RAIB
Rail Accident Investigation Branch

Rail Accident Report

Runaway incidents on Blackpool Transport Services Tramway, 21 November, 3 and 10 December 2005

Department for Transport

Report 05/2006
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This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 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 This report contains the findings of the RAIB investigation into the incidents on the Blackpool Tramway on 21 November and 3 and 10 December 2005 in which trams ran away or failed to stop when they should have done.

4 The purpose of the investigation was to establish:

- the causes of the individual incidents, and whether there was a relationship between them;
- the potential contribution of the infrastructure, rolling stock, operational methods, management, organisation and any other relevant factors.

5 Access was freely given to Blackpool Transport Services Tramways' staff, data and records

6 Appendices at the rear of this report contain Glossaries explaining the following:

- acronyms and abbreviations are explained in the Glossary at Appendix A; and
- certain technical terms (shown in *italics* within the body of this report) are explained in the Glossary at Appendix B.

Summary

7 This report covers three separate incidents. They were all associated with an abnormal method of operating the tramway. The tram operating company usually schedules track repairs and renewals to take place during the winter months. This involves closure of one of the two lines of this double track tramway, and trams in both directions have to use the other line. During late 2005, track renewals meant that *single line working* was taking place between Gynn Square and Talbot Square, over a distance of about one mile, and it was necessary for southbound trams to change direction twice at each end of this section to reach the opposite track (see Figure 2 at paragraph 16).

