered in turn.

The pedestrian's actions

36 The pedestrian did not move out of the path of the tram as it approached.

- 37 The pedestrian had alighted from the tram at the Market Street stop and is reported to have been making his way to a shop on the north side of the tram tracks (paragraph 18); this involved crossing both tracks. The forward facing CCTV from the tram shows that he changed direction as he was crossing the Piccadilly Gardens track (paragraph 20), and that he did not look back towards the tram once he had started crossing the tracks.
- 38 The RAIB's observations indicate that this is not exceptional behaviour for a pedestrian in this area. Pedestrians are entitled to walk in, around and across the tracks in this area without restriction because it is a shared space. Mitigation of the risk arising from unpredictable pedestrian behaviour, such as crossing the tracks without checking to see if a tram is approaching, is provided by the vigilance of tram drivers as well as the low speed of trams through the area.
- 39 It is not known whether the pedestrian was aware that he was walking along the tram tracks⁸; it is possible that he did not observe the demarcation of the tramway (paragraph 31). The RAIB has seen no evidence that he had any impairment of his sight.

⁸ The pedestrian was unable to recall the period immediately before the accident.

- 40 The pedestrian had his back to the tram and did not move out of the way as it approached. The RAIB has been unable to establish why he did not move out of the way, but notes the following possibilities:
- he may not have registered the sounding of the whistle which, although it was sounded as the tram departed from the stop, may not have provided an effective warning to the pedestrian;
 - he may have assumed that all trams would turn right on departure from Market Street tram stop and run towards St Peter's Square⁹; or
 - he may have been aware that the tram was approaching but did not consider it to be a threat.

The driver's actions

41 The driver did not apply the tram's brakes in time to avoid striking the pedestrian.

- 42 The RAIB has concluded that the driver of the tram involved in the accident on 12 May 2015 probably did not see the pedestrian until immediately before the collision occurred. This conclusion is based both on the driver's account of the collision and on a comparison of OTMR data from a number of trams leaving Market Street tram stop in the direction of Piccadilly Gardens. Analysis indicates that the tram accelerated normally from the tram stop until its speed was close to the maximum permitted in the pedestrianised area (9.3 mph (15 km/h) compared with 10 mph (16 km/h)). The driver did not sound the whistle from the time that the tram started to move until one second after he applied the tram's brakes, which he did as the collision occurred (paragraph 21)¹⁰.
- 43 Since the driver had started driving trams on the Metrolink system, in about 2003, he had been involved in four *road traffic collisions* (RTCs) with vehicles and four other operating incidents. The driver's employers (MRDL and its predecessors) determined that he was not to blame for three of the RTCs and two of the operating incidents. The driver had been referred for additional supervision and/or counselling following the remaining three previous incidents, which had occurred in January 2004, June 2013 and May 2014. MRDL has advised that, although he had been involved in a relatively high number of incidents, the driver's record had not given any particular cause for concern.
- 44 The RAIB has considered possible explanations for why the driver did not see the pedestrian walking in front of the tram, and has concluded that the driver probably lost concentration. Possible distractions are considered at paragraphs 45 to 47.

⁹ During construction work associated with changes in the city centre, no trams had used the Piccadilly Gardens track between January 2014 and February 2015.

¹⁰ The whistle sounded again automatically when the driver applied the emergency brake about three seconds after the collision.

Internal distraction

- 45 The driver may have been distracted by his own thoughts; this is sometimes referred to as 'mind-wandering' or daydreaming. Conclusions from research into the effect of mind wandering on driving include:
- Mind wandering while driving, by decoupling attention from visual and auditory perceptions, can jeopardise the ability of the driver to incorporate information from the environment, thereby threatening safety on the roads¹¹.
 - Compared to when on-task, when mind-wandering, participants showed longer response times to sudden events, drove at a higher velocity, and maintained a shorter headway distance ... Collectively, these findings indicate that mind-wandering affects a broad range of driving responses and may therefore lead to higher crash risk ... The results suggest that situations that are likely associated with mind-wandering (eg route familiarity) can impair driving performance¹².

Possible distraction external to the cab

- 46 It is possible that the driver was distracted by something outside the cab, although no obvious distraction is evident in the forward facing CCTV footage. The sun was almost directly ahead of the tram (figure 6) and the driver stated that he might have had the sun in his eyes. However, the RAIB measured the effect of the sun angles relative to the geometry of the driving cab, and concluded that the cab roof would have shielded the driver's eyes from direct sunlight (the sun visor was also lowered at the time of the accident (figure 10)).



Figure 10: View of the tram's driving cab following the accident, showing position of the sun visor (courtesy MRDL)

¹¹ 'Mind wandering and driving: responsibility case-control study', Cédric Galéra, Ludivine Orriols, Katia M'Bailara, Magali Laborey, Benjamin Contrand, Régis Ribéreau-Gayon, Françoise Masson, Sarah Bakiri, Catherine Gabaude, Alexandra Fort, Bertrand Maury, Céline Lemercier, Maurice Cours, Manuel-Pierre Bouvard and Emmanuel Lagarde. *BMJ* 2012;345:e8105.

