RAIB
Rail Accident Investigation Branch

Rail Accident Report

Collision between a tram and road vehicle at New Swan Lane Level Crossing on Midland Metro 8 June 2006

Department for Transport

Report 18/2007
June 2007

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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Collision between a tram and road vehicle at New Swan Lane Level Crossing on Midland Metro, 8 June 2006

Contents

Introduction

1 The sole purpose of a Rail Accident Investigation Branch (RAIB) investigation is to prevent future accidents and incidents and improve railway safety.

2 The RAIB does not establish blame, liability or carry out prosecutions.

3 Access was freely given by Travel Midland Metro (TMM) to their staff, data and records in connection with the investigation.

4 Appendices at the rear of this report contain glossaries explaining the following:

- acronyms and abbreviations are explained in the glossary at Appendix A; and
- technical terms (shown in italics the first time they appear in the report) are explained at Appendix B.

Summary of the report

Key facts about the accident

5 During the morning of 8 June 2006 at approximately 09:44 hrs, a Wolverhampton bound TMM tram collided with a road vehicle (taxi) on New Swan Lane Level Crossing. The location of New Swan Lane Level Crossing is shown in Figures 1 and 2, and the scene following the collision is shown in Figure 3. The taxi was pushed across the junction and collided with a stationary lorry. Both road vehicles and the tram suffered minor damage.

