

Rail Accident Report



**Near miss of two track persons by a tram on
the Manchester Metrolink, Radcliffe
8 November 2005**

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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Near miss of two track persons by a tram on Manchester Metrolink, Radcliffe 8 November 2005

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Introduction

- 1 The sole purpose of an investigation by the Rail Accident Investigation Branch (RAIB) is to prevent future accidents and incidents, and improve railway safety.
- 2 The RAIB does not establish blame or liability, or carry out prosecutions.
- 3 Access was freely given by Serco Metrolink to staff, data and records for the purposes of this investigation.
- 4 Appendices at the rear of the report contain Glossaries explaining the following:
 - acronyms and abbreviations are explained in the Glossary at Appendix A; and
 - certain technical terms (shown in *italics* when they first appear in the body of this report) are explained in the Glossary at Appendix B.

Summary

Key facts about the incident

- 5 During the morning of 8 November 2005 at approximately 09:08 hrs, two track persons were replacing a pair of *fishplates* in the *segregated section* of the Manchester Metrolink system between Bury and Manchester Victoria.
- 6 The track persons were given inadequate warning of the approach of a tram and reached a position of safety with only seconds to spare. The tram then struck a large tool laid in the *four foot* that the track persons had insufficient time to retrieve.
- 7 After the incident, communications between the control room, tram drivers and the track persons became confused. No party reached a clear understanding and neither trams nor the worksite were protected while work was completed. Normal running resumed when the fishplates had been satisfactorily replaced.

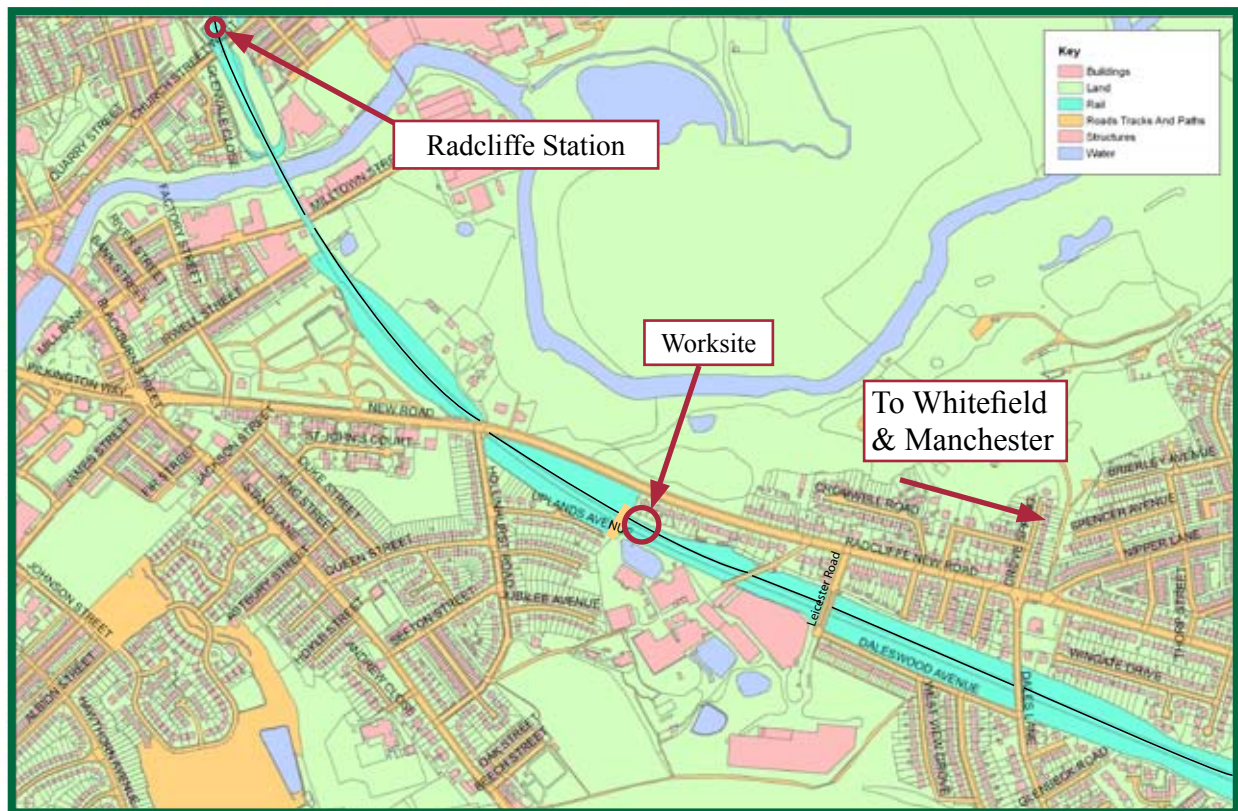


Figure 1: Extract from Ordnance Survey map showing location of incident

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Immediate cause, contributory factors, underlying causes

- 8 The immediate cause of the incident was the inadequate *safe system of work* that was adopted. Particularly, there was insufficient time available for a *lookout* to sight an approaching tram and give warning to the track persons.

9 Contributory factors were:

- The lookout gave a late verbal warning notwithstanding the insufficient sighting time available.
- The tram driver gave only a short duration audible warning.
- The tram driver applied the service brake but not the emergency brake.
- There was no risk assessment for the task of replacing fishplates so the most severe hazard with the fishplates removed, equivalent to a rail break, was neither identified nor measures prescribed to safeguard traffic from this hazard.
- The control room was not aware that members of the Permanent Way Department were undertaking work on or about the railway system at the time of the incident and therefore could not provide protection for track persons and trams.
- The *Person in Charge* (PIC) was inexperienced with respect to work on the segregated section.

10 Underlying causes were:

- the absence of structured, formal mentoring and supervision for inexperienced Permanent Way Department staff;
- the absence of a single source of documented information on Serco Metrolink system hazards for use in the planning of safe systems of work;
- the use of working practices outside Serco Metrolink procedures and Rule Book requirements;
- the absence of a system to monitor and audit safe system of work arrangements to ensure their adequacy.

Severity of consequences

- 11 The severity of the potential consequences increased, because after the incident, subsequent trams approached the worksite at linespeed and were stopped on sight of a red flag.

Key conclusions

- 12 Two track persons came within seconds of being struck by a tram because an inadequate safe system of work was adopted. Further unsafe events occurred as other trams were permitted to operate normally toward the worksite while the repair work continued.

Recommendations

- 13 Recommendations can be found at paragraph 88 and are directed at (i) compliance with the existing Serco Metrolink Rule Book and procedures, and (ii) the incorporation of industry best practice to improve the Serco Metrolink Rule Book and procedures.

