Rail Accident Investigation Branch

Rail Accident Report

Derailment of a Docklands Light Railway train near West India Quay station, London, 10 March 2009

Department for Transport

Report 03/2010
March 2010

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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Contents

Preface

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.

Key Definitions

3 Appendices at the rear of this report contain the following glossaries:

- abbreviations are explained in appendix A; and
- technical terms (shown in *italics* the first time they appear in the report) are explained in appendix B.

Summary of the Report

Key facts about the accident

4 At 10:02 hrs on 10 March 2009, the 09:50 hrs Docklands Light Railway (DLR) service from Bank to Lewisham became derailed as it travelled through a set of points at North Quay junction, just north of West India Quay station (figure 1).

5 There were no injuries to the 80 passengers or the *passenger service agent* on board the train.

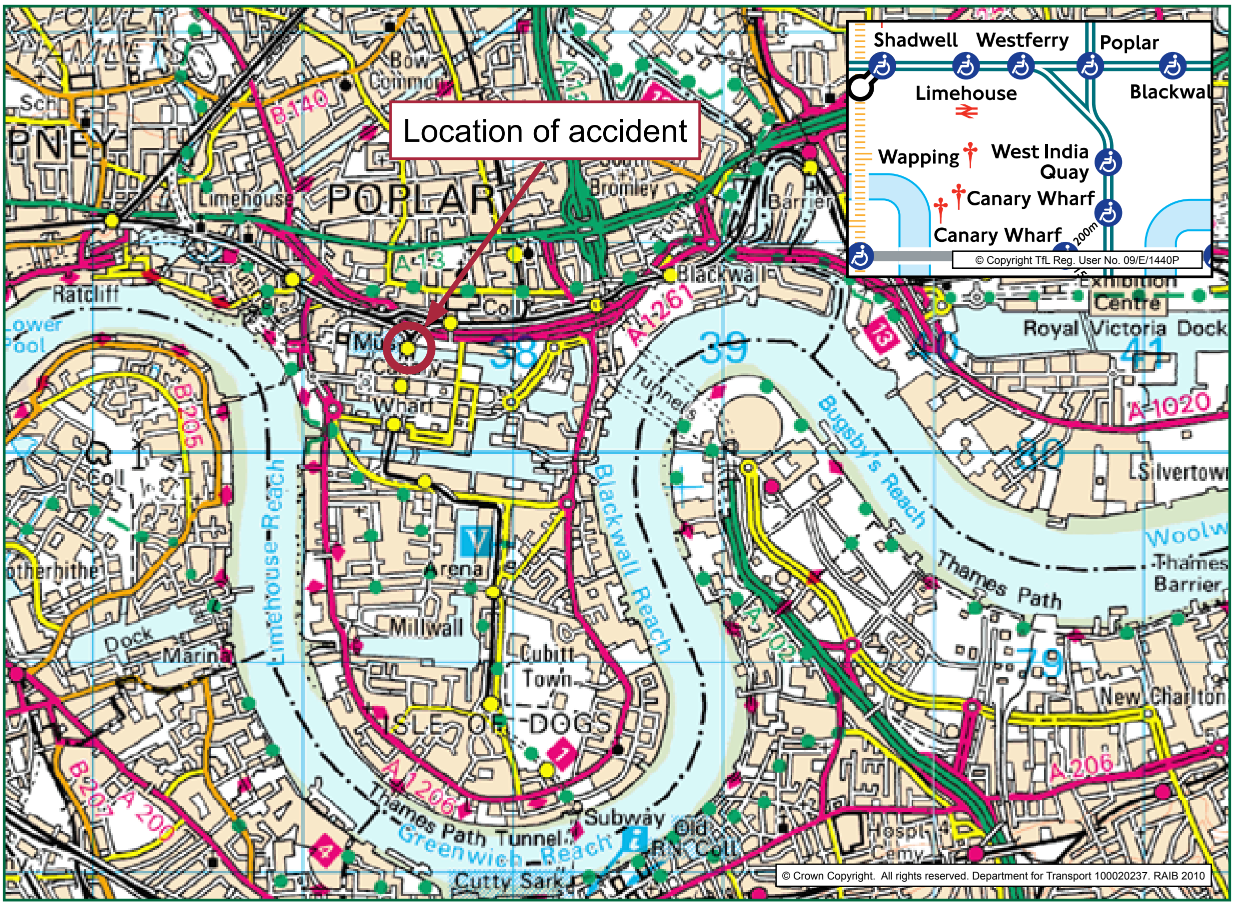

Figure 1: Extracts from Ordnance Survey and Transport for London maps showing location of accident

Immediate cause, causal and contributory factors

6 The immediate cause of the derailment was that the train travelled through the points in a *trailing* direction when the points were not correctly set for this movement, and derailed.

7 Causal and possible causal factors were:

- the passenger service agent did not identify that the points were set reverse, and stop the train;
- the passenger service agent did not see the unlit *point position indicator* and stop the train at the indicator;
- the *control centre controller* did not intervene to stop the movement of the train;

- the control centre controller did not follow the *emergency shunt* procedure and reserve 1125 points in the correct (normal) position;
- the control centre controller was not aware of the exact position of train LEW109 because he had the *block occupancy* switched off on his overview; and
- the 'red bar' lamp in 1125B point position indicator was unlit.

8 The following factors were contributory:

- the control centre controller was distracted by having to give instructions to another train in the delta (paragraph 25) and did not notice that 1125 points had moved to an incorrect position;
- the low maintenance frequency of point position indicators and the inadequate range of tests carried out;
- the procedure for passenger service agents to report unlit point position indicators to the control centre was carried out on an ad-hoc basis;
- there was no process or procedure for the exchange of details of unlit point position indicators between signalling maintenance and the control centre;
- the poor conspicuity of point position indicators when unlit;
- the corroded pin of the lamp inside 1125B point position indicator;
- the maintenance organisation were unaware of the unlit 'red bar' lamp;
- the poor sighting of 1125B point position indicator;
- the existing filament type point position indicators are not conspicuous when lit;
- the poor alarm management (paragraph 40);
- the technical problems in the delta area were not quickly resolved; and
- there was no procedure to mandate that block occupancy display should be turned on at times of degraded working.