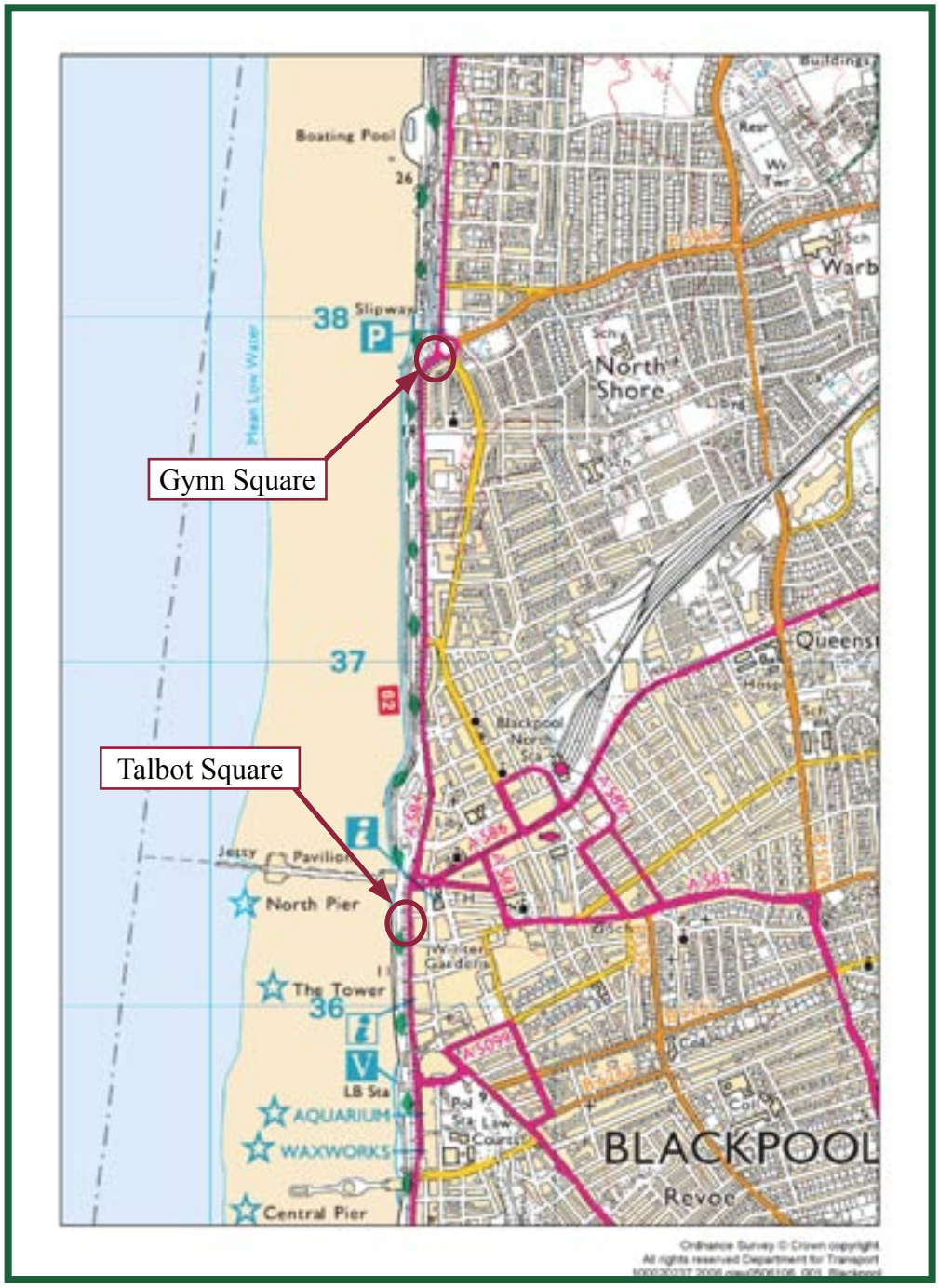

Figure 1: Extract from Ordnance Survey map showing location of incident

8 The first incident occurred on Monday 21 November 2005 at Talbot Square. Tram 644, travelling south, was leaving the single line section. The tram carried out the manoeuvres required, and following the second change of direction, the driver had just started the tram when the controller handle became detached. The driver was unable to replace the handle, and so he attempted to apply the *emergency brake* (activated by a button in the cab). The *emergency brake* failed to act and the tram, which was not under power, continued to roll down a gradient of about 1 in 100 along the promenade as far as the Old Lifeboat House (about 600 metres), where the gradient levelled out and it came to a stop.

9 The second incident was on Saturday 3 December 2005 at Gynn Square. The driver of tram 646, travelling south, left his cab to change ends for the reversal at the start of *single line working*. As he was walking through the tram it began to move and struck the barrier protecting the track repair works after rolling 5 metres. The driver then applied the *emergency brake* and the tram stopped.

10 The third incident occurred on 10 December, also at Gynn Square, and again involved tram 646. After completion of the reversing manoeuvre, the driver moved the tram forward a short distance, some 10 metres, and then attempted to stop to allow a member of staff to alight. The tram did not respond to a *service brake* application, so the driver applied the *emergency brake* and the tram stopped after moving about 27 metres past the point where the driver had intended to stop.

11 A different driver was involved in each incident.

12 The immediate cause of the first incident was the poor condition of the tram controller housing which allowed the handle to come off its spigot while the tram was moving.

13 The immediate cause of the second and third incidents was the design of the tram controller housing. This permitted the controller shaft to move as the control handle was removed by the driver and consequently released the *service brake* without the driver being aware that this had occurred.

14 Contributing factors were:

- The driver had not been trained to apply the *emergency brake* when changing ends (first incident);
- The driver did not apply the *emergency brake* before leaving the cab despite being trained to do so (second incident);
- The location of the reversing points for *single line working* on sloping sections of track (all incidents);
- The design of the controller handle and shaft end, which enabled the shaft to be inadvertently 'flipped' (see paragraph 22 and Figure 9) when the handle was removed (second and third incidents); and
- Failure to inspect and maintain the controllers, so that the loose end cover was not detected or rectified (first incident).
- An instance of exceptionally (for Blackpool) cold weather and freezing fog (first incident).

15 Several measures to improve safety were discussed with the tramway operator during the investigation These are listed at paragraph 45 of this report. All of these have now been implemented.

The Investigation

Background

16 The Blackpool tramway system is double track throughout its eleven mile length from Fleetwood to Starr Gate. It is operated by Blackpool Transport Services Ltd (BTS), a subsidiary of Blackpool Borough Council, which is the owner of the tramway infrastructure. Beginning on 7 November 2005, the Council carried out work to renew and repair approximately 200 metres of track on the section between North Pier (Talbot Square) and Gynn Square. The east track was dealt with first, with *single line working* over a one mile length of the west or seaward track (see Figure 2 below). The west track is segregated from road traffic, as is most of the tramway along the promenade and northwards.