¹² 'Driving With the Wandering Mind: The Effect That Mind-Wandering Has on Driving Performance', Matthew R. Yanko and Thomas M. Spalek. *Human Factors* Vol. 56, No. 2, March 2014.

Possible distraction within the cab

- 47 Once the tram had left the tram stop, the only task inside the cab that might have diverted the driver's attention from the route ahead was occasional checking of the speedometer (paragraph 32e). The RAIB considers that this is unlikely to have been a significant distraction for an experienced driver. MRDL has been unable to confirm whether or not there was any radio communication with the driver during this period, although there is no particular reason for there to have been such communication. The CCTV from the tram saloon does not reveal any significant movement of the driver's head between the time that the tram started to move and the collision; this lack of movement provides no evidence to determine whether the driver was distracted by something in the cab.

Consideration of other possible factors

- 48 There are other possible explanations as to why the driver did not observe the pedestrian walking along the track towards Piccadilly Gardens, ahead of the tram. Three possibilities are discussed below, but the RAIB has found no evidence to suggest that they caused or contributed to the accident:
- a. The driver might not have been expecting a pedestrian to be walking along in front of the tram. The nature of the location is such that pedestrians routinely walk in front of trams; the driver was experienced and MRDL has advised that drivers are trained to anticipate pedestrian behaviour.
 - b. The driver might have subconsciously assumed that the tram would turn right on departure from Market Street (see footnote 9 to paragraph 40). Drivers' duties include checking the points position indicator and the lie of the points in order to confirm their route before departing from Market Street tram stop. In addition, the collision occurred approximately four seconds after the tram would have started turning to the right if it had been routed towards St Peter's Square; this would have allowed sufficient time for the driver to observe the pedestrian on the Piccadilly Gardens track.
 - c. The driver might briefly have lost consciousness. The RAIB has seen no evidence of any medical condition or medication that might have caused such a loss of consciousness, or that the driver might have been fatigued.

Observations

The chain of care for the tram driver

- 49 **The tram driver was put in a position where he drove a road vehicle back to the depot after the accident.**
- 50 The crew supervisor had driven to Market Street in a company van and was acting as both incident officer, which required him to manage the effects of the accident on the tram service, and investigator, in which capacity he was gathering evidence for the subsequent investigation.

- 51 Once Greater Manchester Police (GMP) gave permission for the tram to be moved, the crew supervisor drove it back to the depot. This left the tram driver with the member of the operations planning department (paragraph 22). Witness evidence indicates that there was a lack of clarity as to whether the other staff member would have been covered by the company's insurance to drive the van. The crew supervisor stated that he discussed the situation with the control room and that he believed that the driver would not have to drive himself back, although this is what subsequently happened. The RAIB considers that this was undesirable given his recent involvement in the accident. There was nothing in MRDL's procedures to prevent this.

MRDL's internal investigation

52 More than three weeks elapsed between the date of the accident and MRDL establishing an accurate understanding of the circumstances under which it had occurred.

- 53 MRDL's procedure 'Metrolink Accident / Incident Investigation', Ref. PROC 0165, required a formal investigation to be carried out for serious accidents, including those that result in a fatality or serious injury. Less serious accidents may be subject to a local investigation, which should be completed within 48 hours of an accident occurring. MRDL has advised the RAIB that it considers it is usually obvious when a formal investigation is required, although there is no defined decision point for escalation from a local to a formal investigation.
- 54 The crew supervisor carried out a local investigation into the accident on 12 May 2015; the report was issued on 15 May and was signed as 'accepted' by MRDL's Head of Drivers on 26 May. This did not identify the serious nature of the accident and concluded that the pedestrian had walked into the side of the tram. This had been the understanding shared on site by GMP, the paramedic, the driver, the operations planner and the crew supervisor, although the RAIB has been unable to ascertain how this understanding was reached. In addition, the report listed CCTV from the tram as part of its supporting evidence, implying that the crew supervisor had reviewed this. He had requested that the forward facing CCTV should be downloaded in an email to the control room (and others) on 13 May, but he had not received it before he issued the report. The CCTV was not downloaded until 5 June, following requests by both GMP and the RAIB.
- 55 CCTV from a tram is downloaded by swapping a data storage device and has to be done when the tram returns to the depot (usually at night). A request for the CCTV would normally be logged on the tram maintenance database by a network planning manager in the control room; there would be no indication to an investigator that this had been done and there was no fixed timescale for the recording to be made available to an investigator. The crew supervisor's request for the forward facing CCTV to be downloaded on 13 May was not entered on the tram maintenance database. MRDL has been unable to explain why this did not happen.