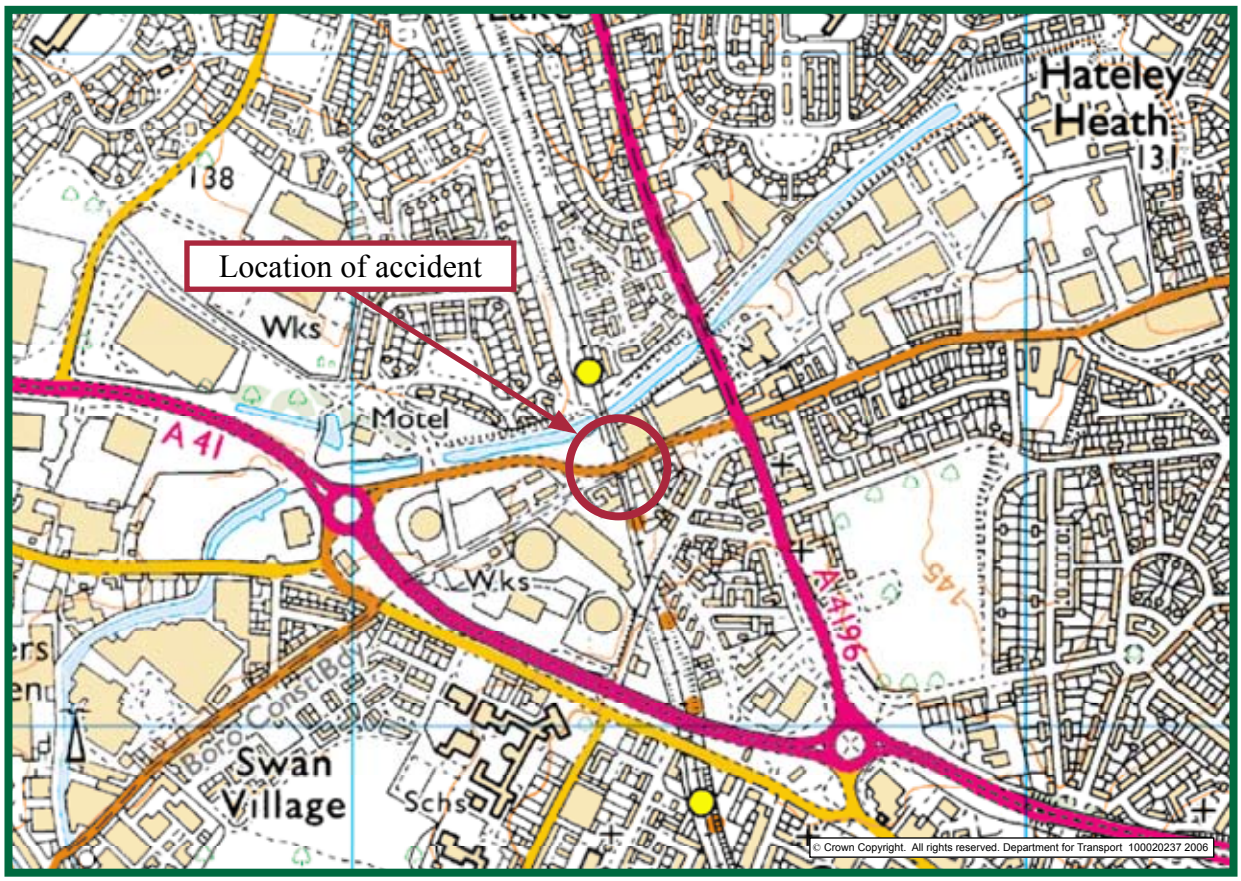


Figure 1: Extract from Ordnance Survey Map showing location of incident

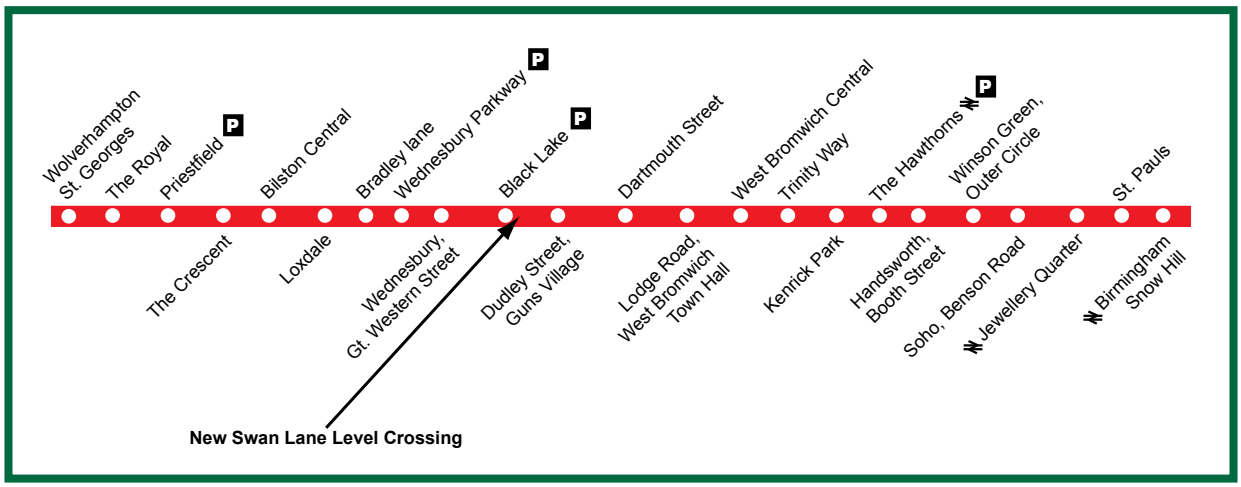


Figure 2: Location of New Swan Lane level on the network

Figure 3: The scene after the collision at New Swan Lane.

Immediate cause, contributory factors, underlying causes

6 The immediate cause of the accident was that the driver of the tram failed to stop at the signal displaying a stop aspect.

7 The driver expected that the signal would change to a proceed aspect before the tram reached the crossing and as such was not adhering to the principles of *Progressive Driving* (see paragraphs 62 to 64).

8 The driver's decision not to apply the *hazard brake* when realising that the signal was unlikely to change to a proceed aspect contributed to the accident. The underlying cause behind this decision was the view amongst drivers that use of the hazard brake was discouraged by the organisation.

9 The lack of familiarity with the performance of the hazard brake (due to minimal training in its use) and the briefing on the possibility of causing injury to the passengers and damage to the tram contributed to the drivers decision not to apply the hazard brake.

Severity of consequences

10 The two occupants of the taxi were taken to hospital and released after two hours.

11 Neither the tram passengers nor the lorry driver suffered any injuries.

Recommendations

12 Recommendations are made in the following areas at paragraph 109 of the report:

- review of the driver training with respect to the use of the hazard brake and newly qualified drivers;
- review of the arrangements for reporting and follow up on use of the hazard brake to ensure that they do not discourage driver's use of it.

The Accident

Summary of the accident

13 During the morning of 8 June 2006 at approximately 09:44 hrs, a Wolverhampton bound TMM tram carrying between 20 and 30 passengers collided with a road vehicle (taxi) on New Swan Lane Level Crossing. The location of New Swan Lane Level Crossing is shown in Figures 1 and 2 and the scene following the collision is shown in Figure 3.

14 A summary of the chain of events is presented in Appendix C.

15 The signals at the junction were showing a stop aspect to the tram and proceed for road traffic.

16 The taxi was pushed across the junction and collided with a stationary lorry, before continuing along the road and stopping shortly after the junction. Both road vehicles and the tram suffered minor damage.

The parties involved

17 The Midland Metro light rail system is owned by the West Midlands Passenger Transport Executive 'Centro' who has granted a 23-year concession to TMM to operate and maintain it. TMM is an operating division of Travel West Midlands, and this in turn is part of the National Express Group.

18 The driver of the tram involved in the accident joined Midland Metro on 27 February 2006, completed training on 11 April 2006 and had two months driving experience at the time of the accident.

The infrastructure

19 The route of the Midland Metro light rail system extends over 20.4 km between Birmingham and Wolverhampton serving 23 stops. Of this, 18.6 km is off-street along a former railway alignment and 1.8 km is on-street.

20 The route is double track with the exception of a short section of the approach to Birmingham Snow Hill.

21 The maximum speed off-street is 70 km/h and 50 km/h on-street, however there is a permanent speed restriction of 30 km/h at New Swan Lane Level Crossing.