The incident

Background

14 The organisation:

- Metrolink is owned by the Greater Manchester Passenger Transport Executive (GMPTE) who granted the concession to Altram (Manchester) Ltd. Metrolink is maintained and operated by Serco Metrolink under contract to Altram.
- Serco Metrolink is the provider of all operations and maintenance services. At the time of the incident, Serco Metrolink was the duty holder under the Railway Safety Case Regulations with respect to infrastructure, train and station operations.

15 The operation:

- Metrolink serves 37 tram stops. Some are former railway stations (eg Whitefield). The remainder are purpose built stops. Trams run every 6 minutes Monday to Saturday daytime on the Bury and Altrincham lines and every 12 minutes between the city centre and Eccles.
- Control of tram movements on street running sections is by 'Line of Sight' operation. Drivers must be prepared to stop within the distance that can be seen to be clear while considering the presence of other road vehicles and pedestrians on or about the track. Control of tram movements on the segregated sections is by *Track Circuit Block* principles and two *aspect* colour light signalling.

16 The infrastructure:

- Manchester Metrolink was built in two phases. Phase 1 from Bury in the north to Altrincham in the south opened in 1992. The line was converted from main line railway routes and was linked across the city centre by a street-running section from Victoria station to G-Mex. A spur connected Piccadilly Gardens and Piccadilly main line station. Phase 2a from Cornbrook to Broadway opened in 1999. Phase 2b from Broadway to Eccles opened in 2000. The current network is 39 km long, 25 per cent of which is street-running.
- The track between Bury and Manchester is a mixture of 60 ft (18.29 m) *bullhead* and *flat bottom* rail fixed to *sleepers* laid on *ballast*.
- The Metrolink is electrified via an overhead line equipment (OLE) system at 750 V DC from which trams draw current through a *pantograph* able to adjust to varying heights of wire.
- Serco Metrolink use Network Rail specifications for permanent way defect identification, immediate action and subsequent correction.

17 The trams:

- The passenger rolling stock comprises 32 Light Rail Vehicles (LRVs or trams): 26 type T68 and T68M trams were built for phase 1; 6 type T68A trams were built for phase 2. The trams are owned by GMPTE and maintained and operated by Serco Metrolink. All trams are identified by a unique four digit number.
- The incident involved tram number 1016, crew duty number 113, journey number 12AD. The tram was working the Bury – Altrincham route.

- Events following the incident involved (i) tram number 1020, crew duty number 106, journey number 06PE and (ii) tram number 1019, crew duty number 115, journey number 13AD.
- All trams have the following characteristics:
 - two articulated passenger cars sharing three bogies – two bogies are motored;
 - dimensions of 30 metres length; 3.7 metres height (pantograph down); 2.65 metres width;
 - two double-leaf power operated sliding doors on both sides of each car with an open width of 1.2 m;
 - *regenerative, rheostatic, air applied* and *magnetic track* braking;
 - driver only operation with a top speed of 50 mph (80 km/h).

18 Serco Metrolink Rule Book and procedures:

- The Serco Metrolink Rule Book comprises instructions and procedures that must be observed by Serco Metrolink staff and contractors. Its status at the time of the incident was issue 8 dated May 2001.
- The Serco Metrolink Rule Book requires a lookout to give a minimum of 25 seconds warning of the approach of a tram to staff and/or contractors working on or about the track. The Serco Metrolink rule book requires a lookout to have in his possession;
 - a whistle or horn;
 - a *track circuit operating clip*;
 - a blue and white chequered flag if required;
 - a red flag during daylight;
 - a *bardic lamp* during darkness, fog, falling snow or if in a tunnel;
 - a current certificate of competency;
 - a means of communication with the operations controller.
- The Serco Metrolink document 'PIC Record of Arrangements and Briefing Form' requires an assessment of site specific factors prior to work commencing. Factors to be considered include line speed, hazards, access/egress, position of safety, warning time calculated from sighting distance and lookout numbers/duties. The form requires a minimum sighting distance of 600 m for a line speed of 50 mph (80 km/h).
- The Rule Book, although based on British Rail practice of the early 1990s, has not been subject to a process of regular review and revision to ensure that current best practice in the wider industry is considered and adopted.

19 The parties involved:

- The Serco Metrolink Permanent Way Department PIC, subsequently identified as PIC 1, joined the Permanent Way Department in August 2004. He followed a Serco Metrolink Permanent Way Department programme of classroom study, on-the-job training and assessment, and satisfactorily completed his 12-month probation period in August 2005. Prior to joining the department, PIC 1 spent 3 years working for the operations department of Serco Metrolink in revenue protection.

- The track person and lookout subsequently identified as contractor A and contractor B respectively were provided to Serco Metrolink by an external supplier. Contractor A had not previously worked on Metrolink infrastructure but had three years of Network Rail permanent way experience and held a valid *Sentinel* card with competencies including lookout, hand signaller and *individual working alone* (IWA). Contractor B had worked on Serco Metrolink infrastructure two years previously, had a total of five years permanent way experience and held a valid Sentinel card with competencies including lookout, *controller of site safety* (COSS), hand signaller and individual working alone (IWA).
- The control room staff subsequently identified as controller A (workstation 1), controller B (workstation 2) and controller C (workstation 3 acting as control room supervisor).
- The driver of the tram involved in the incident and the drivers of the two following inbound trams.

Location

- 20 The incident occurred in the segregated section south of Bury, between Radcliffe and Whitefield tram stops. The location was the inbound running line beyond OLE support BV4/36. It is shown in the photograph (Figure 2) and the site plan (Figure 1). Events following the incident extended the incident site to the operational area bounded by Radcliffe and Whitefield stations.