9 The underlying management factors were:

- inadequate systems for monitoring and reviewing safety performance and for monitoring compliance with rules and procedures;
- the absence of Serco Docklands management systems that could systematically identify process safety indicators; and
- Docklands Light Railway Ltd and Serco Docklands did not have adequate systems in place to satisfy themselves that changes to the infrastructure were being adequately controlled.

10 Additional observation was:

- there was a discrepancy between the content of the Serco Docklands training material and the emergency shunt procedure. In addition, the presentation of material and the assessment of competence related to driving over points in *emergency shunt mode* was inadequate.

Recommendations

11 Recommendations can be found in paragraph 288.

- Four recommendations have been made to Docklands Light Railway Ltd. These cover the areas of:
  - o criteria for the location of point position indicators and the review of their sighting and subsequent improvements;
  - o alarm management systems in the *system management centre* (SMC);
  - o the replacement of all point position indicators with ones that are more conspicuous when lit; and
  - o adequate control of changes to the design and operations of the railway.
- Three recommendations (in addition to the two made as a result of the investigation into the derailment of a DLR train at Deptford Bridge on 4 April 2008[1]) have been made to Serco Docklands. These five recommendations cover the areas of:
  - o the reporting by staff of unlit point position indicators;
  - o monitoring certain staff to assess levels of compliance;
  - o training related to operations in emergency shunt mode;
  - o operational safety management systems; and
  - o identifying safety process indicators.

[1] RAIB report 16/2009, published 22 June 2009, www.raib.gov.uk.

The Accident

Summary of the accident

12 At 10:02 hrs on 10 March 2009, the 09:50 hrs DLR service from Bank to Lewisham (train LEW109) became derailed by both axles of the leading *bogie* as it travelled through a set of trailing points that were not correctly set for the route of the train at North Quay junction, just north of West India Quay station.

13 The train had undergone an earlier automatic emergency brake application initiated by a failure of the signalling between Westferry and West India Quay stations, and was being driven by a passenger service agent in emergency shunt mode.

14 The train was travelling at approximately 10 km/h when it derailed on 1125 points at the junction. The front of the train came to rest 10.3 metres after derailing and approximately in line with the top of the end ramp of platform 2 at West India Quay station (figure 2).

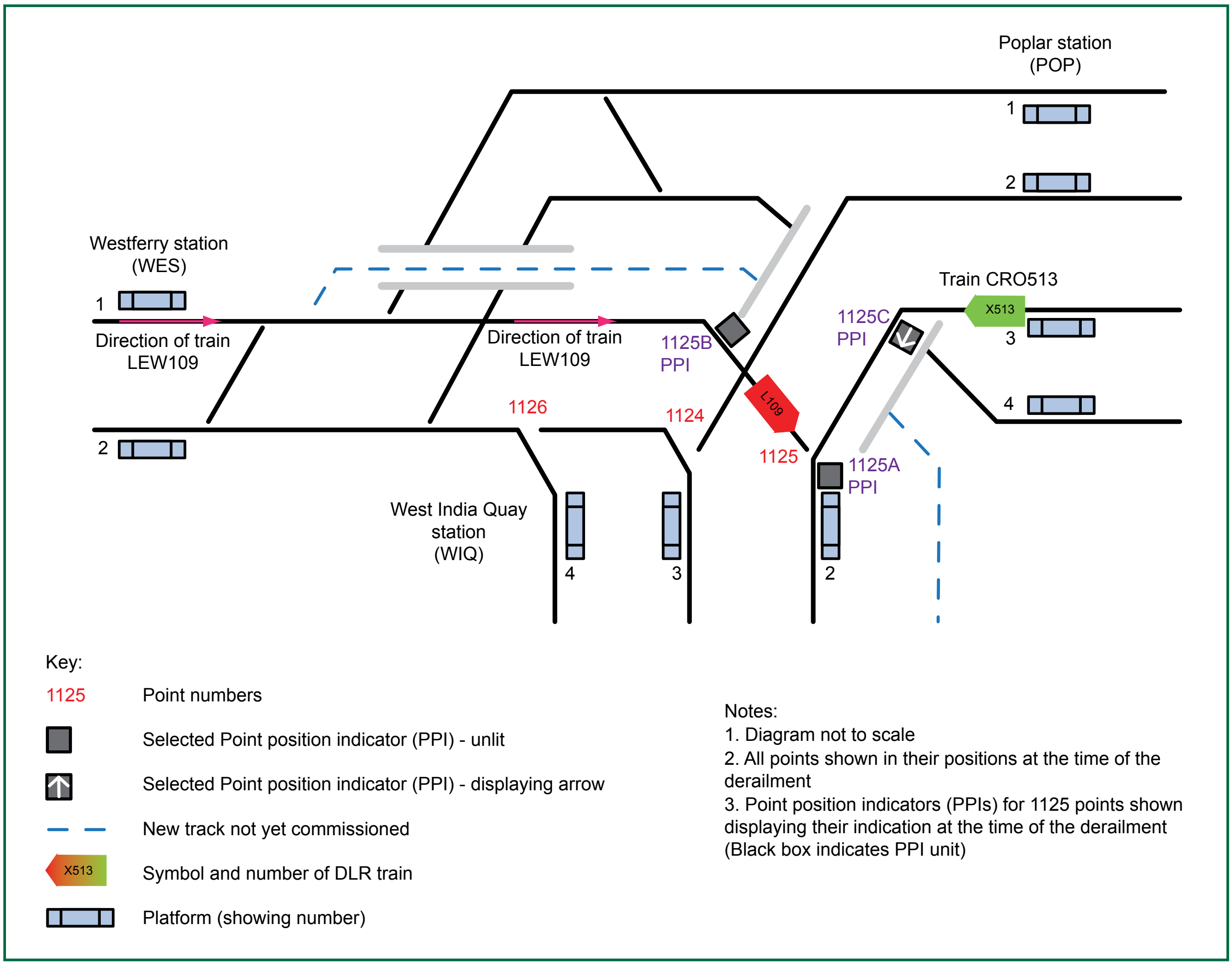

Figure 2: Diagram of the location of the derailment at North Quay Junction

Consequences of the accident

15 There were no injuries to the 80 passengers or the passenger service agent on board the train and all were evacuated safely to West India Quay station.