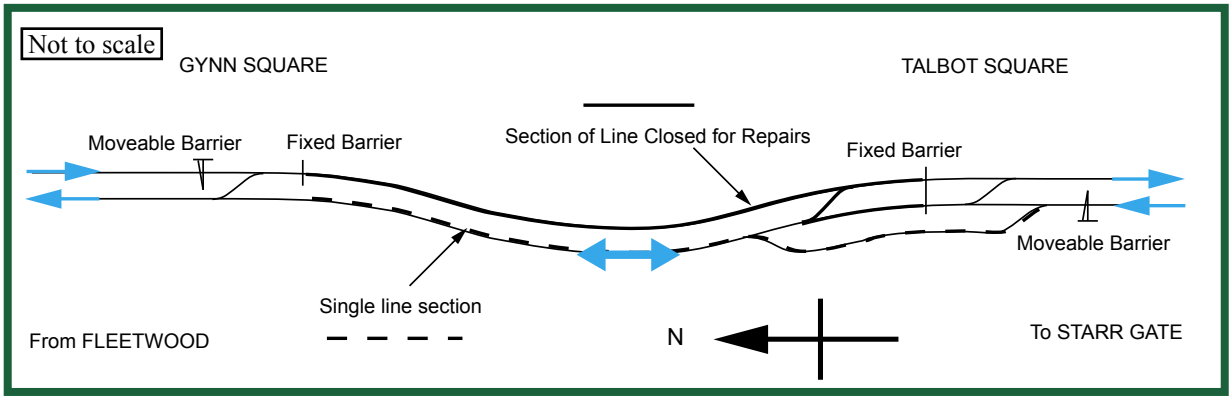

Figure 2: Diagram of lines between Gynn Square and Talbot Square

17 The north end of the single line section, at Gynn Square, is on a gradient of approximately 1 in 30 falling from north to south. The south end, at Talbot Square, is on a gradient of approximately 1 in 100, also falling towards the south.

18 A 'Single Line Supervisor', who was on duty the whole time that trams were running (from approximately 06.30 hrs to 01.00 hrs daily), was in attendance at each end of the single line section. The method of working for southbound trams required drivers to stop at a swinging-gate barrier erected a short distance north of the crossover between the two tracks at Gynn Square (see Figure 3). If there were no northbound trams on the single line, and the driver was in possession of the *baton* authorising the tram to occupy the single line, the supervisor unlocked the gate and the tram passed through it. A fixed barrier protected the section of track that was under repair (see Figure 4).

Figure 3: Southbound tram approaching the temporary swinging gate at Gynn Square

Figure 4: Fixed barrier at Gynn Square

19 The tram driver was then required to change ends, drive the tram over the crossover onto the west track, and change ends again before setting off south, carrying the *baton* with him. The supervisor's duty was to assist the tram driver in changing ends and remain in radio contact with his opposite number at the other end of the single line section.

20 The layout at Talbot Square includes a third line on the west or seaward side. For the initial period of *single line working*, trams used the third line to reach the end of the single line section, enabling both main tracks to be worked on simultaneously. This also meant that southbound trams had to change direction twice at Talbot Square to regain the east track (see Figure 2).

Figure 5: Temporary swinging gate at Talbot Square, looking north

Figure 6: Tram 646, involved in two of the incidents

21 BTS operates a variety of stock of varying ages on the Blackpool tramway. During the winter months, the service on the tramway is mainly provided by the most modern vehicles in the BTS fleet, the 'Centenary' and 'Jubilee' tramcars. The eight single deck 'Centenary' cars (see Figure 6 above) are mechanically and electrically similar to the two double deck 'Jubilee' cars, and all ten date from the 1980s. They incorporate *thyristor control* systems operated through a single combined power/brake controller. The detachable controller handle engages with a spigot on the controller shaft, and the shaft end cover plate is designed to ensure that the controller handle can only be removed when the shaft is in the 'brakes fully applied' position. The shaft end cover plate is secured in place with three screws.