22 Trams nominally run every 8 minutes during the daytime, 12 minutes during evenings and 10 minutes on Sundays.

23 Control of tram movements is by '*Line of Sight*'. 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.

24 New Swan Lane Level Crossing is the only level crossing on the network.

25 At New Swan Lane Level Crossing, the approach of a tram from Birmingham is detected by 'Prepare' and 'Demand' loops located in the track. When these receive a signal from a tram mounted transponder a timed sequence is initiated that results in the road traffic signals showing a stop (red) aspect and the tram signal showing a proceed aspect approximately 10 seconds after demand detection. This arrangement normally results in the tram receiving a proceed aspect before it reaches the crossing. An additional 'Stop' loop is provided immediately before the crossing at which a tram driver may request a manual intervention of the signals using the *Tram Ready To Start* (TRTS) function. A further 'Clear' loop is provided after the crossing indicating that the tram has passed the crossing.

26 When a pedestrian pushes the button to request to cross the line this disables the above timed sequences so that the tram signal at the crossing shows a stop aspect until the pedestrian sequence has completed.

27 If a tram approaching from Wolverhampton has initiated a sequence of signals then a tram approaching from Birmingham may be held at the controlling signal until that sequence has completed and the driver operates the TRTS function.

28 There is a fault logger on the signalling equipment at New Swan Lane Level Crossing; however there is no recording of the actual signal aspect sequences.

29 The location of the New Swan Lane Level Crossing is shown in Figure 1. It is located in the off-street section between Dudley Street Stop and Black Lake Stop. The layout of the crossing and associated signalling system are shown in Figure 4.

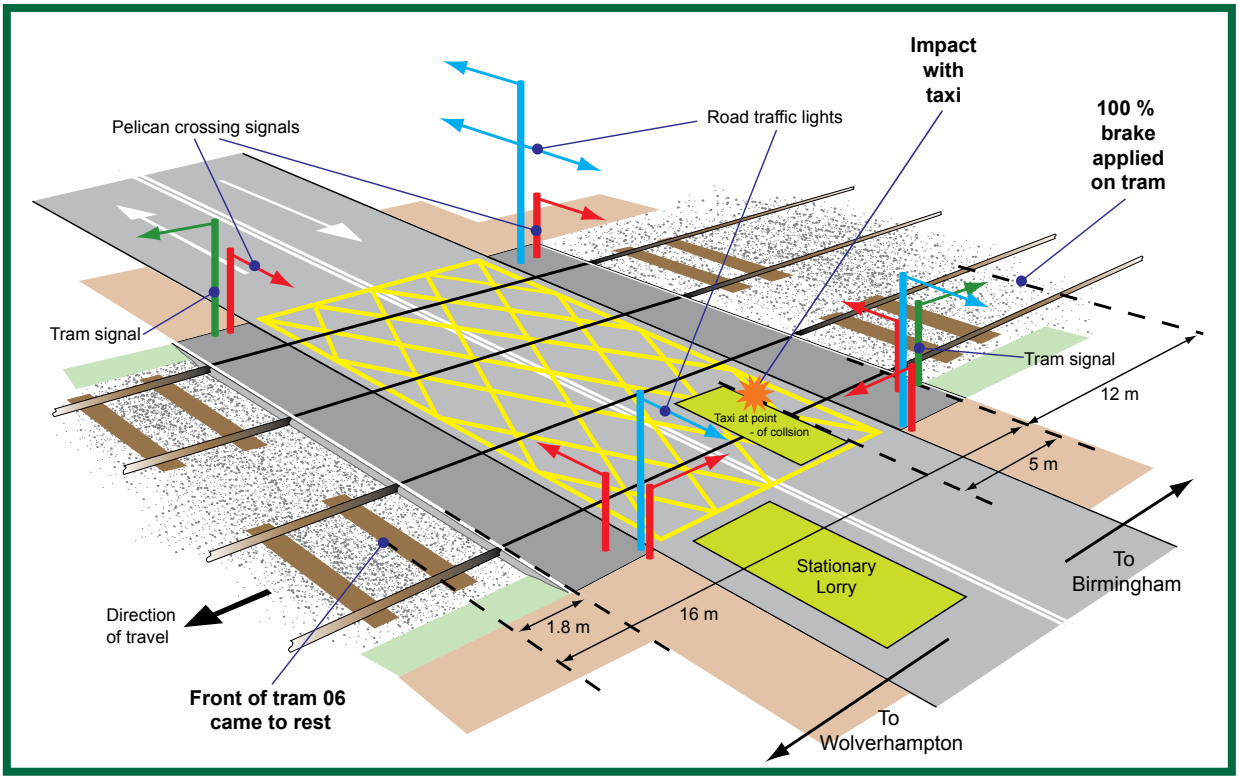


Figure 4: Layout of New Swan Lane Level Crossing.

The trams

30 The tram involved in the accident was tram 06, one of 16 Type 69 articulated three-car trams manufactured by Ansaldo-Firema Transporti, which entered service in 1999.

31 The tram consists of a three bogie double articulated bi-directional unit with a maximum permitted speed of 70 km/h.

32 The tram is equipped with three separate braking systems: electro-hydraulic friction brake; electro-dynamic regenerative and rheostatic braking; and electro-magnetic hazard (track) brakes. Normal *service brake* is achieved through use of the friction and regenerative/ rheostatic brakes (the maximum instantaneous service braking rate is 1.2 m/s^2). The hazard brakes offer increased braking performance above the service brake system (the maximum instantaneous hazard braking rate is 3.6 m/s^2).