16 There was minor damage to the track fixings that the derailed wheels had run over and damage to a section of *conductor rail* and its supports. There was also damage to a small section of the concrete *troughing route* and some traction cabling.

17 The train received minor damage to its underside including damage to the shoe gear on the derailed bogie.

The parties involved

18 Docklands Light Railway Ltd is part of Transport for London (TfL) and owns the assets of the railway with the exception of the infrastructure within the *concessionaires'* areas. Docklands Light Railway Ltd oversees the operation of the railway and plans for the future development of the railway. It also manages the operating franchise and concessionaires' contracts to ensure that services are provided and the assets are maintained.

19 Serco Docklands has been the franchise operator for Docklands Light Railway Ltd since April 1997. Serco Docklands operates the whole of the railway and provides maintenance services for specific areas of the network. In May 2006, Serco Docklands was awarded a renewed seven year franchise.

20 Serco Docklands employed the passenger service agent on-board the train and the control centre controller involved in this accident.

21 Serco Docklands has separate engineering and project divisions within its organisation. The engineering division is mainly involved with the day to day operation and maintenance of the railway, while the projects division works with Docklands Light Railway Ltd and other contractors on the development of new projects.

22 Thales Rail Signalling Solutions Ltd (based in the UK) and Thales Rail Signalling Solutions Inc. (based in Canada, and which was formerly known as Alcatel) are jointly contracted to Docklands Light Railway Ltd to undertake alterations to the DLR signalling systems as required. Thales Rail Signalling Solutions Inc. provides the software engineers to design, test and undertake software alterations to the signalling systems installed on the DLR.

23 Since 2007, Thales Rail Signalling Solutions engineers have been working on the planning and delivery of staged alterations to the DLR signalling systems as part of a project to accommodate the operation of three-car trains, and other works associated with the Stratford International extension.

24 Docklands Light Railway Ltd, Serco Docklands and Thales Rail Signalling Solutions freely co-operated with the investigation.

Location

25 The track layout between Westferry, Poplar and West India Quay stations is known as the 'delta' junction. The report makes use of the term 'the delta' to describe this area of the DLR system. The convergence of the line from Westferry with the line from Poplar is located immediately to the north of West India Quay station and is known as North Quay junction.

26 The accident took place on 1125 points at North Quay junction, immediately north of West India Quay station (figure 2). At this location the track is level and constructed on a series of viaduct structures, approximately 9.5 metres above ground level.

27 The DLR lines between Westferry and West India Quay are known as the up and down City lines. The up line is normally used by trains travelling towards Bank station from West India Quay, platforms 3 and 4, and the down line is normally used by trains in the opposite direction towards West India Quay, platform 2.

28 On the approach from the direction of Westferry into platform 2 at West India Quay the track alignment follows a right-hand curve. The curve is approximately 82.5 metres long and of 44 metres radius, and has a maximum permitted speed of 20 km/h.

29 This report makes use of the terms 'left' and 'right' rails. These terms are used in relation to the direction of travel of the train that derailed.

External circumstances

30 At the time of the accident at 10:02 hrs, the weather was dry and clear. The weather was not a factor in the derailment.

The DLR driverless system

31 A DLR train consists of two cars coupled together. A car consists of two articulated coaches that are supported by three bogie*s* and are permanently coupled together. The centre bogie supports both coaches. One end of the car is known as end 'A' and the other end is known as end 'B'.

32 The train involved in this accident consisted of cars 86 and 30. Car 86 'B' end was leading.

33 Trains on the entire DLR network normally operate automatically, without drivers. This is achieved by means of a fully automatic train control system, which is monitored by the permanently staffed control centre at Poplar. The signalling system is based on the *moving block* (SelTrac) system supplied and installed by Thales Rail Signalling Solutions Inc. and combines both Automatic Train Protection (ATP) and Automatic Train Operation (ATO). It works on the principle of controlling the separation between trains and so permits a very intensive train service to be operated.

34 ATP ensures that trains remain a safe distance apart and have sufficient warning to allow them to stop without colliding with another train. The system also regulates the maximum speed that the train may operate on any section of the track. The highest normal speed on the railway is 80 km/h.

35 A train running automatically is described as being in ATO mode. ATO is the non-safety part of the train operation related to station stops and starts.

36 Trains are monitored by the *Vehicle Control Centre* (VCC) system, which compares the position of each train with a stored schedule. The train's on-board computer constantly communicates with the central computer, and if this transmission is broken the train will stop until given authorisation to continue. Information is passed to the train to enable it to open its doors on the platform side, together with the necessary information to make adjustments in speed to maintain the schedule.

37 Another feature of the system is the use of *axle counters*. These are interconnected devices that count 'in' (and 'out') the number of axles on a train to detect whether a section of physical track is occupied. These devices are installed in junction areas and throughout the DLR system. The associated sections of track are known as *axle counter blocks*. During normal operations the signalling system will allow multiple trains to safely follow each other through an axle counter block utilising ATP (paragraph 34). When a train stops communicating with the VCC, the system will prevent other trains entering the axle counter block containing the failed train. The occupation of axle counter blocks containing points will also prevent the movement of those points.