22 The photographs below (Figures 7 and 8) show the controller with and without the handle in position. The handle is pushed fully forward to apply power, and pulled back to brake. A foot pedal must also be depressed to obtain power, but release of this pedal does not apply the brake. The controller has a central neutral position. It is possible to withdraw the controller handle in such a way that in disengaging from the shaft it 'flips' the controller shaft from the brake to the neutral position (see diagrams, Figure 9). If this happens it is impossible for the driver to replace the handle. A special fork tool must be used to reset the shaft position. This tool is carried by operating supervisors and fitters, but not by drivers.

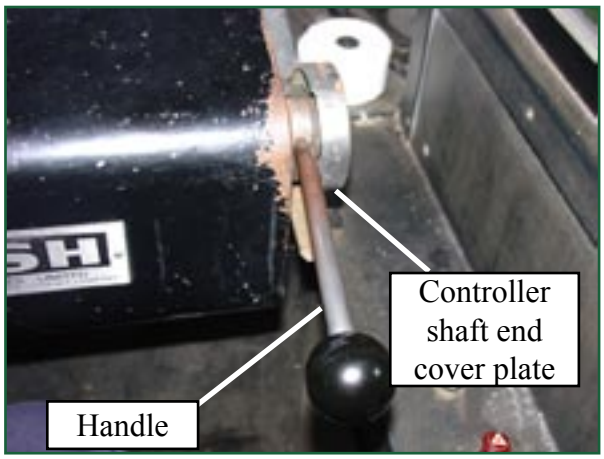

Figure 7: Controller with handle in place

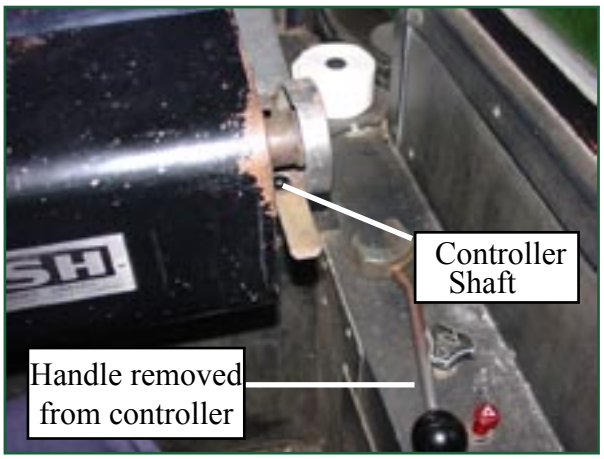

Figure 8: Controller with handle removed

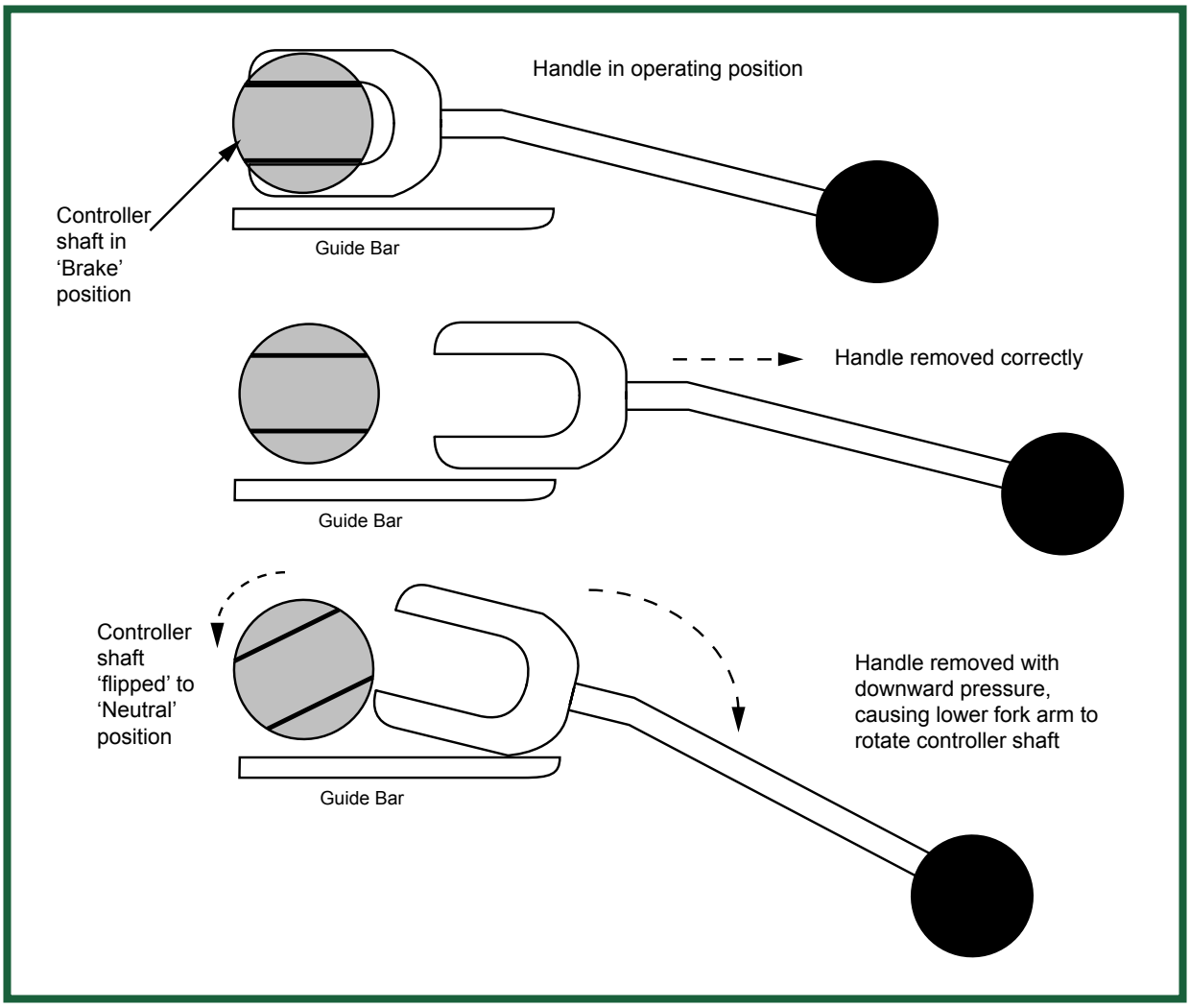

Figure 9: Removal of handle and 'flipping' of controller shaft

23 The control circuits are so arranged that if a controller shaft is 'flipped' out of position in this way, power and braking cannot be obtained from the controller at the opposite end of the tram until the shaft is reset.

24 The braking system of these trams is operated by compressed air, and the system layout and components are derived from commercial road vehicle practice. However, the trams are also fitted with an emergency/parking brake system operated from latching push-buttons. There is one button in each cab and one above each set of doors, making six in all. Operation of any button sends a signal to the multi-circuit relay valve, which opens to exhaust the air from the brake chambers, and spring pressure applies the brakes. The drop in chamber pressure is confirmed by a tell-tale light on the cab *bulkhead* at both ends of the tram, which illuminates when pressure falls below 20 pounds/square inch. Drivers are instructed to wait until this light comes on, in order to confirm that the brakes are applied, before removing the controller handle and leaving the cab.

The first incident: 21 November 2005

25 On Monday 21 November there was freezing fog on the promenade which had persisted all day. 'Centenary' car 644 passed through the single line section at about 17.30 hrs. On reaching Talbot Square, the double reversal manoeuvre was carried out, with passengers on board, and the driver applied power to continue towards Starr Gate. As he did so, the controller end cover came loose and the handle slipped off the end of the shaft. The driver was unable to refit the handle to regain control of the tram, so he released the foot pedal, which cut off the power, and used the button in the cab to attempt to activate the *emergency brake*. There was no response from the brakes and the tram continued to roll on the falling gradient. The driver operated other emergency stop buttons but none had any effect. The tram travelled about 600 metres to the Old Lifeboat House, where the track becomes level, and then rolled to a stop. This section of track is segregated from road vehicular traffic, there were few pedestrians about, and no collision occurred.