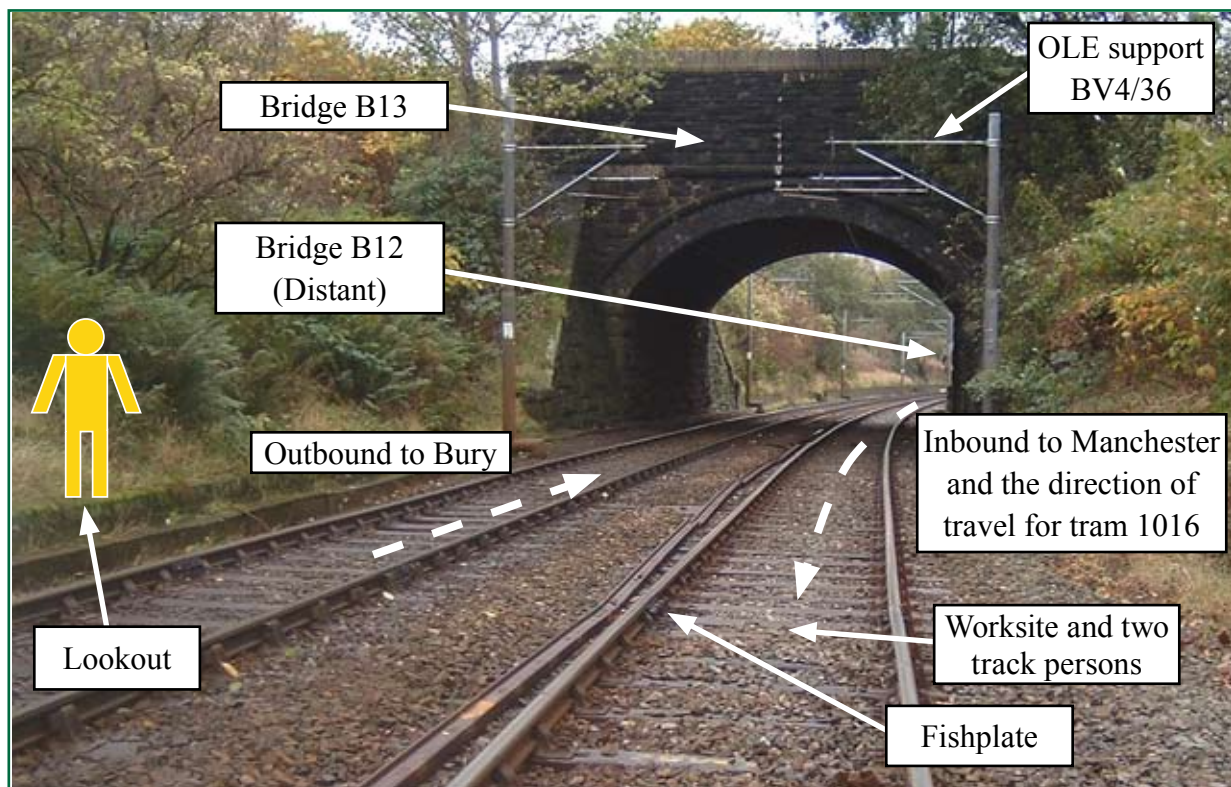


Figure 2: Photograph of the location

External circumstances

21 The weather at the time of the incident was overcast but dry. Visibility was good.

Events preceding the incident

22 A cracked fishplate was found on the *six foot* rail of the inbound line, at the location identified in paragraph 20, during a track inspection on the morning of Monday 7 November 2005. PIC 1 acted as lookout for the track person conducting the inspection. See Figure 3 for the organisational structure of the Serco Metrolink Permanent Way Department.

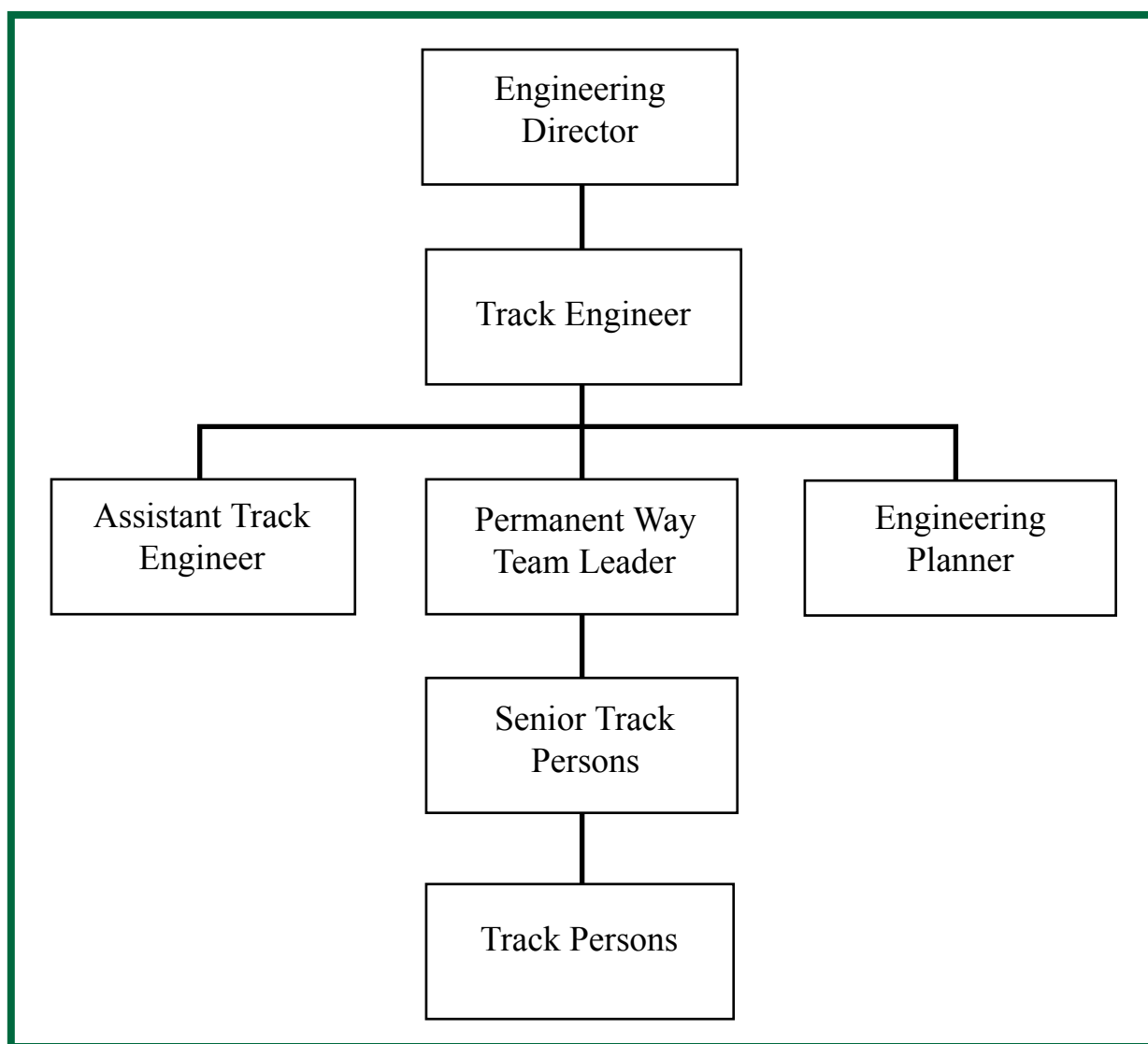


Figure 3: Serco Metrolink Permanent Way Department organisational structure

23 The track person classified the defect as a cracked fishplate in accordance with Network Rail standard NR/SP/TRK/001. The corrective action stipulated in the standard was replacement of both fishplates within 24 hours. A speed restriction was not required.

24 PIC 1 booked on duty on the morning of Tuesday 8 November 2005. A senior track person allocated two contract staff to assist PIC 1 with the work for that day.