38 Passenger service agents normally undertake customer care and revenue duties on board the trains. They can also drive trains in a manual mode, with all the protection of Automatic Train Protection. In this *ATP manual* mode, the passenger service agent drives from the *lead emergency driving position*. This is a control position at the front of the train that allows the passenger service agent an unrestricted view of the line ahead. If the passenger service agent attempts to over-speed or depart when a route has not been set, the train's control system will automatically apply the emergency brakes, preventing further movement.

39 If the signalling system fails completely, trains may be driven in another type of manual mode known as emergency shunt mode. The speed of the train is limited to 20 km/h and there is limited automatic train protection. This mode may only be used when instructed by the control centre controller, who gives authority for movement to the passenger service agent.

40 The controller has a complete overview of the entire railway and control of all the signalling and points, which he can operate via the SMC system.

The DLR three-car upgrade project

41 Docklands Light Railway Ltd, with both Serco Docklands and Thales Rail Signalling Solutions are undertaking various projects to allow for the addition of an extra car per train (the three-car upgrade project). This work involves extra vehicles, platform extensions, bridge strengthening works and the associated signalling works.

42 This work has been ongoing since 2007 and has involved many staged alterations to the existing infrastructure and the workings of the train service patterns. This work was ongoing at the time of the derailment.

The Investigation

Investigation process and sources of evidence

43 The incident was notified to the RAIB by Serco Docklands at 10:18 hrs on 10 March 2009. The RAIB attended the site of the derailment and initiated an investigation.

44 The main sources of evidence used in this investigation were:

- witness interviews;
- discussions with managers and other staff regarding safety management systems, operational procedures and training;
- data obtained from the SMC system;
- data obtained from the On Train Data Recording (OTDR) system fitted to DLR car number 30;
- voice recordings from the control centre;
- Closed Circuit Television (CCTV) downloads;
- photographs and measurements from the site;
- site testing of a DLR train for visibility tests (for 1125B point position indicator and 1125 points) at West India Quay station; and
- review of Serco Docklands documentation.

Key Information

Events preceding the derailment

45 On 10 March 2009, from the start of passenger services at 05:30 hrs, there had been some major signalling system failures. This had resulted in all trains on the system (including those at the delta junction) being operated in emergency shunt mode. This situation had lasted until 06:30 hrs. At that time, and because of the failures, only 6 out of a normal 30 trains were in use on the system.

46 At 05:45 hrs, a control centre controller (part of a team of day shift controllers) booked on for duty at the control centre to relieve the night shift controllers.

47 At 07:33 hrs, the signalling system failed in the area of the delta following the malfunction of an axle counter. This caused a number of tracks in the area to show as 'closed'[2] when they were in fact clear of trains ('false occupation'). There were a further seven similar occurrences that morning up to the time of the derailment.

48 Each time the signalling system failed it caused an emergency brake application on any ATO trains that were in the affected tracks at the time[3]. As a consequence, the overall service pattern on the DLR system had been disrupted.

49 As part of his work shift pattern, the passenger service agent boarded the train involved in the derailment at Poplar station, and the train departed for Bank station in ATO mode at 08:18 hrs. At this time the passenger service agent had been instructed by the control centre controller to be at the 'lead emergency driving position' at the front of the train until further notice.

50 When the train arrived at Bank station it became a Bank to Lewisham service. The train departed Bank station at 08:39 hrs in ATO mode but still with the passenger service agent in the lead emergency driving position. The train travelled to Lewisham and subsequently returned to Bank station.

51 At 09:50 hrs, the train left Bank station again, now described in the DLR control system as train number LEW109[4], going towards Lewisham in ATO mode, still with the passenger service agent seated at the control desk in the lead emergency driving position. At 09:58:47 hrs, train LEW109 departed from Westferry station and accelerated to 29 km/h before decelerating and coming to rest 176 metres after leaving Westferry platform. It remained stopped for 24 seconds while the next part of its route was set ahead.

52 At 09:59:52 hrs the train began to move again, and accelerated briefly to a maximum of 43 km/h before reducing its speed to approximately 17 km/h in readiness for the 20 km/h speed restriction through the right-hand curve into West India Quay.

[2] 'Closed' tracks are shown in red to the control centre controller on the SMC computer.

[3] 'Closing' of a track will cause the emergency braking of any train which is within the tracks limits.

[4] LEW is the abbreviation for Lewisham station.

53 At 10:00:15 hrs, 1125 points (figure 2) moved from the reverse[5] to normal position as part of the normal route for train LEW109 to enter West India Quay station. 1125B point position indicator displayed a white arrow indication to indicate that 1125 points were set in the correct position.

54 At 10:00:28 hrs, an axle counter became *disturbed* in the delta area and as a consequence a number of tracks in the area became shown as 'closed'. This resulted in the brakes of train LEW109 automatically applying. The train came to a stop at 10:00:35 hrs, 463.8 metres after leaving Westferry station.

55 The train had stopped 21.1 metres before the 1125B point position indicator, 67.9 metres from 1125 *switch toes* and 78.2 metres from the top of the end ramp of platform 2 of West India Quay station. The point position indicator was still displaying a white arrow indication, which should have been visible to the passenger service agent.

56 At 10:01:02 hrs, the control centre controller contacted the passenger service agent on board train LEW109 via the radio system. The controller first requested confirmation that the train's emergency brakes had applied and then instructed the passenger service agent to select emergency shunt mode, and then to check the point position indicators and points as he travelled forwards into the platform. Once in the platform (and out of the area affected by the signalling failure) the train could be reconfigured to continue in automatic operation as normal. The passenger service agent correctly repeated back the message to the controller and the radio communication ended at 10:01:35 hrs.

57 While this radio communication was underway, the controller had been checking his SMC computer. At that time, 1125 points were shown in the correct position for trains from the direction of Westferry. Having observed the position of the points, the controller did not take steps to prevent the signalling system from moving 1125 points away from the normal position (this action, known as *reserving* the points, is required by Serco Docklands procedure: SOP/M-4.01, 'Emergency Shunt Operation').