- 56 The serious nature of the accident became apparent to MRDL only when GMP notified it of the pedestrian's serious injuries on 2 June; MRDL subsequently notified the RAIB on 4 June. The crew supervisor had been off duty for three weeks and was shown the forward facing CCTV on 8 June, after his return to work. He then carried out a second local investigation into the accident, and issued the report on 17 June. This concluded that the tram driver stated he did not see the pedestrian due to the angle of the sun.
- 57 MRDL's Director of Safety & Quality has subsequently carried out a formal investigation and issued a report on 18 November 2015. This MRDL report concluded:
- the immediate cause was that the pedestrian was walking along the tramway in front of the tram when he was struck by the vehicle;
 - the underlying cause was that the driver failed to see the injured party walking in front of his tram; and
 - that the root cause was driver error.

MRDL's driver management

58 MRDL's arrangements for managing its drivers do not include any mechanism for periodic reviews of driver performance with a line manager.

- 59 The requirements for managing the competence of its tram drivers are set out in MRDL's procedure PROC 0076 'Minimum Requirements and Maintenance of Standards for Tram Drivers'. This requires drivers to receive refresher training, including training in rules and regulations, and have a formal in-cab assessment of their driving skills every two years.
- 60 MRDL's drivers are organised into 'mentor groups', each of which is overseen by one of sixteen crew supervisors who report to the driver manager; each mentor group consists of about thirty drivers. MRDL's safety management system requires that all employees should have a formal performance appraisal every twelve months. Witness evidence indicates that crew supervisors stopped holding annual appraisals with each of their drivers about three years ago due to the increased workload resulting from Metrolink's expansion. As a consequence, there is no longer a formal annual opportunity for an individual driver to discuss any issues that they might have with their crew supervisor. Instead, drivers are able to raise issues or concerns at the start of each shift, when booking on with the crew supervisor on duty. Witness evidence indicates that drivers do take advantage of this opportunity although it is unclear whether it is as effective as the formal appraisals mandated by the safety management system.
- 61 PROC 0076 also requires MRDL to have a proactive system to identify drivers with the potential to cause unacceptable risk to its tram operations. The driver manager advised that this is fulfilled by unobtrusive monitoring of driving standards: from Monday to Friday a crew supervisor is rostered to travel on trams and identify any issues with driving standards.
- 62 The RAIB does not consider that a deficiency in MRDL's driver management processes was one of the causes of the accident on 12 May 2015. The record of the driver involved provided no evidence of a persistent problem of inattentiveness, and it is unlikely that any management system would be able to prevent an occasional loss of concentration by a driver.

MRDL's risk assessment

63 MRDL's risk assessment did not identify the dominant contributors to the overall level of risk from tram operations in the pedestrianised area.

64 MRDL issues a 'Service Review Report' every four weeks. This includes twelve key performance indicators (KPIs) for safety issues, which are discussed with TfGM. One of these KPIs is 'Metrolink blameworthy RTCs', covering accidents with both vehicles and pedestrians occurring on on-street sections of tramway. Although the report refers to non-blameworthy RTCs, there is no KPI that includes either near misses or accidents deemed to have been caused by a party other than MRDL.

65 MRDL does not routinely aggregate statistics on pedestrian accidents occurring in pedestrianised areas, whether 'blameworthy' or not; this would be needed in order to understand the risk fully. The RAIB has reviewed data provided by MRDL for 2004-2014 and compiled a chart showing accidents and near misses between trams and pedestrians in the pedestrianised area near Piccadilly Gardens (figure 11)¹³. In absolute terms, the data records an average of five accidents and eight near misses per year over the eleven year period (it does not record the severity of any resulting injuries). Data supplied by TfGM indicates that the average footfall for Market Street and Piccadilly Gardens is approximately 20 million pedestrians per year.