- 25 The senior track person gave PIC 1 the task of replacing the fishplates. This task was in addition to the planned full day of work vacuuming and lubricating points on the Eccles Line and in Manchester City Centre.
- 26 PIC 1 and the two contractors loaded the Serco Metrolink pick-up with tools and equipment, before travelling together to site. At the access point, PIC 1 gave the standard two-page Serco Metrolink briefing document to contractor A.
- 27 Contractor B advised PIC 1 that he need not read the briefing document because of his knowledge and prior experience of the Serco Metrolink system. PIC 1 did not brief contractor B.
- 28 PIC 1 confirmed that contractor A had read and understood the briefing document. PIC 1 and the contractors then collected the tools and equipment and walked to the worksite.
- 29 PIC 1 placed contractor B on the outside of the curve in the *cess* adjacent to the outbound line to act as lookout. Refer to the photograph in Figure 2 and the site plan in Figure 1 for clarification.

Events during the incident

- 30 Work commenced immediately after the passage of an inbound tram. PIC 1 and contractor A used a Bance (petrol driven) impact wrench to remove the fixings from the fishplates while contractor B acted as lookout. Neither PIC 1 nor contractor A wore ear protection while operating the Bance, a large and heavy power tool, although this was a Serco Metrolink requirement. Ear protection is Personal Protective Equipment (PPE) issued to Serco Metrolink staff. Contractors are required to provide their own PPE.
- 31 The rail joint became misaligned vertically by approximately 25 mm when the fishplates were removed, the proud rail facing the direction of tram travel (ie it presented itself as a step to the wheels of approaching trams). The joint was realigned using the bolts and the replacement fishplates. The joint was part assembled when PIC 1 and contractor A heard a verbal warning from the lookout. PIC 1 and the contractor reached a position of safety with only seconds to spare before the tram passed the worksite.
- 32 The driver of tram 1016 had sighted the lookout after exiting Radcliffe New Road overbridge B12, briefly sounded the warning horn and slowed the tram using the service brake. The driver then sighted PIC 1 and contractor A on the inbound track. At this moment the lookout displayed to the driver a red flag that had not been unfurled.
- 33 The driver applied the service brake and did not make an emergency brake application. The maximum service brake rate was only achieved briefly due to low adhesion conditions and *wheel slide protection* (WSP) activity throughout the stop.
- 34 The tram struck the Bance that neither PIC 1 nor contractor A had the opportunity to take to a position of safety. The tram stopped with its rear car 40 metres from the worksite. The actions of the driver and the response of the tram can be seen in the context of time, distance and location in the diagram in Appendix C.

Fatalities, injuries and material damage

- 35 There were neither fatalities nor injuries among the tram driver, passengers or track persons. The tram sustained minor damage to brake rigging adjacent to the leading axle, the Vehicle Recognition System (VRS) coils and an Automatic Tram Stop (ATS) beacon. Inspection, repairs and functional testing were carried out during the day of the incident and the tram was back in service by early evening. Photographs of the lower aspect of a phase 1 tram and the irreparably damaged Bance are shown in Figures 4 and 5.



Figure 4: Photograph of the lower aspect of a phase 1 tram



Figure 5: Photograph of the irreparably damaged Bance

Events following the incident

36 The sequence of events following the incident are illustrated in Figure 6.

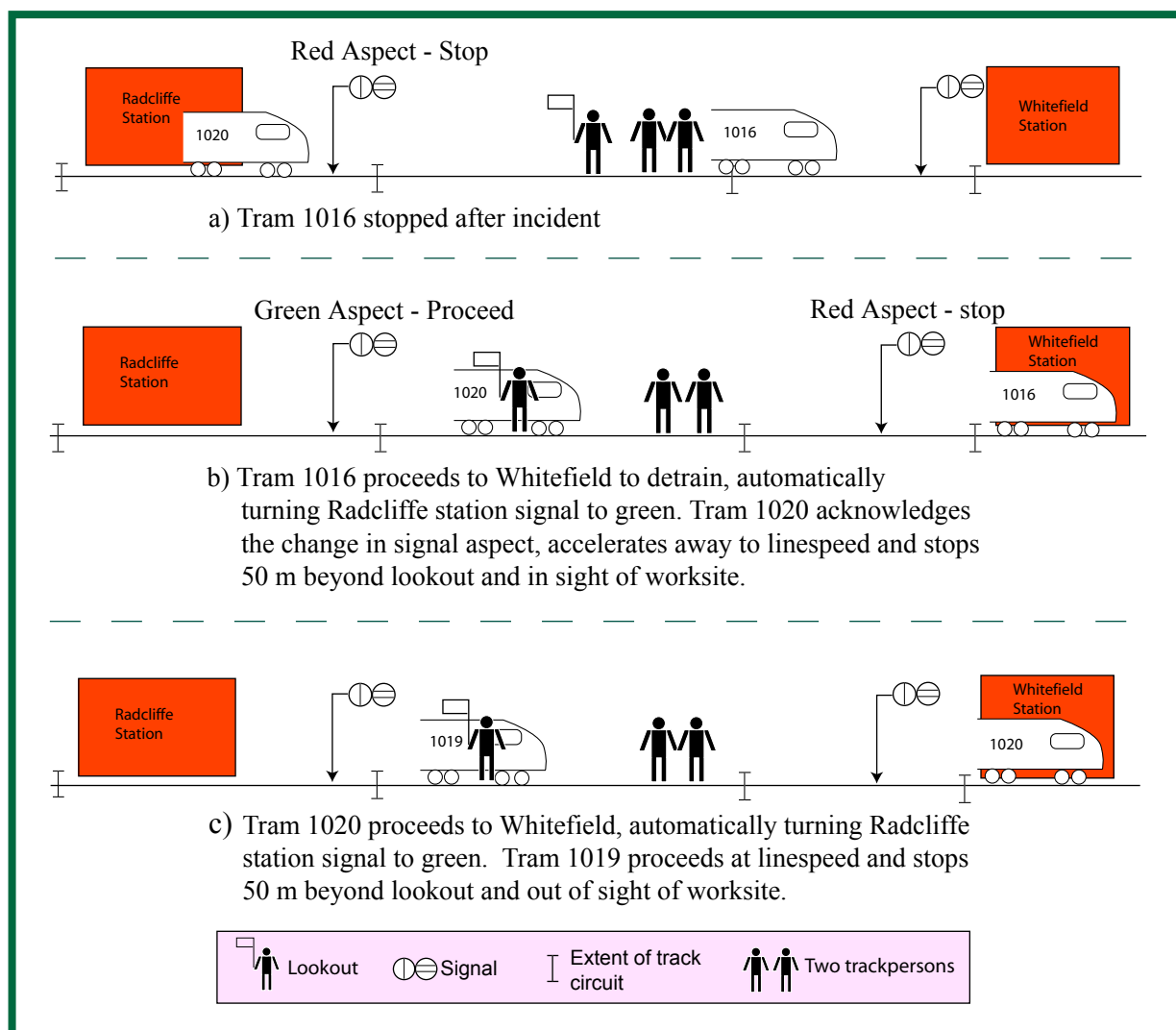


Figure 6: Sequence of events following the incident

- 37 The driver of tram 1016 contacted control by cab radio and was answered by controller A. He reported that the tram had struck a workers tool.
- 38 Controller A asked the driver to:
- speak with the track persons and have them contact the control room;
 - detrain passengers at Whitefield station;
 - bring the tram back to Queens Road Depot at reduced speed.
- 39 PIC 1 contacted control via mobile telephone after speaking with the tram driver and was answered by controller C. PIC 1 asked for trams to be stopped while work was completed and stated that the lookout was walking outbound to stop trams with the red flag. No clear understanding was reached between PIC 1 and controller C, and trams were not stopped.