58 The controller then contacted another train (BAN119[6]) in the delta (which was travelling towards Westferry station on the Up City line) that had also been subjected to an emergency brake application for the same reasons as train LEW109, and gave the passenger service agent on train BAN119 instructions on actions to take.

59 At 10:01:39 hrs, the passenger service agent selected emergency shunt mode and train LEW109 moved forward at 10:01:43 hrs, now being driven by the passenger service agent, standing at the control desk in the lead emergency driving position.

[5] If 1125 points are set reverse, a route from Poplar 3 to West India Quay 2 is set. If the points are set normal, then a route from Westferry 1 to West India Quay 2 is set (figure 2).

[6] BAN is the abbreviation for BANK station.

60 At the same time as train LEW109 began to move forward the VCC system automatically called 1125 points into the reverse position. The points were now incorrectly set for the safe passage of train LEW109 into platform 2 at West India Quay. In normal circumstances this should have caused the associated point position indicator (1125B) to display a red bar symbol. However, because the lamp associated with the red bar did not light up, the white arrow on the point position indicator went out and the signal became unlit (paragraph 117). At this moment the train was approximately 15 metres before the unlit point position indicator, and accelerating to a maximum of 10 km/h. The passenger service agent did not notice that the point position indicator was not lit and continued to drive his train towards 1125 points.

61 At 10:01:52 hrs, a train that was still operating in ATO mode, with running number CRO513[7], arrived at Poplar station and automatically requested a route through 1125 points into West India Quay. These points were already in the reverse position required for this movement (paragraph 60).

Events during the derailment

62 Train LEW109 was now nearing 1125 points, but the passenger service agent onboard did not notice that they were set reverse (and not set for the route of his train). At about the same time, the controller completed his radio communication with train BAN119 and noticed that 1125 points were incorrectly set for train LEW109.

63 At 10:02:13 hrs, the controller made an emergency radio call to the passenger service agent on board train LEW109 and told him to stop his train. At exactly this moment, the train derailed on the trailing points. Both axles of the leading bogie were derailed towards the *six foot*. The train travelled a further 10.3 metres before finally coming to a stop.

64 The train stopped with the front of the train approximately in line with the top of the platform end ramp at West India Quay station.

Events following the derailment

65 As the train stopped, the passenger service agent, who was listening to the emergency stop call from the controller, reported the derailment.

66 Other Serco Docklands staff arrived at West India Quay station within minutes and assisted with the safe evacuation of all passengers from the derailed train.

67 At 10:02:38 hrs (25 seconds after train LEW109 had derailed) train CRO513 departed from Poplar station towards West India Quay. Train CRO513 travelled for approximately 90 metres and at 10:03:17 hrs was automatically stopped. This was due to train LEW109 occupying the axle counter blocks in the delta area ahead and reserving 1125 points. In this position, train CRO513 was approximately 232 metres from 1125 points.

[7] CRO is the abbreviation for Crossharbour station.

Design and operation of the control centre and systems

68 In August 2008, a new computer system had been commissioned at the Serco Docklands control centre in Poplar. The new system had been designed and installed by Thales Rail Signalling Solutions Inc.

Information displayed to controllers

69 At the control centre, two controllers sit side by side, each facing two monitors. These monitors can be configured to display the line overview screen, an alarm screen (paragraph 82) and other information. Control of the system is by keyboard and mouse commands in a 'windows' type environment.

70 The line overview screen can display an overview of the entire rail system, as well as allowing the controller the option to 'zoom' into any required area to see greater detail of the track, signalling and train data. In the overview display, the controller is able to switch on and off various options. These may include:

- display of which tracks/blocks are occupied (block occupancy); and
- modified visibility of various items (e.g. *loop boundary*, depot signals etc).

71 The controller can also open other 'pop up' windows on his screen to display detailed train, platform, point and track information.

72 The SMC system which controls what is displayed on the monitors has a time delay. For example, the time delay between the movement of a set of points and the display of this on the line overview screen display may be about 5 seconds.

73 There are no procedures or instructions for controllers to provide guidance on what should be displayed on the monitors. Controllers are allowed to configure the monitors to suit their own personal requirements.

74 The controller involved in this derailment had one monitor displaying the line overview with block occupancy turned off[8], and the other monitor displaying the alarm screen.

75 With the block occupancy turned off, the occupation of blocks is not displayed to the controller. At junctions, it is therefore impossible to see if a particular train has occupied blocks in which points are located.

Overview screen detail at the delta junction area

76 Figures 3 to 6 show the differences between overview screens with block occupancy turned off and on. They also demonstrate the effect of the position of a train at the delta and how this is displayed to the controller. The delta area shows the closed sections of track (in red) caused by the axle counter block that had become disturbed. These screen displays were obtained from the 'playback' facility of the SMC (for 10 March 2009).

77 Figure 3 shows the line overview screen displayed following the emergency braking of a train at 07:42 hrs that morning (paragraph 227) in the vicinity of the delta area. This train had stopped after passing 1125B point position indicator and had occupied the block that includes 1125 points. However, since the block occupancy option had not been selected, the occupation of the block (displayed in blue on the screen) containing the points was not visible to the controller.

[8] If the DLR is operating in full ATO mode, the display of block occupancy symbols is not necessary for the operation of the railway.

78 Figure 4 shows the same line overview screen display as it would have looked if the block occupancy option had been turned on. In this view, the display indicates that the block containing 1125 points is occupied. The effect of the occupied block is that 1125 points cannot be moved.

79 Figure 5 shows the line overview screen that was displayed to the controller at 10:00:33 hrs, approximately two minutes before the derailment. In this case, train LEW109 was 21.1 metres on the approach to 1125B point position indicator. This train (coloured red) can be seen in the delta having just had its automatic emergency brake applied. The green arrows indicated on the track ahead of train LEW109, and the green dot located on 1125 points, indicated to the controller that the VCC system had set and secured the points for train LEW109. Since the block occupancy option was not activated the line overview screen did not indicate whether train LEW109 had occupied the block containing 1125 points.