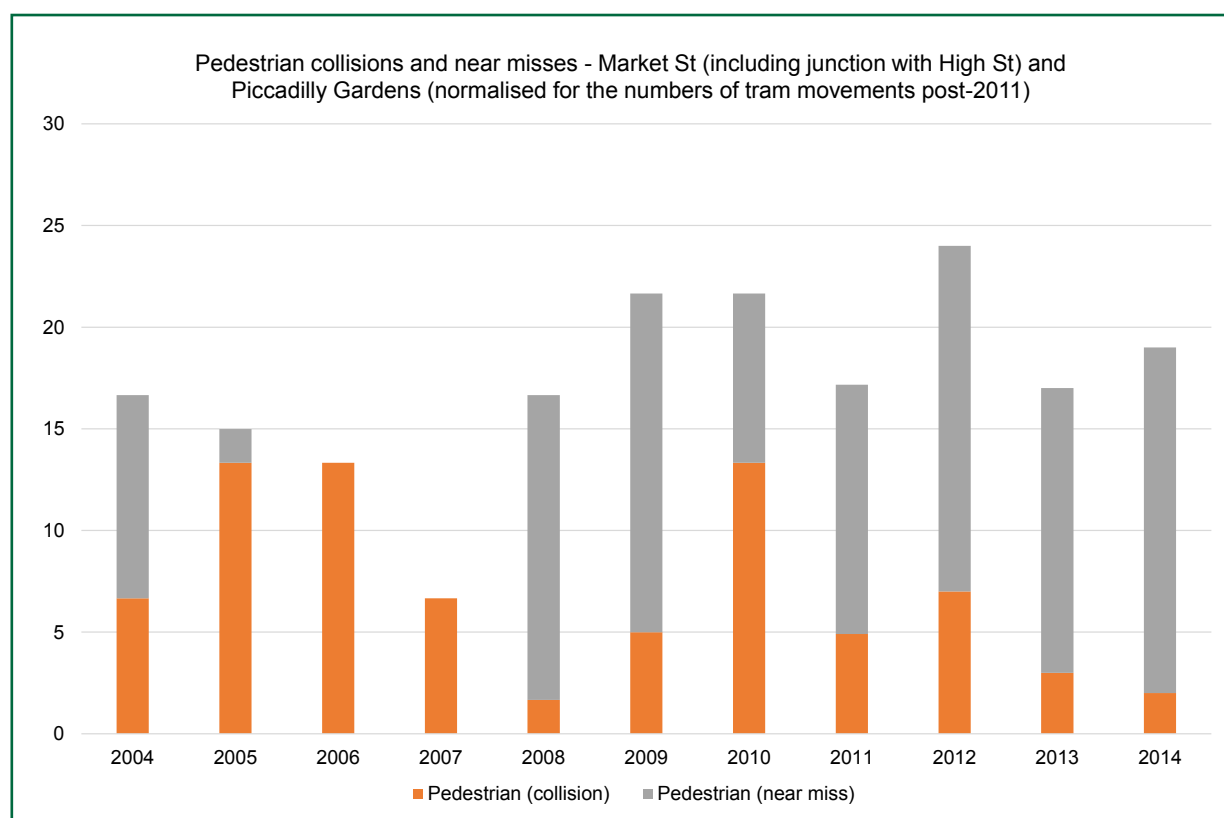


Figure 11: Collisions and near misses in pedestrianised area

¹³ This includes blameworthy and non-blameworthy incidents. The data has been normalised for the numbers of tram movements through the Market Street tram stop following the introduction of the new timetable in 2011 (ie the number of incidents has been scaled up in inverse proportion to the lower number of trams that were operating pre-2011).

- 66 UK Tram has advised the RAIB that comparative data for the operation of trams through pedestrianised areas in other cities in the UK and Europe is not available. This is due both to differences in the operation of such areas in different cities and in the way data is gathered.
- 67 Following a fatality at the Market Street tram stop in January 2014, MRDL, in conjunction with TfGM and the city council, assessed the risk associated with operating trams through Market Street. An extract from this risk assessment is included at paragraph G1 of appendix G, showing those activities that explicitly refer to pedestrians. The activity that is most relevant to the accident on 12 May 2015¹⁴, ‘pedestrians entering the swept path along footpaths’, has been given a severity score of 4 (high) whereas other pedestrian accidents have severities of 5 (very high). The effect of the control measures identified is to reduce the likelihood of each of the pedestrian activities from 5 (very likely – if corrective measures not taken) to 1 (not likely – no significant risk present¹⁵). As a result, the risk associated with each of these activities has individually been assessed as either low (broadly acceptable – additional controls only required if simple to implement) or medium (tolerable – risk is acceptable provided all reasonably practicable control measures have been implemented).
- 68 It is not clear how the authors of the risk assessment justified their conclusion that the identified control measures changed the level of risk from critical to low/medium; this is an inherent difficulty with semi-quantified risk assessments in which judgements are applied. The rate at which accidents and near misses actually occur (paragraph 65) indicates that the likelihood of a pedestrian accident occurring is significantly higher than the risk assessment included at paragraph G1 of appendix G concludes.
- 69 A separate high level risk assessment contains one hazard relevant to pedestrians; this is shown at paragraph G2 of appendix G. This does not identify causes such as pedestrian factors (eg awareness of the swept envelope, awareness of an individual tram, misjudgement, risk-taking) or driver factors (eg loss of concentration, misjudgement). Consequently the RAIB considers that it cannot be used to determine the effectiveness of the control measures in the pedestrianised area.
- 70 Elements of the risk assessment methodology are confused. An assessment of risk normally requires two components to be considered individually: the frequency / probability of an undesirable event occurring (such as a person being struck by a tram) and the consequences of that undesirable event. The outcome can then be expressed as a level of harm over a given period, eg fatalities / year. Although the risk assessment methodology applied to tram operations in Manchester does include consideration of these two factors (referred to as ‘likelihood’ and ‘severity’, paragraph G3 of appendix G), the definitions applied to their ranking are confused:
- the definition applied to a ‘possible’ likelihood of occurrence is ‘probability low and significant risk minimal’; and

¹⁴ The accident occurred after the tram had left Market Street tram stop.

¹⁵ The RAIB observes that this confuses likelihood (probability) with ‘risk’. Risk is normally considered to be the product of probability and consequence.

- the definition applied to a ‘not likely’ likelihood of occurrence is ‘no significant risk present.’