- 40 The call between PIC 1 and controller C remained open although PIC 1 believed the call was concluded. At this time the driver of inbound tram 1020 called control and was answered by controller B. The driver questioned being stopped at Radcliffe station by a signal with a red aspect. The signal changed to a green aspect immediately contact was made with controller B who advised the driver that the previous tram had been involved in an incident at a worksite but was now on the move. The driver was advised that normal running had resumed and he accelerated away from Radcliffe as normal.
- 41 The driver of tram 1020 sighted the lookout displaying the red flag and braked to a stop approximately 50 metres beyond the lookout and in sight of the worksite. PIC 1 used hand signals to instruct the tram to move towards him and pass the worksite at slow speed as the replacement fishplates had not yet been secured. Tram 1020 passed the worksite and continued normally.
- 42 Controller C terminated the call to PIC 1 and contacted tram 1020 by cab radio to have the driver advise PIC 1 to contact control. The driver advised controller C that he had been stopped by the lookout and then allowed to continue past the worksite by PIC 1.
- 43 Inbound tram 1019 then approached the worksite travelling normally. The driver sighted the lookout displaying the red flag and braked to a stop approximately 50 metres beyond the lookout and out of sight of the worksite. The lookout continued to walk outbound as instructed by PIC 1.
- 44 The driver of tram 1019 contacted control via cab radio and was answered by controller C. He reported that he was stopped and was asked to instruct PIC 1 to contact the control room.
- 45 PIC 1 finally contacted control by mobile telephone and was answered by controller C. He advised that the work was complete and traffic could now run normally. PIC 1 and the two contractors then made their way back to the depot.
- 46 On arrival at the depot PIC 1, the contractors and the driver of tram 1016 completed incident reports and were tested for the presence of drugs and alcohol (D&A). All D&A test results were negative. PIC 1 and the contractors remained at the depot to be interviewed by RAIB. The driver had worked the early shift and was permitted to leave the depot for this reason.

The Investigation

- 47 Serco Metrolink advised the RAIB of the incident by telephone. This notification was later than expected because of the lack of detail given in communications between Serco Metrolink parties during and immediately after the incident and a failure to recognise the significance of the incident.
- 48 The RAIB investigation included the following:
- interviews conducted with PIC 1 and the contractors on the day of the incident;
 - follow up meetings with Serco Metrolink;
 - a cab ride through the incident site;
 - analysis of voice recordings between control room staff and the other parties involved;
 - a reconstruction which considered the incident from worksite and tram driver perspectives;
 - analysis of the incident data from the tram data recorder (raw data was analysed in a spreadsheet as this was not possible using software from the original equipment manufacturer (OEM));
 - analysis of the Serco Metrolink Rule Book and procedures with respect to validity, applicability and the extent to which they were followed.

Previous occurrences of a similar character

- 49 There have been no reported previous occurrences of a similar character on the Manchester Metrolink system.

Analysis

Identification of the immediate cause

- 50 The 50 mph (80 km/h) linespeed at the worksite required a minimum sighting distance of 600 metres in accordance with the Serco Metrolink document titled 'PIC Record of Arrangements and Briefing Form'. This form was not considered, completed or taken to the worksite.
- 51 The Serco Metrolink Rule Book required the lookout to provide a warning time of no less than 25 seconds for staff and/or contractors on or about the track on the approach of a tram.
- 52 The lookout's sighting of inbound trams from his position at the worksite was restricted to 250 metres by track curvature and Radcliffe New Road overbridge B12. This sighting distance would have been further reduced by the passage of an outbound tram.
- 53 The maximum warning time available on sighting the inbound tram at a distance of 250 metres was 11 seconds.
- 54 There was insufficient time available for a lookout to sight an approaching tram and give warning to the track persons. The lack of warning time was corroborated by all evidence considered and reinforced by the analysis of data recorder data. Thus the immediate cause of the incident was the inadequate safe system of work adopted (Recommendation 1).

Identification of contributory factors

- 55 Given the inadequate safe system of work adopted, the following matters contributed to the near miss that resulted, but are not considered causal to it.
- 56 The lookout gave a verbal warning approximately 5 seconds before the tram passed. The warning given by the lookout was considered late given the maximum available warning time of 11 seconds identified in paragraph 53. The Serco Metrolink Rule Book requires a lookout to be able to provide a minimum of 25 seconds warning of the approach of a tram.
- 57 Serco Metrolink drivers are required to give one long blast on the warning horn when approaching staff on or near the line who must in turn acknowledge the warning. A series of short sharp blasts on the horn indicating a warning of danger should be given if the first warning is not acknowledged. Analysis of data recorder data confirmed that the horn was sounded for a short duration of one second.
- 58 Analysis of the data recorder data and tram brake performance calculations confirmed that the driver applied a full service braking rate and the tram stopped beyond the worksite. If the driver had applied the emergency brake on sighting the two track persons, the tram would have passed the worksite at a reduced speed but still stopped beyond it.
- 59 The driver's immediate call to controller A reported the tram striking a worker's tool but at no time was reference made to narrowly missing one or more track persons. The driver's actions - neither selecting the emergency brake nor giving one long blast on the horn when approaching the lookout and then a series of short sharp blasts to indicate a warning of danger when the lookout did not acknowledge the horn - may have been due to his judgement that PIC 1 and contractor A had moved to a position of safety.

- 60 A review of documentation at Serco Metrolink identified that no risk assessment existed for the task of replacing fishplates. A competent risk assessment for this task would have identified that the principal hazard was equivalent to a transverse rail break with the fishplates removed. The Network Rail specification used by Serco Metrolink for inspection and maintenance of permanent way - NR/SP/TRK/001 - requires that the line be blocked until a transverse break is repaired (Recommendation 2).
- 61 Analysis of voice recordings and statements confirmed that control room staff were not aware that personnel of the Permanent Way Department were on or about the railway system at the time of the incident and therefore could not warn trams and/or protect the worksite (Recommendation 3).
- 62 Training records, completed 'PIC Record of Arrangements and Briefing Forms', interview notes and statements were analysed and confirmed that PIC 1 was inexperienced with respect to work undertaken in the segregated section.
- 63 Since being passed competent there were four recorded occasions of PIC1 carrying out the role of PIC prior to the day of the incident. Two occasions involved work on city centre and Eccles lines where trams operate by driver's line of sight. Another occasion was within a *possession*. The final occasion was in the segregated section on the day prior to the incident with PIC 1 under the supervision of a senior track person.
- 64 PIC 1 was required to establish a safe system of work using a lookout in the segregated section and without supervision for the first time on the day of the incident.