80 When train LEW109 was later switched into emergency shunt mode (paragraph 59), the green arrows and the green dot reservation immediately switched off, because the train was no longer in ATO mode and therefore the automatic route setting system no longer functioned.

81 Figure 6 shows the same line overview screen display, as it would have looked if the block occupancy option had been turned on. In this case the line overview screen would have looked similar to that displayed with the block occupancy switched off, but with the addition of blue and purple occupancy indications for each train. However, the screen would also have provided an indication to the controller that train LEW109 had not occupied the block containing 1125 points.

Alarms management

82 The alarm screen can either display an overview of the different types of alarms or it can be configured by the controller to display selected types of alarms. Each alarm is prioritised as high, medium or low, and categorised under the following headings:

- regulation;
- train;
- wayside – (which includes unlit point position indicators);
- miscellaneous; and
- history.

83 The controller involved in this derailment had one of his monitors displaying the alarm screen. He had chosen to display high priority train alarms only and any alarms indicating that point position indicators were unlit would not have been brought to his attention.

84 Figure 7 shows the alarm screen, shortly before the derailment, that the controller had chosen to display with high priority train alarms only. All other alarms had been turned off. Train LEW109 emergency brake application (E.B. active) can be seen displayed at 10:00:33 hrs.

85 Figure 8 shows the alarm overview screen that the controller could have seen at 10:00:33 hrs, if the screen had been configured to display all alarms. Train LEW109 emergency brake application (E.B. active) can be seen displayed at 10:00:33 hrs under both the train and history category headings on the screen.

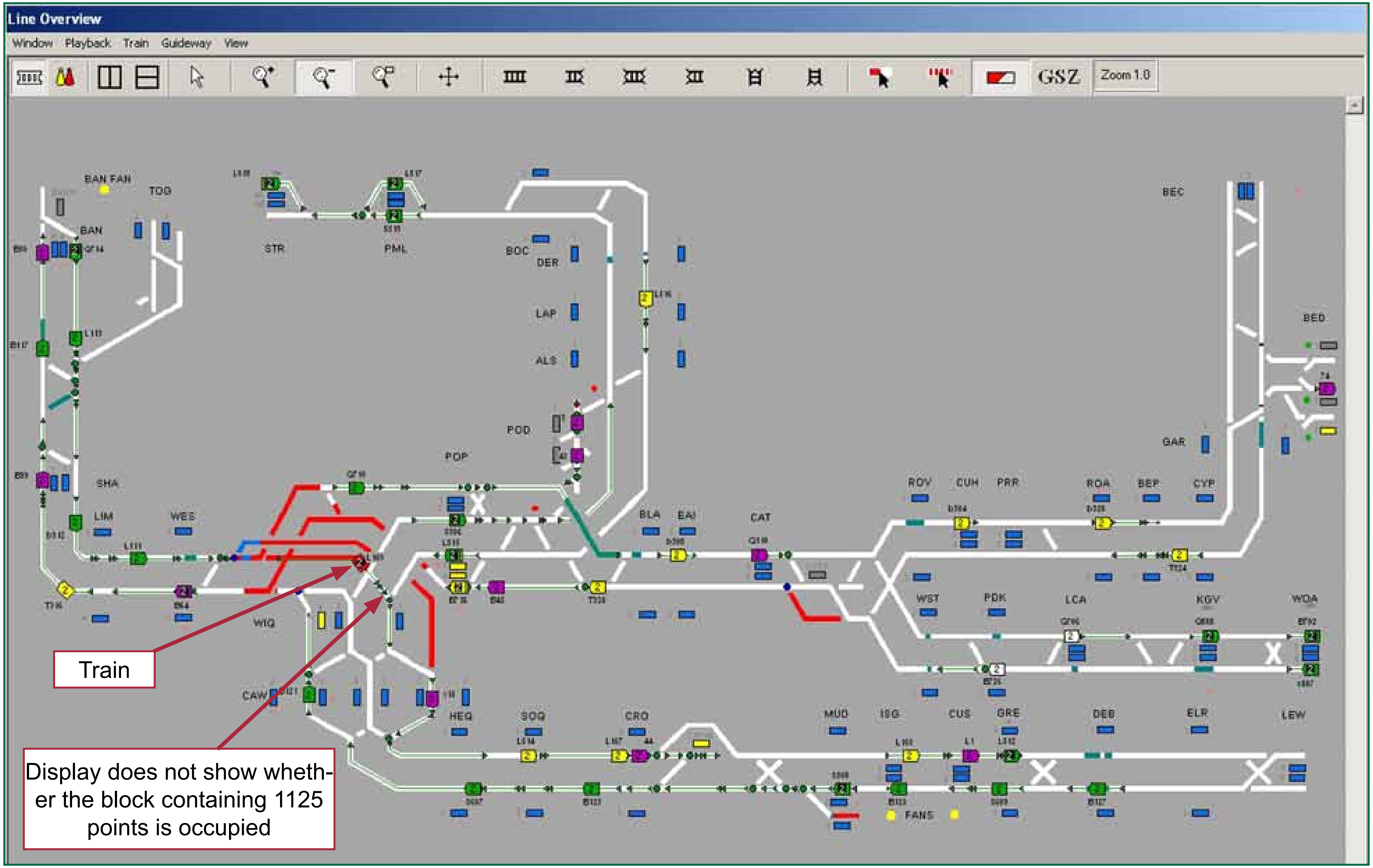

Figure 3: Line overview screen display at 07:42 hrs with the block occupancy turned off