33 Each tram has 58 seats and can carry 206 passengers

Events preceding the accident

34 The driver involved in the accident joined tram 06 at 07:09 hrs driving it from Wednesbury Great Western Street, the depot stop, to Wolverhampton St Georges. The driver completed a subsequent round trip to Birmingham Snow Hill and was returning to Wednesbury Great Western Street to be relieved for a 33 min break due to start at 09:47 hrs. The accident occurred as the tram approached New Swan Lane. The previous trips had been completed without any events of significance.

35 The weather was hot and sunny, with no cloud coverage. There was therefore no restriction on visibility.

36 Rail conditions were dry. There was no evidence of any poor wheel to rail adhesion which could have adversely affected the braking of the tram.

Events during the accident

37 All times quoted in this section are taken from tram 06's *data recorder* and are for relative purposes, they may not be accurate to British Summer Time. All distances are relative to the position at which the front of the tram came to a stop, ie 1.8 m north of the northern edge of New Swan Lane Level Crossing.

38 Tram 06 departed Dudley Street Stop at 09:39:05 hrs with between 20 and 30 passengers on board. It passed over the 'Prepare' loop for the signal at New Swan Lane Level Crossing (300 m) and then the 'Demand' loop (280 m). The tram was accelerated up to a maximum speed of 62.41 km/h before the service brake was applied at 09:39:28 hrs (265 m). The driver selected between 56 % and 81 % service brake to reduce the speed to below 30 km/h.

39 At 09:39:47 hrs (28.1 m) the driver realised that the signal may not change from a stop aspect to a proceed aspect and applied 100 % service brake and sounded the horn. There was no attempt to apply the hazard brake.

40 A lorry approaching the crossing from the west, although receiving a green aspect, noticed the tram and stopped at the crossing road stop line. However, a taxi coming from the opposite direction did not stop and the tram hit it on its rear-near side. The taxi was subsequently pushed across the crossing and hit the front-off side of the lorry.

41 Tram 06 came to rest with its front end 1.8 m north of the northern edge of the crossing at 09:39:55 hrs.

Consequences of the accident

42 The two occupants of the taxi were taken to hospital and released after two hours.

43 Neither the tram passengers nor the lorry driver suffered any injuries.

44 The taxi sustained rear impact damage to both sides, and the lorry suffered impact damage to the front-off side. The tram sustained minor superficial damage to its 'A end' bumper.

Events following the accident

45 Following the collision the driver remained in the cab and called Midland Metro Control at Wednesbury to report what had happened.

46 Control requested that the driver of tram 11, which was at Black Lake Stop at the time of the accident, attend the scene and wait with the driver until the Incident Officer arrived at 10:00 hrs.

47 The Incident Officer requested an ambulance at 10:02 hrs. It arrived at 10:20 hrs. At this time tram 06 was moved forward to allow the ambulance to traverse the crossing.

48 The driver of tram 11 then escorted the passengers from tram 06 to Black Lake stop. Tram 11 was then reversed and used to take passengers on their onward journeys.

49 The driver of tram 06 was taken to the depot as a passenger on tram 06 and then tested for alcohol in accordance with TMM's routine post incident procedures, with satisfactory results. The driver was taking medication (pain killers) at the time of the accident. This medication was brought to TMM's attention at the time of the drivers' pre-employment medical and the driver was declared fit by their contracted occupational health practitioner.

50 Tram 06 was subject to a post incident vehicle test which did not reveal any defects.

The Investigation

Investigation process

51 The investigation covered the following elements:

- the role of the signalling system;
- the driver's approach to the crossing;
- the tram brake performance; and
- the non use of the hazard brake.

Sources of evidence

52 The primary sources of evidence were:

- photographic records;
- tram 06's data recorder,;
- interviews;
- test results; and
- data/operations logs.

Key evidence

The signalling

53 The signalling at New Swan Lane Level Crossing is locally controlled, but monitored by the Wolverhampton Metropolitan Borough Council *Urban Traffic Control* (UTC) system. Many functions of the traffic control system are monitored, with faults being recorded in the fault log of the controller memory. Faults are also transmitted to the Traffic Control Centre

54 At the time of the accident UTC records indicate that the traffic signals were functioning correctly and no operational faults were logged against the site. A functional inspection carried out at 13:25 hrs on 12 June 2006 showed that the signal controller was working correctly.

55 Tram 06 passed the previous Birmingham bound tram at West Bromwich. Tram 11 (see paragraph 46) had not operated the TRTS function at Black Lake stop. Therefore New Swan Lane Level Crossing had not been operated by a Birmingham bound tram at the time that tram 06 approached it.

The driver and driving technique

56 At the end of formal training, the driver passed through a stop signal on the first unaccompanied exit from the depot. This was due to forgetting the location of the *Limit of Shunt* signal, but the driver stopped on realising that the tram had gone the wrong way. As a result of this additional training was given.

57 An instructor rode with the driver, as part of TMM's ongoing driver competence assessment, less than one month before the accident. No driving style issues were identified.