Identification of underlying causes

- 65 PIC 1 was neither under supervision at the worksite nor was he supported in his preparations to set up a safe system of work in the segregated section. There was an absence of structured, formal mentoring and supervision for inexperienced Serco Metrolink Permanent Way Department staff (Recommendation 4).
- 66 Analysis of statements and the events occurring before, during and after the incident confirm that the parties involved were accustomed to the use of working practices outside Serco Metrolink procedures and Rule Book requirements. Such practice dated back to Metrolink's inception. Examples from this incident follow to aid understanding (Recommendation 5).
 - PIC 1 and control room staff permitted the lookout to act as a watchman/hand signaller to stop trams – a practice only acceptable under line of sight operation;
 - the absence of a structured protocol for safety critical communications between the control room and other parties on or about the railway system;
 - the fishplate defect was not logged on the track inspection report sheet because those involved in its identification expected the defect to be corrected later in the day on which it was identified;
 - the lookout was not in possession of a warning horn, a whistle or a track circuit operating clip;
 - PIC 1 and contractor A did not wear ear protection while operating the Bance.
- 67 Short duration work was often not planned in advance of arrival at the worksite. Prior planning of work was made difficult by the absence of a single source of documented information on Serco Metrolink system hazards (Recommendation 6).

- 68 Serco Metrolink did not have a formalised system for monitoring and auditing safe system of work arrangements to ensure their adequacy.

Observations

- 69 The Serco Metrolink Rule Book and company procedures are out of date and inconsistent. The Rule Book and procedures have not followed the development of best practice elsewhere in the industry. Examples follow to aid understanding (Recommendation 7).
- The 'PIC Record of Arrangements and Briefing Form' (the form) requires that the calculated warning time be corroborated by a measurement of the actual time taken for a sighted tram to pass the worksite. This measurement may be based on a tram travelling at less than line speed. RISK: The warning time available for subsequent trams may be much less than that measured.
 - The form makes reference to red and green zone working, neither of which is recognised as a method of working in the Serco Metrolink Rule Book.
 - The form makes reference to the lookout operated warning system (LOWS), equipment Serco Metrolink neither owns nor operates.
 - The form and Rule Book mandate differing distances to a position of safety: 1.2 metres and 1.25 metres respectively.
 - The Rule Book makes general reference to the use of detonators. Serco Metrolink would only use detonators in an emergency on the Network Rail section of the system.
 - Neither the Rule Book nor the form satisfactorily differentiate the risks and working practices applicable to on-street and segregated sections.
 - Hand signals: Specifically, the Rule Book does not make reference to the use of a red flag for stopping trams in an emergency. Generally, the Rule Book does not identify who is authorised to use hand signals and the circumstances in which they may be used.
 - Serco Metrolink acknowledged a requirement to revise the Rule Book in their Railway Safety Case issue 8 May 2005 section B08 page 48 item 652. Some work had been undertaken on section S (Engineers Possessions) and R (Engineering Works) although this work had not been published at the time of the incident.

Severity of consequences

- 70 Analysis of voice recordings between control room staff and other parties on or about the railway system confirmed that there was no clear understanding reached with respect to protecting trams and the worksite while work was completed. The result was that after the initial incident the two following trams were signalled towards the worksite with controllers A, B and C all managing individual aspects of the incident and no one controller fully informed (Recommendation 8).

- 71 At the time of the incident controller C, an Operations Controller, was fulfilling the role of Control Room Supervisor on workstation 3. In this event, Serco Metrolink requires that a qualified Control Room Supervisor is present to provide support to the Operations Controller acting above his substantive role. In an incident, it is the Control Room Supervisor's responsibility to recognise when technical input is required and to consult suitable persons to determine the fitness for continued operation of both LRV and infrastructure. Operations Controllers are not similarly competent with respect to recognising the need for technical input.
- 72 At the time of the incident the rostered Control Room Supervisor was attending a training course. The control room was therefore adequately staffed in number but inadequately staffed with respect to required competence. The significance of the track work undertaken, the risk it presented to trams, the damage sustained by the tram and the fitness of the driver to continue his duties was not satisfactorily evaluated (Recommendation 9).

Causal analysis

- 73 The causal analysis is presented below.