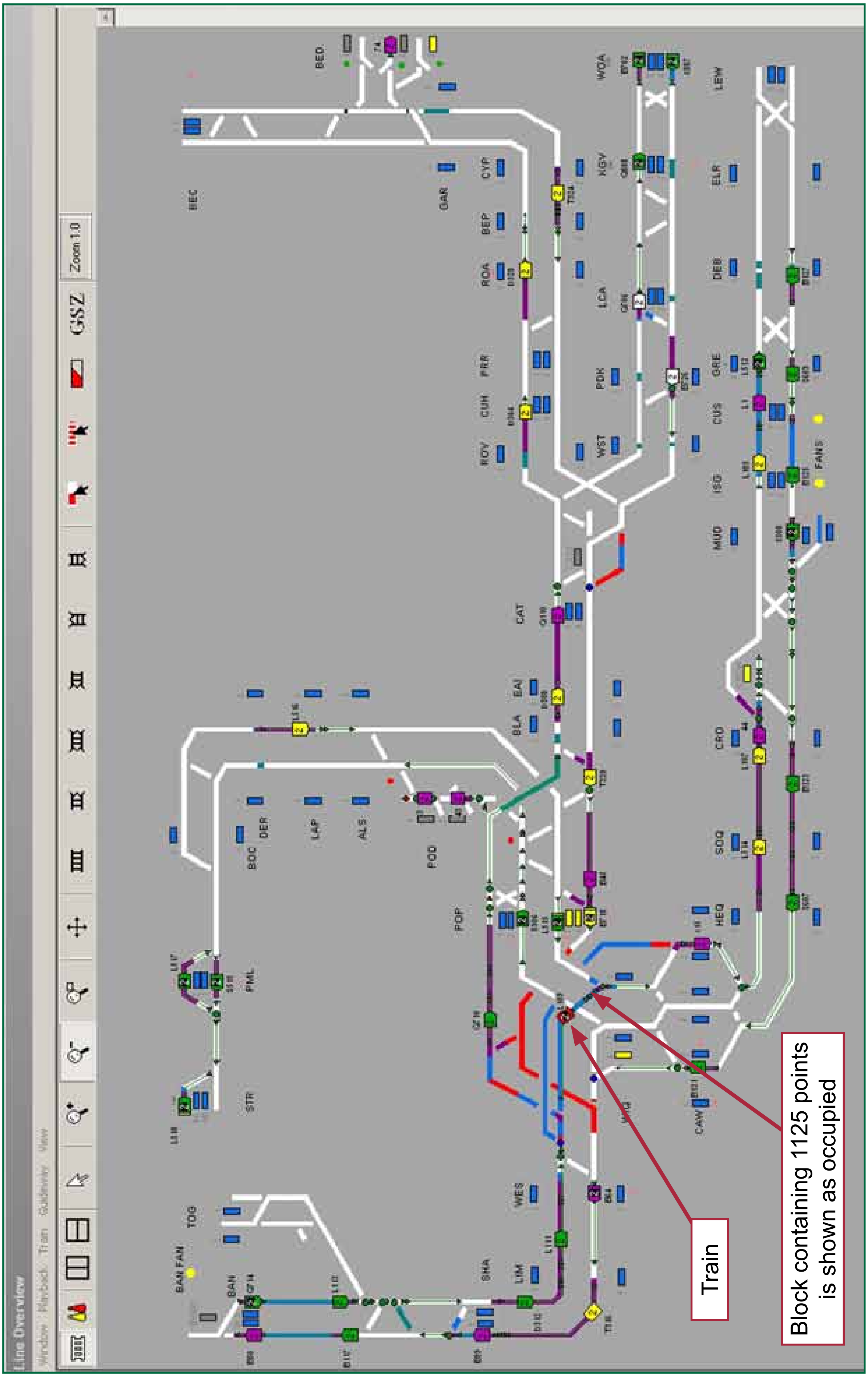

Figure 4: Line overview screen display at 07:42 hrs with the block occupancy turned on