These definitions cannot be logically applied because risk can be evaluated only once likelihood and severity have been combined. The risk associated with a not likely event may actually be relatively high if the outcome is always severe.

- 71 A further difficulty with this approach is that it breaks the risk from tram operations through the pedestrianised area down into a series of sub-hazards (activities), each of which is assessed separately and deemed to have an associated low level of risk. This process is essentially qualitative and does not help to determine whether the overall level of risk arising from tram operations in the pedestrianised area is tolerable. Furthermore, it does not identify which of the hazards are the dominant contributors to that risk. Such intelligence might help in determining whether and what type of additional risk mitigation might be desirable.

Tramway design guidance

72 The tramway design guidance documents provide little specific content on shared space environments.

- 73 RSP2 is the principal document providing guidance on tramway design in the UK (paragraph 26)¹⁶. Beyond the section on demarcation of the tramway discussed at paragraph 31, the only specific guidance in RSP2 that is directly relevant to a shared space such as Piccadilly Gardens is that crossing points in ‘pedestrian zones’ should be marked with a dropped section and have tactile surfaces. RSP2 also states that for ‘streets which have high densities of pedestrians, the pedestrians should be encouraged to use defined crossing points over the tram track ... These crossings should be designed so that they are obviously the safest crossing point.’ ORR states that this is applicable to a shared space environment. As discussed at paragraph 32g, the RAIB has observed that pedestrians move freely throughout this area.
- 74 The more detailed technical guidance note TTGN2 ‘Pedestrian Safety’ (paragraph 26), does not refer explicitly to shared space or pedestrianised areas. It refers to areas requiring pedestrian access (typically a pedestrian crossing), areas where pedestrians should be discouraged from walking and areas where pedestrians are prohibited. TTGN2 is based on the principle of keeping pedestrians and trams separated as far as possible, and does not reflect the nature of the Piccadilly Gardens area.
- 75 In addition to the UK guidance notes, COST (European Cooperation in Science and Technology) has published ‘Operation and safety of tramways in interaction with public space’ (ref. TU1103). This report acknowledges that pedestrian behaviour ‘is problematic and causes accidents with trams: distractions due to mobile phone use, jaywalking’. It also identifies risk mitigation measures adopted by various European tramways (see appendix E). The measures identified for shared spaces include limiting tram speeds to 10 - 25 km/h (6 - 16 mph) and differentiating the surface of the tramway by its texture or colour and material.

¹⁶ As noted at footnote 3 to paragraph 26, detailed guidance on the use of road markings is contained in the Traffic Signs Manual.

- 76 The Department for Transport has published 'Shared Space', a local transport note (ref. LTN 1/11), which is intended to assist those 'designing and preparing street improvement and management schemes' involving shared space. However this document makes only passing references to buses and no specific reference to trams.

Previous occurrences of a similar character

- 77 The RAIB has previously investigated accidents between trams and pedestrians that occurred at:
- Staniforth Road, Sheffield, on 27 October 2005 ([RAIB report 01/2006](#));
 - Norbreck, Blackpool, on 5 August 2009 ([RAIB report 09/2010](#));
 - Piccadilly Gardens, Manchester, on 5 June 2011 ([RAIB report 08/2012](#));
 - Sandilands tram stop, Croydon, on 16 May 2012 ([RAIB report 03/2013](#)); and
 - Bayles and Wylies footpath crossing, Nottingham, on 28 November 2012 ([RAIB report 19/2013](#)).

The circumstances of these accidents are not directly relevant to this investigation.

Summary of conclusions

Immediate cause

78 The pedestrian was in the path of the tram as it approached (**paragraph 35**).

Causal factors

79 The causal factors were:

- a. the pedestrian did not move out of the path of the tram as it approached (**paragraph 36, Recommendation 2**).
- b. the driver did not apply the tram's brakes in time to avoid striking the pedestrian (**paragraph 41, see paragraph 83 and Recommendation 2**).

Additional observations

80 Although not considered to be causal factors, the RAIB observes that:

- a. The tram driver was put in a position where he drove a road vehicle back to the depot after the accident (**paragraph 49, Recommendation 1**).
- b. More than three weeks elapsed between the date of the accident and MRDL establishing an accurate understanding of the circumstances under which it had occurred (**paragraph 52, see paragraph 81**).
- c. MRDL's arrangements for managing its drivers do not include any mechanism for periodic reviews of driver performance with a line manager (**paragraph 58, Learning point 1**).
- d. MRDL's risk assessment did not identify the dominant contributors to the overall level of risk from tram operations in the pedestrianised area (**paragraph 63, Recommendation 2**).
- e. The tramway design guidance documents provide little specific content on shared space environments (**paragraph 72, Recommendation 3**).

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

- 81 MRDL has reissued its accident investigation procedure. This now includes a requirement for an accident investigator to decide whether a local investigation should be escalated to a formal one (to be signed off by their line manager). It also includes a checklist that details the information required by an investigator, such as CCTV from a tram; the checklist provides confirmation that the relevant action has been completed (paragraph 80b).