58 During two months of driving the driver had never experienced the signal at New Swan Lane Level Crossing not changing to a proceed aspect. Other drivers indicated that it is usual to encounter the signal remaining at stop between once per month and once every two months. The signal remaining at stop is therefore a normal operating characteristic of the system.

59 On approaching the signal on the day of the accident the driver expected that the signal would change. Only when close to the signal was it that the driver realised that the signal was remaining at a stop aspect and applied 100 % service brake and sounded the horn. The driver did not attempt to apply the hazard brake. The following information from the tram data recorder concurs with this description of events:

- the maximum speed reached by the tram after leaving Dudley Street Stop was 62.41 km/h.
- the driver slowed the tram, using between 56 % and 81 % service brake, to 30 km/h 50 m before the signal and then released the brake. The driver demanded 100 % service brake 30 m before the signal. The driver sounded the horn 12 m before the signal.
- there were no additional brake demands, of either service or hazard brakes.

60 The driver had only applied the hazard brake once before this accident, during training and reported that the training was to use the hazard brake only in an emergency. Other drivers indicated that it was usual to make full hazard brake applications between once per year and once every two years.

61 The driver made claims about poor brake performance on tram 06. These are addressed in paragraphs 67 to 71.

Operational procedures and training

62 TMM adopts and teaches a driving style referred to as Progressive Driving. This is a technique which should enable drivers to anticipate and respond to operating and environmental conditions in a way that minimises the risk of an incident. This is in accordance with the Defensive Driving element of the professional train driving initiative recommended by the National *SPAD* Focus Group[1].

63 TMM's Operational Procedure OPS007 Progressive Driving Techniques describes the policy on Progressive Driving. This instructs drivers:

- 'To be particularly careful at locations where signals always display a stop aspect but then subsequently change as a matter of routine. NEVER EXPECT SIGNAL TO CHANGE BUT ALWAYS BE PREPARED TO STOP.'
- 'Unless you can see a proceed aspect is displayed, treat all signals as if at stop.'
- 'Brake early … ensuring that you are in control as you approach the signal. You should always bring a tram to a stand well clear of the signal'

[1] SPADWEB – The website of the rail industry's National SPAD Focus Group (www.spadweb.com)

64 Additionally, TMM's Procedure OPS003 Tram Operation Off-Street Sections instructs the following:

- 'the driver should adjust speed so that it is always possible to bring the tram to a safe stop on the service brake within the distance that can be seen to be clear. It should only be necessary to apply greater braking force, including track brakes, in an emergency.'

Operational data from TMM

65 Data records on the number of *Signals Passed at Stop* (SPAS) were reviewed. Drivers are trained that passing a stop aspect will be detected by the track circuit, which in turn shows on the signalling system mimic in the control room and alerts control room staff. TMM document CMP 020 states that staff are to immediately complete a report form and return it to the depot following any SPAS. There are a few areas on the street running section that do not show a failure if a signal is passed, reporting in these locations generally relies on the honesty of the drivers, although there maybe CCTV, especially at junctions controlled by UTC, and road users may report such incidents. There is therefore a high degree of confidence in the data on SPASs.

66 The data indicates that there have been 37 SPASs, including this accident, since operations began in 1999. There was one previous SPAS at New Swan Lane Level Crossing on 8 March 2001. Since the service pattern was changed in 2001 to increase the headway between trams the number of SPAS incidents has reduced to between 1 and 3 per year. There are 30 signals on the network and each is passed over 100 times per day. Without knowing the number of times each of these displays a stop aspect to an approaching tram it is not possible to calculate the probability of a SPAS. However, if each displayed a stop on 10 % of approaches this would indicate a SPAS probability of less than 10^{-4} per signal. The 10 % figure is considered realistic as the signalling system generally acts to give priority to trams (see paragraph 25).

Brake performance tests

67 A series of service brake tests and comparisons were undertaken following the accident. The tests and comparisons are described below:

- Post incident full service brake tests, consisting of measuring the stopping distance of tram 06 with 100 % service brake from 70 km/h on the network. This was repeated 9 times in each direction from the appropriate cab.
- Comparison of results from above with those from previous tests on tram 06.
- Comparison of results from above with those from previous tests on other trams.
- A limited number of full service brake applications were also made from 30 km/h, the speed at which the driver selected full service brake during the accident, on a selection of trams.

68 All testing was undertaken at *Tare weight* and in dry conditions.

69 The post incident testing indicated that although tram 06 service braking distance from 70 km/h was, on average, 13 % greater than the other trams tested it was within specification.

70 TMM undertook tests on a random selection of trams, plus the tram involved in the accident, to determine the hazard brake stopping distance from 30 km/h to assess whether tram 06 would have collided with the taxi if the driver had selected the hazard brake instead of full service brake.

71 The maximum stopping distance from 30 km/h from the tests was 15 m. Tram 06 stopped within 14 m. There is no specified stopping distance at 30 km/h, however for this collision to have been avoided the tram would need to have stopped within 25 m of the location where the driver applied 100 % service brake or 17 m from the location where the driver sounded the horn.