26 Examination of the tram after this incident showed that the controller shaft end cover plate was loose and one retaining washer was missing. After this had been replaced and the cover plate tightened, the emergency braking system was tested and found not to work. There was severe frosting on the outside of the air pipes adjacent to the multi-circuit valve. After the tram was placed in a heated shed and left for two hours the system was tested again, and worked normally.

27 This driver had not been trained in the use of the *emergency brake* when changing ends, which should be standard practice on this type of tram.

The second incident: 3 December 2005

28 On Saturday 3 December car 646 was in service southbound at Gynn Square with about 50 people on board. It stopped at the first barrier and then moved forward south of the points. The driver then left the cab to change ends. As he was walking through the tram it began to move and struck the second barrier at the entrance to the section under repair. The driver ran to the nearest cab, which was at the north end, and applied the *emergency brake*. The tram stopped, having pushed the sandbags which formed the second barrier back by about three metres.

29 The driver returned to the south end cab and discovered that he was unable to insert the handle into the controller because the shaft had 'flipped' (see Figure 9). He called the Single Line Supervisor, who used a thin fork tool to reset the position of the shaft.

The third incident: 10 December 2005

30 On Saturday 10 December 2005, car 646 was again in service southbound at Gynn Square. The driver, assisted by the Single Line Supervisor, carried out the manoeuvre onto the west track. He then released the *emergency brake* and started the tram, but when he applied the *service brake* to stop at the tram stop immediately south of the crossover the tram did not respond. The driver tried the *service brake* two or three times, but there was still no response, so he operated the *emergency brake* button and the tram stopped in about two metres, having travelled onto the single line section about 25 metres past the point where the driver was intending to stop. On investigation, the controller in the north end cab was found to be 'flipped' to the 'neutral' position (see Figure 9).

31 The first and second incidents were notified to RAIB, but were not selected for investigation. The initial investigation was therefore carried out by BTS. The actions taken following the first incident have been described above.

32 Following the second incident, BTS concluded that the driver had not applied the *emergency brake* before changing ends.

33 The third incident was notified to RAIB on 11 December 2005. In view of the two previous incidents, an RAIB investigation into the series of runaways was launched. Two inspectors visited Blackpool on 12 December 2005 and interviewed members of staff. Tram 646 and the *single line working* arrangements between Gynn Square and Talbot Square were also examined.

Analysis

34 The first incident occurred during abnormal weather conditions in that freezing fog persisted throughout the day. This is extremely unusual in Blackpool, where the influence of the sea temperatures in Morecambe Bay means that average minimum winter temperatures are 2-3 degrees Celsius above those recorded inland in the south of England, and sub-zero temperatures are much less common than in inland areas.

35 The loose controller end cover meant that the controller handle was not properly retained on the spigot and could be inadvertently removed when being moved to the "power" setting. This left the driver able to shut off power by removing his foot from the pedal, but with no means of applying the *service brake*. He therefore attempted to use the *emergency brake*, which failed to operate. Any compressed air system which uses air from the atmosphere will (unless special dryers are used) contain water, which condenses from the atmosphere in the normal operation of the system. System dryers are used to remove this condensate, but when the external air temperature drops below freezing increased quantities of moisture will be carried around the system. It is therefore important that valves are used regularly to reduce the risk of freezing.

36 The driver in the first incident had not been trained to use the *emergency brake* each time he changed ends, so the *emergency brake* system on tram 644 had not been used during the day. Examination of the tram following the incident showed severe frosting on the outside of the air pipes adjacent to the multi-circuit valve. The tram was taken to the depot and allowed to stand for two hours, after which the *emergency brake* operated normally. The conclusion that can be drawn from this is that as the temperature dropped in the evening, the multi-circuit valve froze and failed to apply the brakes when required.

37 BTS has now added lagging to the pipework in this area to reduce the risk of freezing of moisture in the pipes and valves.

38 Following the incident, BTS immediately reviewed the training records of all tram drivers and identified those who had not been instructed in the use of the *emergency brake* in this situation. The reason for this omission, which had occurred some years previously, could not be identified. These drivers were then briefed individually. A notice was issued reminding all drivers of the importance of following the procedure.