Other reported actions

- 82 UK Tram has developed and implemented a new database for the reporting of accidents and incidents involving trams. The requirements were developed partially in response to Recommendation 1 of [RAIB report 08/2012](#) (Fatal accident at Piccadilly Gardens, Manchester, 5 June 2011). This read as follows:

UK tram operators should work together to improve the data collection on tram front end collisions with pedestrians. This is to include greater detail on the type and severity of any injury received as far as possible, and the likely points of contact with the tram.

- 83 MRDL carried out a joint review of the Piccadilly Gardens end of Market Street tram stop on 19 August 2015, together with TfGM and Manchester City Council. This included a qualitative assessment of the risk at the location, taking account of the high footfall, and considered possible additional mitigations.
- 84 MRDL investigated the accident and took disciplinary action against the driver. The driver was also prosecuted and pleaded guilty to driving without due care and attention at Manchester and Salford Magistrates' Court.

Learning point

85 The RAIB has identified the following key learning point¹⁷:

- 1 Regular reviews and/or appraisals with tram drivers undertaken by a line manager or other competent person are important for identification and follow-up of any issues that might affect their driving performance.

¹⁷ '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.

Recommendations

86 The following recommendations are made¹⁸:

- 1 *The intent of this recommendation is to improve MRDL's care of drivers and other staff involved in an accident.*

Metrolink RATP Dev Ltd should improve its process of providing for the welfare of staff who have been involved in potentially traumatic incidents. This should include immediately releasing them from safety critical activities as well as arranging for them to be accompanied to an appropriate location. It should also contain provisions for support and/or counselling, taking account of the possibility that the individual may need to provide evidence to investigating authorities (paragraph 80a).

continued

¹⁸ 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 ORR 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.

- 2 *The intent of this recommendation is to promote a further examination of the need for additional risk control measures in the Piccadilly Gardens area.*

Metrolink RATP Dev Ltd in conjunction with Transport for Greater Manchester should review the effectiveness of risk mitigation measures associated with tram operations through the pedestrianised area in the vicinity of Piccadilly Gardens. This review should include:

- reference to previous risk assessments;
- identification of the dominant contributors to the overall level of risk;
- historical experience of accidents and near misses in this area (based on collation of existing data); and
- the experience and knowledge of tramway staff, including drivers.

The findings of this review should be used to identify and evaluate possible additional mitigation measures. Any that are considered to be reasonably practicable should then be programmed for implementation (paragraphs 79a, 79b and 80d).

- 3 *The intent of this recommendation is for guidance on tramways explicitly to promote measures to evaluate and manage the risk to pedestrians arising from the operation of trams through pedestrianised areas such as Piccadilly Gardens.*

UK Tram should, as part of revising guidance for the design and operation of urban tramways, make explicit provision for the management of risk in areas where trams and pedestrians/cyclists share the same space. This should include:

- guidance on the collection and collation of data on accidents and incidents;
- the types of hazards to be considered;
- methods of risk assessment; and
- examples of design and operational measures for mitigating the risk.

(paragraph 80e)

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed circuit television
GMP	Greater Manchester Police
KPI	Key performance indicator
LTN 1/11	Department for Transport local transport note 'Shared Space'
MRDL	Metrolink RATP Dev Ltd
ORR	The Office of Rail and Road
OTMR	On tram monitor and recorder
RSP2	ORR railway safety publication 'Guidance on Tramways'
RTC	Road traffic collision
TfGM	Transport for Greater Manchester

Appendix B - Glossary of terms

Crew supervisor	A person with the first level of management responsibility for a team of drivers.
Defensive driving	A driving technique which actively encourages drivers to anticipate hazards and respond appropriately to operating and environmental conditions.
Line of sight (taken from RSP2)	A mode of operation in which a tram should be able to stop before a reasonably visible stationary obstruction ahead from the intended speed of operation, using the service brake.
Off-street tramway	A section of tramway in which both the track and the alignment are separated from any highway (see appendix D).
On-street tramway	A section of tramway in which the rails are laid either in the surface or within the boundaries of a highway. Such sections may be either 'integrated' or 'segregated' (see appendix D).
Points position indicator	An illuminated signal providing the driver with an indication of the direction in which the points are lying.
Road traffic collision (based on the Road Traffic Act 1988)	<p>An accident involving a mechanically-propelled vehicle on a road or other public place which causes:</p> <ul style="list-style-type: none"> • personal injury to a person other than the driver of the vehicle; • damage to a vehicle other than the vehicle which caused the accident; • injury or damage to an animal, other than one being carried on the vehicle; or • damage to property constructed on, affixed to, growing in, or otherwise forming part of the land on or adjacent to which the road is situated.
Shared space (taken from LTN 1/11)	A street or place designed to improve pedestrian movement and comfort by reducing the dominance of motor vehicles and enabling all users to share the space rather than follow the clearly defined rules implied by more conventional designs.