Previous occurrences of a similar character

72 There have been seven previous collisions at New Swan Lane Level Crossing. These have occurred evenly spread over time since the metro came into operation in 1999. However, all of these incidents were a result of failures on behalf of road traffic users. These have resulted in a permanent speed restriction of 30 km/h at the crossing and a high level repeater signal for road traffic.

Analysis

Identification of the immediate cause

73 The immediate cause of the accident was the driver failing to stop the tram at the signal displaying a stop aspect.

74 The driver expected the signal to change to a proceed aspect as the tram approached it. It was only on realising that the signal was unlikely to change that the driver selected full service brake. This did not prevent the tram traversing the crossing.

Identification of causal and contributory factors

75 A number of issues were considered to identify factors that may have contributed to the accident. These are discussed in the following sections.

Signal remaining at stop aspect

76 The system is set up to detect the approach of a tram and to initiate a sequence of aspects that give the tram a proceed aspect at New Swan Lane Level Crossing. If the signal does not clear due to a pedestrian request, a tram coming in the opposite direction or non-detection of the tram, the safety of traffic is assured by the tram signal remaining at stop and the tram operating rules instructing drivers to stop at signals displaying a stop aspect.

77 Statements from other drivers indicated that although it was normal for the signal at this crossing to change to a proceed, it was not unusual for it to remain at stop. This scenario can be generated by a demand from a pedestrian or a tram travelling in the opposite direction as explained in paragraphs 26 and 27.

78 The signalling system is therefore not considered causal or contributory to the accident.

Driver's approach to the crossing

79 This is the only level crossing on the system; it is a relatively complicated crossing for drivers since they have to reduce the tram's speed to the crossing speed and be prepared to stop if they do not receive a proceed aspect.

80 Evidence indicates that the driver was aware of the location and that there were no internal or external distractions or time pressures that could have affected the drivers' approach to the crossing.

81 The driver expected the signal to change to a proceed aspect on approach, as had always been the case (paragraph 58). The tram data recorder shows the tram being slowed to the crossing speed and then the brakes being released. Discussions with other drivers indicate that it is unusual practice for all braking effort to be removed on approach to the crossing. However, this is compatible with a driver expecting the signal to change.

82 The Driver was not following the Progressive Driving procedure on the approach to the crossing. Had it been followed, the driver would have been prepared for the signal not to change and would have ensured that the tram's speed was slow enough for it to have been bought to a stop before it reached the signal.

83 The limited experience of the driver raises the question as to how well the training has enforced the Progressive Driving principle. The driver training programme is generally structured along the lines of allowing drivers to practice normal driving, however it does include a single unexpected scenario. Had there been more exposure to unexpected scenarios and hazard conditions during the driver training programme it may have better enforced the need for, and practice of, Progressive Driving. However, the SPAS statistics indicate that the principles of Progressive Driving are generally well adhered to.

84 Not following the principles of the Progressive Driving procedure is considered the root cause of the accident.

85 Experience at TMM has shown that drivers are between two and three times as likely to be involved in a safety-related incident in their first six months of driving compared to the average post this period. This performance trend is generally found in newly qualified car, bus and train drivers, as well as drivers on other tramways.

86 The limited experience of the driver may have contributed to the accident.

Service brake performance

87 The post incident testing indicated that tram 06 braking distance from 70 km/h was within specification (paragraphs 67 to 69).

88 Comparison with results from previous tests of tram 06 showed no deterioration in the braking performance.

89 The distance to stop at the accident was 9 m (30 %) longer than that recorded during the testing of tram 06; however, the initial deceleration rates were comparable indicating no delay in achieving brake effort. If the tram had achieved the shorter braking distance during the accident it would still have collided with the taxi. It has not been possible to conclusively explain the longer braking distance. However, the different distances do not affect the root cause of the accident.

90 Service brake tests from 30 km/h on a selection of trams indicated that none of the tested trams would have stopped before the collision with the taxi.

91 The service braking performance of tram 06 is therefore not considered causal or contributory to the accident.

Non-use of the hazard brake

92 The testing undertaken demonstrated that if the driver had applied the hazard brake at the time of sounding the horn, then the tram would have stopped before it collided with the taxi, although the tram would have encroached onto the crossing by up to 2 m.

93 The driver had only once previously applied the hazard brake and that was during training. Whilst TMM originally undertook training in the application of the hazard brake from full speed, problems with *wheel flats* resulted in the speed being reduced to 15 km/h in 2000. Therefore the driver had neither an instinctive reaction to apply the hazard brake when in a dangerous situation nor appreciation of its effectiveness from greater speeds.

94 During training drivers are briefed on the possibility of causing injuries to passengers on application of the hazard brake. During interviews drivers raised concerns as to the degree of injury, or even fatality, that passengers may suffer should they apply the hazard brake. They reported that this would be a consideration before they would decide to apply the hazard brake in an incident.

95 Discussions with drivers indicated that there was a view amongst them that the TMM organisation discouraged the use of the hazard brake, unless it was to protect against something beyond the drivers' control.