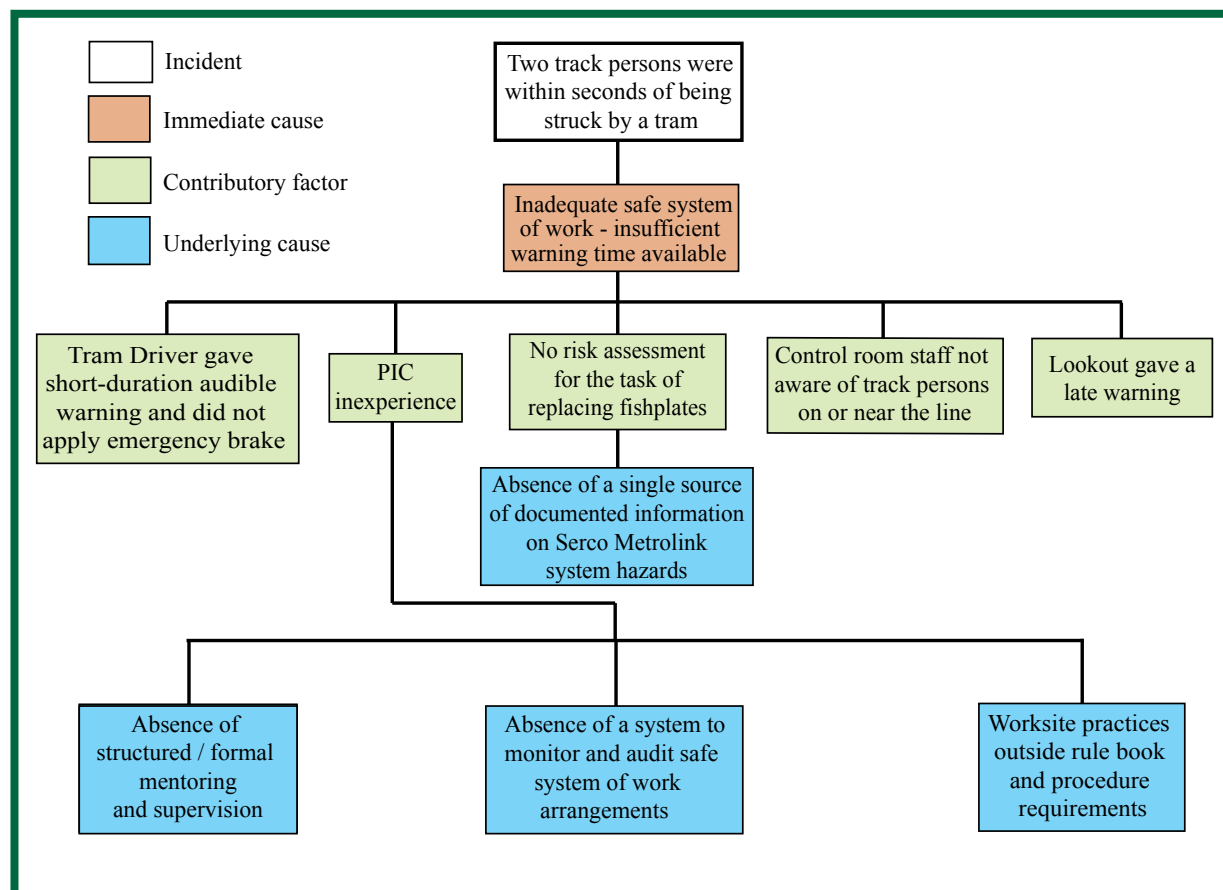


Figure 7: Summary of causal analysis

Conclusions

- 74 The immediate cause of the incident was the inadequate *safe system of work* that was adopted. Particularly, there was insufficient time available for a *lookout* to sight an approaching tram and give warning to the track persons.
- 75 Contributory factors were:
- The lookout gave a late verbal warning notwithstanding the insufficient sighting time available.
 - The tram driver gave only a short duration audible warning.
 - The tram driver applied the service brake but not the emergency brake.
 - There was no risk assessment for the task of replacing fishplates so the most severe hazard with the fishplates removed, equivalent to a rail break, was neither identified nor measures prescribed to safeguard traffic from this hazard.
 - The control room was not aware that members of the Permanent Way Department were undertaking work on or about the railway system at the time of the incident and therefore could not provide protection for track persons and trams.
 - The *Person in Charge* (PIC) was inexperienced with respect to work on the segregated section.
- 76 Underlying causes were:
- the absence of structured, formal mentoring and supervision for inexperienced Permanent Way Department staff;
 - the absence of a single source of documented information on Serco Metrolink system hazards for use in the planning of safe systems of work;
 - the use of working practices outside Serco Metrolink procedures and Rule Book requirements;
 - the absence of a system to monitor and audit safe system of work arrangements to ensure their adequacy.
- 77 The severity of the potential consequences increased, because after the incident, subsequent trams approached the worksite at linespeed and were stopped on sight of a red flag.
- 78 The Serco Metrolink Rule Book and company procedures are out of date and inconsistent. The Rule Book and procedures have not followed the development of best practice elsewhere in the industry.

Actions already taken or in progress

- 79 Serco Metrolink Special Safety Brief S003 dated 14/11/05 required (i) tram drivers to report unscheduled stops in the segregated section to the control room (ii) subsequent tram movements to be under the instruction of the Duty Manager or his delegated representative.
- 80 Serco Metrolink Special Safety Brief S004 dated 14/11/05 was directed at PIC, lookout and control room staff and stated that hand signals could only be used on the segregated section by (i) a hand signaller appointed by control in place of defective signalling equipment or (ii) a PICOP during engineering work. The techniques to stop a tram in an emergency were also clarified.
- 81 Serco Metrolink Special Safety Brief S005 dated 14/11/05 was directed at PIC staff and gave examples of when lookout protection would not be permitted, specifically (i) if the work adversely affected track integrity (ii) if it was foreseeable that tools/equipment/material in use could present a derailment hazard (iii) if the warning time required to clear site would exceed 45 seconds.
- 82 Serco Metrolink Special Safety Brief S006 dated 14/11/05 was directed at all control room and PTS certificated staff and gave advice on good practice with respect to Safety Critical Communications.
- 83 Serco Metrolink Safety Management Review dated December 2005 appendix D table 4 required (i) the identification and publication of lineside hazards (ii) a review of in-traffic maintenance work with a view to reducing reliance on lookout protection (iii) improvements to the Rule Book to ensure that safe systems of work are planned in advance.
- 84 Serco Metrolink Rule Book was reviewed and revised to include relevant best practice and lessons learned from this investigation. The following specific items were incorporated: Requirements for protecting worksites on signalled sections of the system; Use of hand signals; Role of hand signalman; Initiating emergency procedures and protecting the line; Operating LRVs at 'caution' and at 'reduced speed'. Changes were briefed to staff ahead of the revised rules coming into force on 1 July 2006.
- 85 Serco Metrolink document PROC-0049 (Safety of Staff Required to Work Trackside Without a Possession or Lookout Protection) revised to provide an alternative to using lookout protection during traffic hours.
- 86 Serco Metrolink 'PIC Record of Arrangements and Briefing Form' revised to ensure that the option of stopping rail vehicle movements is considered before resorting to lookout protection and ensure that adequate warning time is provided where lookout protection is necessary. Different forms are now available for work in 'line of sight' and segregated sections.
- 87 The Serco Metrolink internal audit regime has been revised to include: Sample checks on completed 'PIC' forms and other documentation relevant to protecting work on or near the line and additional site checks by managers and supervisors to worksites of short duration.

Recommendations

88 Implementation of the recommendations below is the responsibility of the organisations identified in each one. When they have considered the recommendations, the organisations should establish a priority and timescale for the necessary work, taking into account their health and safety responsibilities and the risk profile of their activities.

- 1 Serco Metrolink should put in place a system to monitor and audit safe system of work arrangements to ensure their adequacy (paragraph 54).
- 2 Serco Metrolink should put in place risk assessments for all permanent way repair tasks and should consider the difference in risk when tasks are executed in street and segregated sections (paragraph 60).
- 3 Serco Metrolink should put in place a system to ensure that the control room is advised prior to Permanent Way staff working in segregated sections (paragraph 61).
- 4 Serco Metrolink should put in place a structured and formalised system for the mentoring and supervision of all persons carrying out PIC duties (paragraph 65).
- 5 Serco Metrolink should put in place a system of monitoring and auditing to provide assurance that working practices outside Serco Metrolink procedures and Rule Book requirements are not employed (paragraph 66).
- 6 Serco Metrolink should put in place a single source of documented information on system hazards to aid the planning of safe systems of work (paragraph 67).
- 7 Serco Metrolink should put in place a board level supervisory system to ensure that the rule book and its supporting procedures are continually improved to (i) remove inaccuracies and anomalies and (ii) incorporate the developments of best practice elsewhere in the industry (paragraph 69).
- 8 Serco Metrolink should ensure that safety critical communications are effectively executed and understood by all when staff on or about the railway system contact the control room (paragraph 70).
- 9 Serco Metrolink should ensure that at all times the control room is staffed by suitably qualified personnel who can ascertain the severity of a reported incident and confirm its resolution before normal operation is resumed (paragraph 72).