Appendix C - Investigation details

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

- information provided by witnesses;
- information taken from the incident tram's data recorder (OTMR) and comparative data from other trams;
- forward facing closed circuit television (CCTV) recordings taken from the incident tram;
- site photographs and measurements;
- weather reports;
- observations of the Market Street environment by human factors specialists;
- the tram driver's personnel records;
- MRDL data on past accidents and incidents;
- MRDL procedures; and
- a review of previous RAIB investigations that had relevance to this accident.

Appendix D - Extract from 'Guidance on Tramways' ORR Railway Safety Publication 2

DEFINITION OF TRAMWAY

- 16 For the purposes of this guidance, 'tramway' means a system of transport used wholly or mainly for the carriage of passengers, employing parallel rails which provide support and guidance for vehicles carried on flanged wheels, and in respect of which:
- (a) the rails are laid in a place to which the public have access; and
 - (b) on any part of the system, the permitted speed of operation of the vehicles is limited to that which enables the driver of any such vehicle to stop it within the distance he can see to be clear ahead (in this document [RSP2], referred to as 'operation by line-of-sight' and considered further in paragraph 22 and Chapter 7).
- 17 For the purposes of this guidance, tramways falling within the definition in paragraph 16 have been divided into three categories: integrated on-street tramways, segregated on-street tramways, and off-street tramways.

Integrated on-street tramways

- 18 In this category:
- (a) operation is by line-of-sight;
 - (b) the rails are laid in the highway; and
 - (c) the part of the highway occupied by the rails is capable of being used by other vehicles or by pedestrians.

Note: In this category, access to the tramway by others may be restricted, for example to pedestrians only, buses only or for access only.

Segregated on-street tramways

- 19 In this category (see also paragraph 89 of [RSP2] Chapter 2):
- (a) operation is by line-of-sight;
 - (b) the rails are laid within the boundaries of a highway; and
 - (c) the part of the highway occupied by the rails may be crossed by pedestrians, and by other vehicles at designated crossing points, but is not normally shared with other road vehicles except vehicles for maintenance purposes.
- 20 Integrated on-street tramways and segregated on-street tramways are together referred to as 'on-street tramways' for the purposes of this guidance.

Off-street tramways

- 21 In this category:
- (a) operation is by either line-of-sight or signalled, or by a combination of the two;
 - (b) the track is wholly segregated from any highway; and
 - (c) the alignment is wholly separate from any highway.

Appendix E - Extract from 'Operation and safety of tramways in interaction with public space,' European Cooperation in Science and Technology publication Ref. COST TU1103

9.5.4.1 Pavement treatment in shared space

One way of inserting the light rail system into the urban fabric is the use of streets that are dedicated to pedestrians, cyclists (in this case) and the light rail system itself. Speed must be limited on these zones to values around 10---25 km/h, in order to avoid incidents/accidents from happening.

Another way of improving safety in this kind of street is to use the surface of the pavements in order to ensure that pedestrians and cyclists are well aware of the presence of light rail vehicles running in the street. This pavement differentiation can be achieved by means of its texture or by means of its colour and material.

Appendix F - Extract from Metrolink RATP Dev Ltd 'Rule Book,' Ref. 1614 Issue 02, August 2014

D.14 TRAM HORN

- D.14.1 When staff are working on or near the line, Drivers must remain alert to their presence and sound warnings of their approach on the tram horn.
- D.14.2 Drivers must sound one long blast on the horn when:
- approaching staff working on or about the line
 - approaching other persons dangerously near the line
 - as dictated by track side signs
 - passing a signal at danger; and
 - when non-stopping at a station to warn any passengers on the platform
- D.14.3 Drivers must sound one short blast on the horn:
- before moving off in a depot or siding, or crossing any walkway
 - before moving an Engineers Train working within a Possession; and
 - acknowledging a hand signal as defined in C.2.3 AND D.13.
- D.14.4 A series of short sharp blasts on the horn will indicate a warning of danger.
- D.14.5 When street running, Drivers must act in accordance with Rule J.5.
- D.14.6 In order to prevent annoyance to passengers on stations and residents in the vicinity of Metrolink, Drivers must only sound the horn as required by the Rules and Regulations.

J.5 USE OF THE WHISTLE

The whistle must be used by the Driver when necessary to safeguard the safety of:

- passengers
- other road users
- pedestrians; and
- himself

More specifically the whistle must be used:

- in compliance with any fixed warning sign
- on the approach to a crowded platform
- entering or leaving an enclosed area
- when passing another tram, or passing or overtaking other road vehicles
- when passing through an area of intense pedestrian activity
- when moving off from a stand
- when entering a sharp curve
- to attract the attention of the driver of a road vehicle obstructing the passage of the tram; and
- in an emergency - a series of short blasts.

Drivers must avoid unnecessary use of the tram whistle, especially between the hours of 23:00 and 07:00 and take into consideration residential areas.