96 During training TMM instructs all drivers that any applications of the hazard brake are to be notified to Control and a report completed. This report is generated to allow TMM to record details should there be reports of injuries sustained by passengers.

97 The limited use in training, the way in which the possibility of causing injuries to passengers is trained, the awareness of the possibility of causing wheel flats and the requirement to complete a report following any application combine to discourage drivers from using the hazard brake.

98 Discussions with drivers revealed that application of the hazard brake to mitigate the effects of other road users actions, eg to avoid a road traffic accident, was more likely to be a natural reaction than using it to protect against their own errors.

99 The driver's view that use of the hazard brake was discouraged, the lack of familiarity with its performance (due to minimal training in its use) and briefing on the possible effects of its use are considered to be contributory to the accident.

Conclusions

Immediate cause

100 The immediate cause of the accident was the driver of the tram failing to stop at the signal displaying a stop aspect.

Causal and contributory factors

101 The causal factor leading to the collision was that the driver expected that the signal would change to a proceed aspect before the tram reached the crossing. This is considered to be a consequence of the driver not adhering to the principles of Progressive Driving. The limited experience of the driver may have contributed to the accident.

102 The driver's decision not to apply the hazard brake on realising that the signal was unlikely to change to a proceed aspect contributed to the accident. The underlying cause behind this decision was the view amongst drivers that use of the hazard brake was discouraged (recommendation 1 and 2).

103 The lack of familiarity with the performance of the hazard brake (due to minimal training in its use) and the briefing on the possibility of causing injury to the passengers and damage to the tram contributed to the driver's decision not to apply the hazard brake (recommendation 1).

104 Newly qualified tram drivers with less than six months experience are more likely to be involved in a safety-related incident than those who have been driving for a longer period (paragraph 85). Statistics show that the extent of this phenomenon at TMM is not dissimilar to that experienced on other tramway systems (and by car, bus and train drivers). No safety-related incidents on the system involving a newly qualified driver, prior to this event, has involved any injuries (Recommendation 1).

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

105 TMM issued a memo on 12 June 2006 to tram drivers reinforcing hazard awareness at the New Swan Lane Level Crossing

106 TMM has modified the driver training programme to give drivers experience of comparative braking from varying speeds using both the service and hazard brakes. Additionally, they have undertaken a review of driver training procedures against the proposed National Occupational Standards. TMM has now developed and started to apply a 'working draft' of the National Occupational Standards for light rail vehicle driver training (TMM Procedure OPS-054).

107 TMM have reviewed the crossing layout arrangements and approach speed signage locations. The road and tram signals at the junction have now been replaced with high intensity signal heads and the Wolverhampton bound speed board for the 30 km/h permanent speed restriction has been moved 25 m further away from the crossing.

108 TMM have produced specific briefing material on both Swan Lane Level Crossing (D-TBT 001) and Hazard Brake Application (D-TBT 002) and are briefing their drivers on these two documents.

Recommendations

109 The following safety recommendations are made[2]:

Recommendations to address causal and contributory factors

1. TMM should review the driver training programme:
   - to ensure familiarity with use of the hazard brake, both at initial and refresher training (paragraphs 102 and 103).
   - to ensure that the training given to new drivers is keeping risks as low as is reasonably practicable; in particular they should consider the need for specific monitoring and assistance for newly qualified drivers (paragraph 104).

2. TMM should review the arrangements for reporting and follow up on use of the hazard brake to ensure that they are not acting to discourage driver's use of the hazard brake (paragraph 102).

[2] Responsibilities in respect of these recommendations are set out in the Railways (Accident Investigation and Reporting) Regulations 2005 and the accompanying guidance notes, which can be found on RAIB's web site at www.raib.gov.uk

Appendices

Glossary of abbreviations and acronyms — Appendix A

SPAD	Signal Passed At Danger
SPAS	Signal Passed At Stop
TMM	Travel Midland Metro
TRTS	Tram Ready To Start
UTC	Urban Traffic Control