39 The second and third incidents had in common the 'flipping' of the controller shaft when the handle was withdrawn, as shown in Figure 9. Tests showed that this can be done relatively easily if the driver leans on the handle while getting up from the seat and at the same time pulling the handle out of the controller - a combination of actions which is quite normal for a heavily built person in easing themselves from the driver's seat.

40 This phenomenon had been known about by BTS for a number of years, and the thin forks had been manufactured to enable controllers to be reset easily. It had been regarded as a nuisance but the safety risk had not been appreciated until this particular sequence of incidents. A modification to the end cover to make it impossible to 'flip' the shaft was

designed after the second incident, and a prototype had been constructed and fitted to a tram in the company's workshops when the third incident occurred. This modification has since been applied to the whole fleet. BTS has also designed a parking brake operating mechanism which can be used by the driver in an emergency, and trials of this will take place early in 2006.

41 The need to reverse on a gradient is not a normal part of tram operations in Blackpool, but in connection with the track renewal between Gynn Square and Talbot Square, every southbound tram was required to reverse on gradients of 1 in 30 and 1 in 100 at the ends of the single line section. This exposed the risk of a runaway if the braking system was not handled correctly.

42 In the second incident, the tram would not have run away if the driver had followed the correct procedure and applied the *emergency brake* before leaving the cab. Omitting this step meant that as soon as the controller shaft was 'flipped', the brakes were released and the tram rolled down the hill, being stopped by the *emergency brake* and by running into the barrier at the start of the track under repair.

43 In the third incident, the driver had correctly carried out the procedure for changing ends. He was unaware that the controller in the north end cab had been disabled by the 'flipping' of the shaft and the effect that this would have on the controls at the other end of the tram. He tried to take power from the south end cab, and the tram moved off; in fact it was moving only under gravity. Application of the *service brake* had no effect, but the *emergency brake* stopped the tram very quickly.

Conclusions

44 The immediate causes of the first incident were the loose controller cover, which permitted the controller handle to come off the shaft when it was pushed to the 'power' position, and the freezing of the *emergency brake* relay valve, which prevented the brakes from being applied.

45 The immediate cause of the second and third incidents was the inadvertent 'flipping' of the controller shaft by the drivers as the control handle was removed.

46 Contributing factors were:

- The driver had not been trained to apply the *emergency brake* when changing ends (first incident);
- The driver did not apply the *emergency brake* before leaving the cab despite being trained to do so (second incident);
- The location of the reversing points for *single line working* on sloping sections of track (all incidents);
- The design of the controller handle and shaft end, which enabled the shaft to be inadvertently 'flipped' (see paragraph 21 and Figure 9) when the handle was removed (second and third incidents);
- Failure to inspect and maintain the controllers, so that the loose end cover was not detected or rectified (first incident); and
- An instance of exceptionally (for Blackpool) cold weather and freezing fog (first incident).

Recommendations

47 During the RAIB investigation, the measures described below were identified and discussed with BTS. All of them have now been implemented.

1 Following the first incident, BTS took action as described in paragraphs 37 above to fully brief drivers about the correct procedures when changing ends.

2 BTS lagged air pipes on the 'Centenary' and 'Jubilee' tramcars to reduce the risk of the braking system freezing, as described in paragraph 36. RAIB agrees these actions would mitigate the risks associated with the first incident.

3 After the second incident, BTS designed a modification to the controller end cover which prevents the shaft from turning while the handle is being removed. A prototype was inspected during the RAIB's investigation. A production version has since been fitted to all ten trams with this type of controller.

4 Inspection and maintenance procedures for the controllers were reviewed following the first incident. Controllers are now inspected daily and the screws securing the covers tightened if necessary, and records are kept of this check.

Appendices

Glossary of abbreviations and acronyms — Appendix A

BTS	Blackpool Transport Services

Glossary of terms — Appendix B

Baton	Wood or metal staff used to provide physical confirmation that a tram has authority to occupy a single line section
Bulkhead	Interior partition in a tramcar
Emergency Brake	System which is designed to apply the brakes of the tram when a button is pressed.
Service Brake	The normal braking system used by a tram driver
Single Line working	A method of operating a tramway or railway when only one (of two) lines is available for use
Thyristor control	A system which uses switched electronic components to vary the power applied to the motors of a tram and hence the speed of the vehicle

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