Appendix G - Extracts from Metrolink RATP Dev UK Risk Assessments

G1 Extract from risk assessment RA-OPS_0078 'Operating trams through Market Street Stop'

Department: Operations		Activity: Operating trams through Market Street Stop						
Note - generic risks that are very similar to those elsewhere on the system are not covered in this assessment. This risk assessment reviews the action of normal actions of members of the public.								
General mitigations in place		Driver Training?? Tramstop design, signage, line of sight, permit to work, speed, tram design, PA,s Customer Services Representative's Event planning,						
Activity	Hazard	L	S	R	Control Measures	L	S	R
Pedestrians under the influence	Pedestrian struck by tram	5	5	25	Tram driver training / Customer Services Representative / Tram CCTV / Tramstop CCTV / Media campaigns / Bye laws / Signage / PA	1	5	5
Pedestrians/ passengers during special events	Pedestrian struck by tram / Mobility vehicle struck by tram / Crushing	5	5	25	Tram driver training / PA & PIDS / Customer Services Representative / Tram CCTV / Tramstop CCTV / Event Management plan	1	5	5
Pedestrians hurrying towards the stop from shops, etc in the vicinity of the stop	Pedestrian struck by tram / Pedestrian struck by vehicle	5	5	25	Tram driver training / System speed / Line Of Sight / Signage / Pedestrian crossing / Road Markings / Lighting / Tram Audible warnings	1	5	5
Pedestrian crossing at outbound end ignored by pedestrians	Pedestrian struck by tram / Pedestrian struck by vehicle	5	5	25	Tram driver training / System speed / Line Of Sight / Signage / Pedestrian crossing / Road Markings / Lighting / Tram Audible warnings	1	5	5
Pedestrians falling between double tram unit gap	Falling between tram	5	4	20	Lighting / Tactiles / White Lines	1	4	4
Mobility scooters, pushchairs, wheelchairs restricting pedestrian movement	Pedestrian falling off platforms / Pedestrian hit by tram	5	5	25	Lighting / Tactiles / White Lines	1	5	5
Pedestrians entering the swept path along footpaths	Pedestrian collision	5	4	20	Tram driver training / System speed / Line Of Sight / Tramstop Markings / Lighting / Tram Audible warnings / Internal staff training	1	4	4
Pedestrian distraction ¹⁹								

Key: L: Likelihood; S: Severity; R: Risk

¹⁹ The assessment for this activity is incomplete.

G2 Extract from risk assessment SYST 0021 'Operating trams in Manchester City Centre under TMS Signalling Control'

DEPARTMENT: Driver, NMC		ACTIVITY: Operating trams in Manchester City Centre under TMS Signalling Control						
EQUIPMENT SUPPLIED: City Centre street running Tramway with trams, UTC type signals, points and crossings with PPI, UTC signals and road vehicle and Pedestrian interaction.								
CURRENT PPE SUPPLIED: High visibility clothing, safety footwear.								
TRAINING OR INSTRUCTIONS RECEIVED: Metrolink rule book, personal track safety, LRV Driver training, Controller training, Points operation, Driver's Manual, Operational briefings. P-way training, Electrical training, Signal and telecommunications training, Contractor PTS training.								
Hazard	Without Control Measures	Severity	Likelihood of Occurrence	Risk factor	Control Measures	Severity	Likelihood of Occurrence	Risk factor after action
Public Interface	Mosley Street platform closed and removed. When trams stop to activate the RTS at the UTC Driver inadvertently enables the tram doors.	4	3	12	Driver training, driver competence. Staff briefing. Good sight lines. Platform barriered off to prevent access. Platform barriers remind drivers the platform is closed. Platform to be demolished and removed in a timely manner. UTC to be approach released.	4	2	8

G3 Criteria used by MRDL and TfGM to determine the acceptability of risks assessed in RA_OPS_0078:

'HAZARD SEVERITY' should be assessed on a scale of 1 - 5 as follows:	
5	Very high Causing death, multiple deaths or widespread destruction.
4	High Causing reportable injury, absent from work for 7 days or more.
3	Moderate Causing injury or disease, absent from work, lost time.
2	Slight Causing minor injury. First aid treatment. No lost time.
1	Nil No significant risk of injury or disease
'LIKELIHOOD OF OCCURRENCE' should be assessed on a scale of 1 - 5 as follows:	
5	Very likely If corrective measures not taken
4	Likely Probable only, requires additional factor (e.g. carelessness, bad weather etc.)
3	Quite possible Additional factors could precipitate, but unlikely without such factors
2	Possible Probability low and significant risk minimal
1	Not likely No significant risk present
Severity rating and action priority to attain acceptable ALARP	
1 - 4	Low Broadly acceptable. Additional controls only required if simple to implement
5 - 12	Medium Tolerable. Risk is acceptable provided all reasonably practicable control measures have been implemented
15 - 16	High Unacceptable except in special circumstances where there is no reasonable alternative way of carrying out task. Must be subject to close supervision and regular review
20 - 25	Critical Not acceptable. Task may only be carried out if additional controls can be implemented to reduce the risk to a lower band

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