Glossary of terms — Appendix B

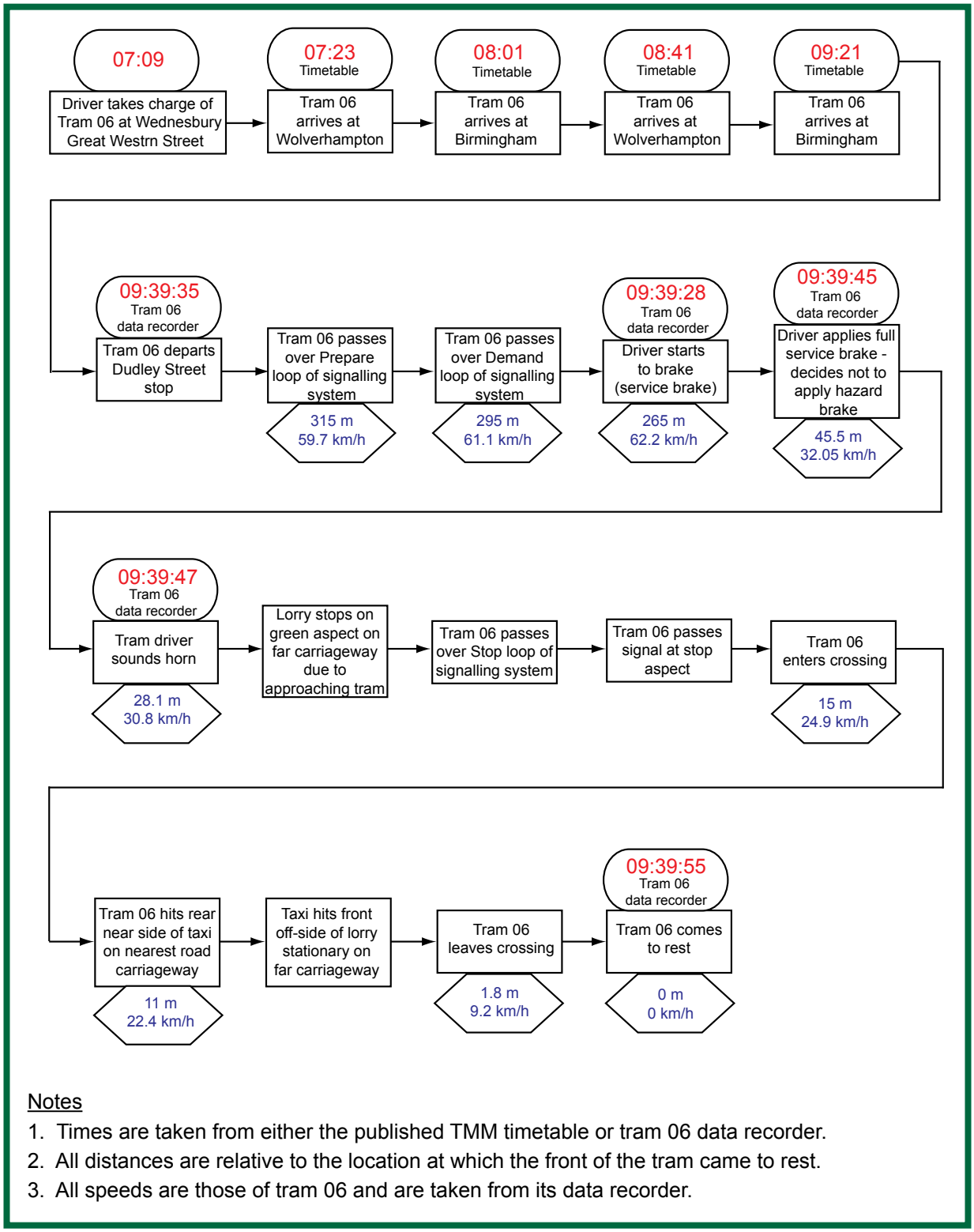
Data Recorder	A device fitted to trams to record and store key tram parameters and driver actions.
Defensive Driving	A technique which focuses on enabling the driver to anticipate and respond to operating and environmental conditions in a way that minimises the risk of an incident. Defensive driving is one element of the professional train driving initiative recommended by the National SPAD Focus Group.
Demand Loop	Track based receiver that detects the presence of a tram and initiates a timed signalling system sequence.
Hazard Brake	A brake that provides a high rate of retardation for use in emergency situations. The rate is higher than would normally be acceptable to passengers. Passengers and luggage may fall over when the hazard brake is applied.
Limit of Shunt	A signal, usually a board, marking the point beyond which trams must not pass during shunting operations.
Line of Sight	Mode of operation whereby the tram should be able to stop before a reasonably visible stationary obstruction ahead from the intended speed of operation, using the service brake.
National SPAD Focus Group	The industry body leading the driver to reduce the incidence of signals passed at danger on the UK rail network
Prepare Loop	Track based receiver that detects the presence of a tram and arms the signalling system to expect a tram.
Progressive Driving	TMM's policy to achieve the "Defensive Driving Initiative" promoted by the National SPAD Focus Group.
Service Brake	The braking system that is used to control speed and bring the tram to a halt during normal operation.
Signal Passed at Danger	An event where a driver fails to bring a train to rest before passing a signal displaying a danger (red) aspect. An expression generally used on the mainline railway.
Signal Passed at Stop	An event where a driver fails to bring a tram to rest before passing a signal displaying a stop aspect. An expression generally used on light rail systems.
Stop Loop	Track based receiver that detects a manually initiated signal from a tram and initiates a signalling system sequence.
Tram Ready To Start	A system by which a tram driver can initiate the tram phase of the signalling system.
Tare Weight	The weight of an empty railway vehicle
Urban Traffic Control	The process of controlling and managing signals at traffic junctions from a centralised computer.

Vecom	A proprietary system used to detect the presence of a tram at specific locations on the network
Wheel flats	A form of wheel damage caused by the wheel skidding on the rail instead of rotating

Summary of the event chain

Appendix C

The chain of events from the time at which the driver took charge of tram 06 is presented below.:



Notes

1. Times are taken from either the published TMM timetable or tram 06 data recorder.
2. All distances are relative to the location at which the front of the tram came to rest.
3. All speeds are those of tram 06 and are taken from its data recorder.

This report is published by the Rail Accident Investigation Branch,
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