89 Recommendations 4, 6 and 7 relate to improvements required of the Serco Metrolink Rule Book and procedures. Recommendations 1, 2, 3, 5, 8 and 9 relate to compliance with the Serco Metrolink Rule Book and procedures.

Appendices

Glossary of abbreviations and acronyms

Appendix A

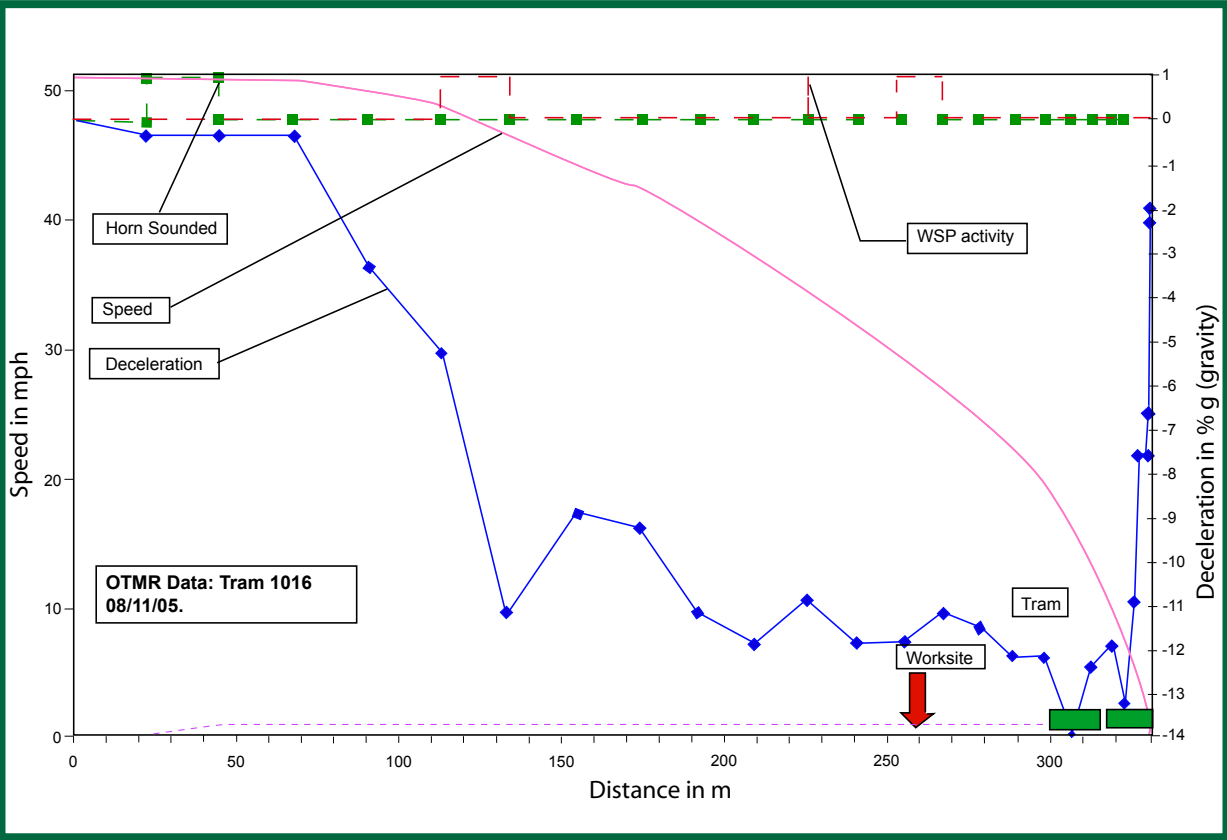
ATS	Automatic Tram Stop
COSS	Controller of Site Safety
D&A	Drugs and Alcohol
GMPTE	Greater Manchester Passenger Transport Executive
IWA	Individual Working Alone
LOWS	Lookout Operated Warning System
LRV	Light Rail Vehicle
OEM	Original Equipment Manufacturer
OLE	Overhead Line Equipment
PIC	Person in Charge
PICOP	Person in Charge of a Possession
PPE	Personal Protective Equipment
PTS	Personal Track Safety
VRS	Vehicle Recognition System
WSP	Wheel Slide Protection

Glossary of terms

Appendix B

Air applied (braking)	Disc brake operated by compressed air.
Aspect	Visual indication of a signal as displayed to the driver.
Ballast	Graded stone sub-base used for drainage and support of the track.
Bardic lamp	A battery operated lamp with a coloured filter, which rotates to show white, red or green aspects.
Bullhead	A type of rail characterised by a narrow and deep base or 'bottom', little used outside the UK.
Cess	The area either side of the railway immediately off the ballast shoulder. This usually provides a safe area for authorised workers to stand when trains approach.
Controller of site safety (COSS)	A person appointed and certificated as competent to ensure a safe system of protection is in place to enable work to be carried out by a group of persons.
Fishplate	Steel plate used to align and secure together the ends of two rails in jointed track.
Flat bottom	A type of rail characterised by a broad and shallow base or 'bottom' used worldwide.
Four foot	The area between the inner running faces of a pair of rails.
Individual working alone (IWA)	A person certificated as competent to ensure their own protection, to enable them to carry out work.
Lookout	A person responsible for observing the approach of trams who must warn staff working on the line.
Magnetic track (braking)	An electromagnetic friction brake applied to the railhead under emergency braking.
Pantograph	Device on the roof of a tram through which electric power is drawn from the contact wire.
Person in charge (PIC)	Person certified as competent to take responsibility for the safety of a worksite and the supervision of those working within it.
Possession	A section of the line which is under exclusive occupation for maintenance, repairs or other attention. Comprehensive safety arrangements ensure that safe conditions are maintained until the possession is given up.
Regenerative (braking)	Braking by the use of the traction motors as generators, the generated current being returned to the overhead power supply.

Rheostatic (braking)	Braking by the use of the traction motors as generators, the generated energy dissipated as heat from resistors.
Safe system of work	The arrangements necessary to conduct work while fully protected from the hazards of moving trams, electrification, plant, slips, trips, falls etc.
Segregated section	Former British Rail lines used exclusively by Serco Metrolink trams.
Sentinel	A certificate of competence issued for staff working on Network Rail lines.
Six foot	Distance between two sets of tracks. The distance may not be six feet.
Sleeper	Wood, concrete or steel beam which holds the rails apart and supports the track on the ballast.
Track circuit	An electrical device using rails in an electric circuit which detects the absence of trains on a defined section of line.
Track circuit block	A modification of the absolute block system employing track circuiting throughout. A train may proceed as soon as the line is clear to the next stop signal plus the overlap beyond that signal.
Track circuit operating clip	A safety device which, when placed on the track, places the signal on the approach to red.
Wheel slide protection	The train equivalent of ABS braking.



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