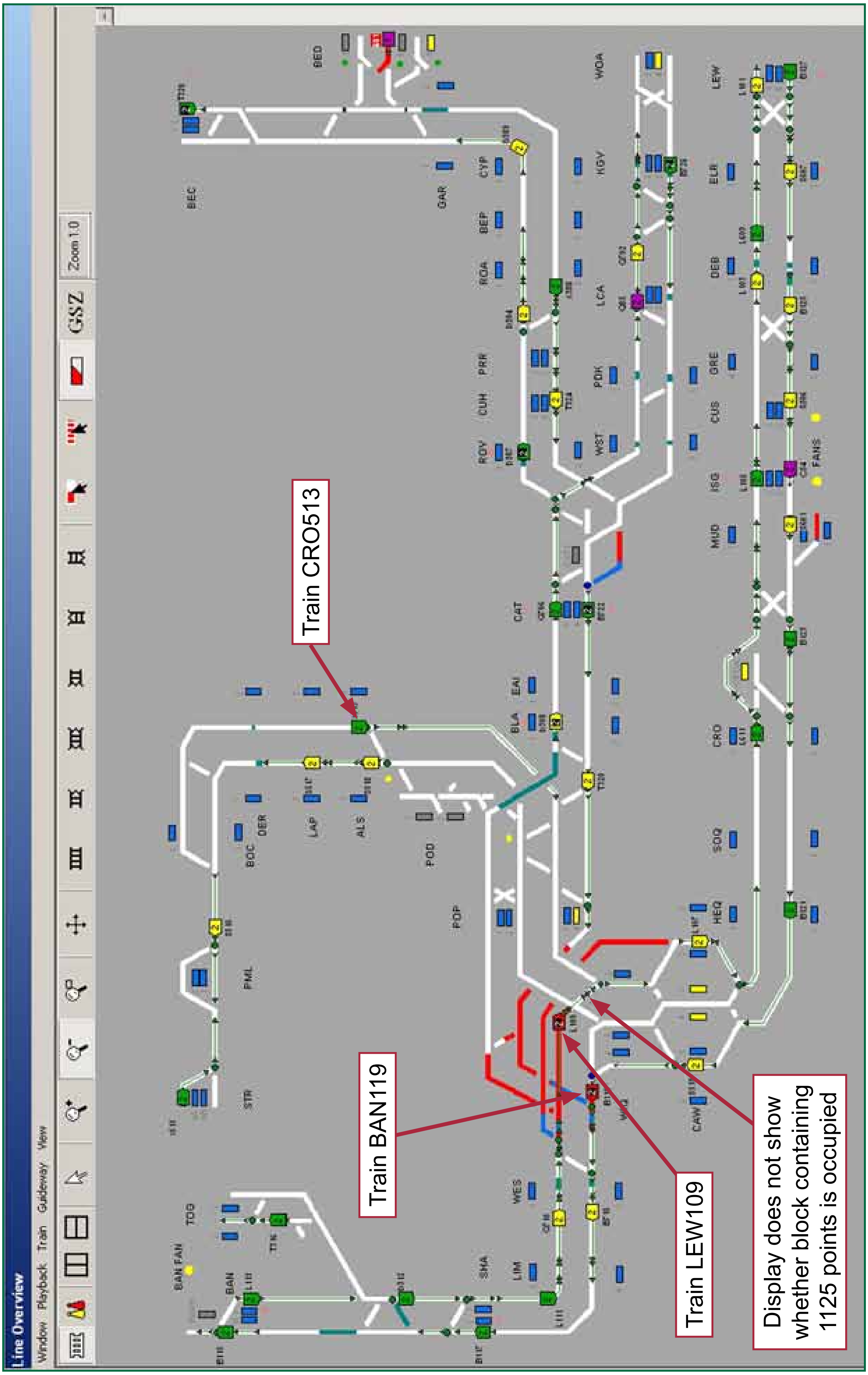

Figure 5: Line overview screen display at 10:00:33 hrs with the block occupancy turned off

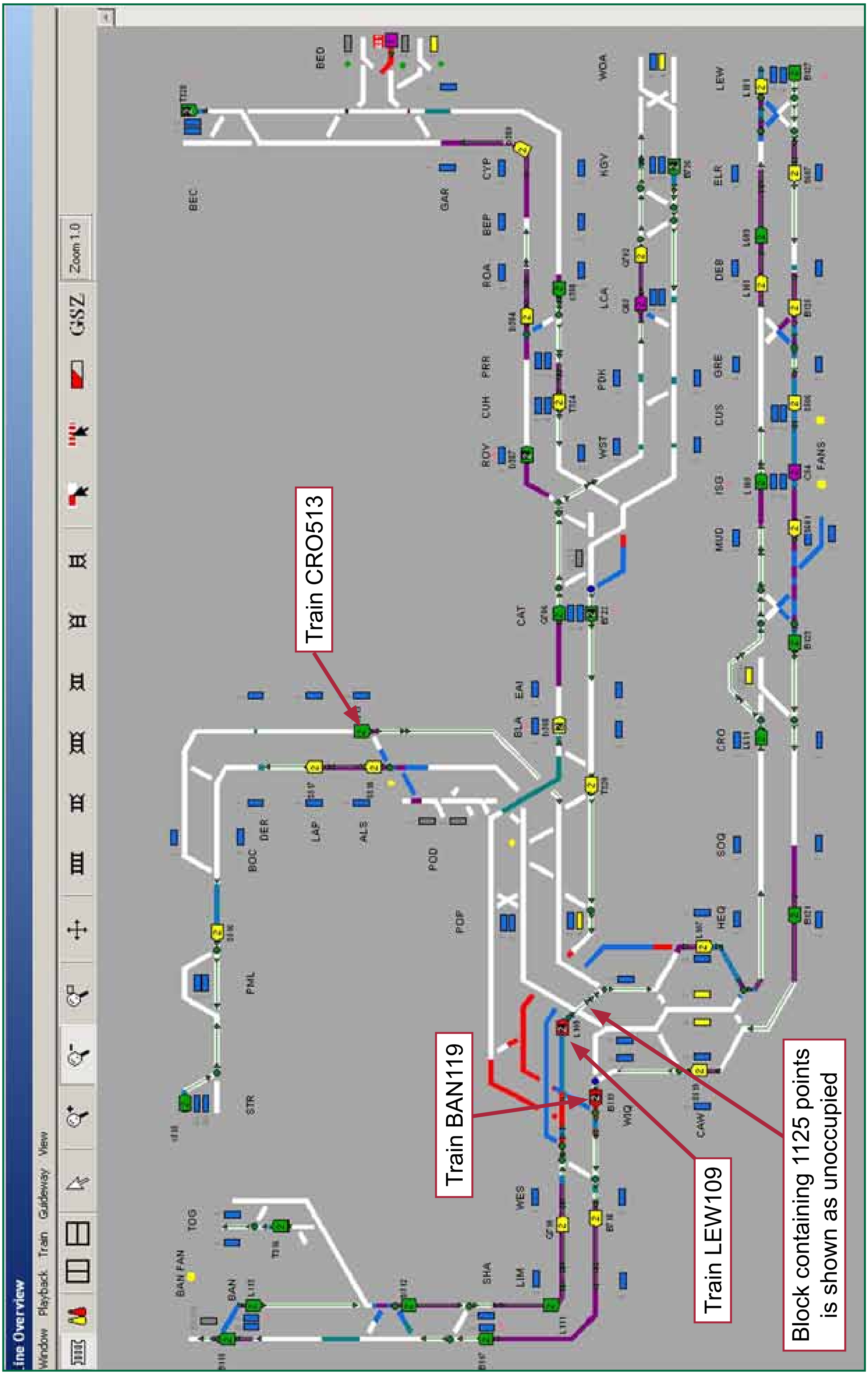

Figure 6: Line overview screen display at 10:00:33 hrs with the block occupancy turned on

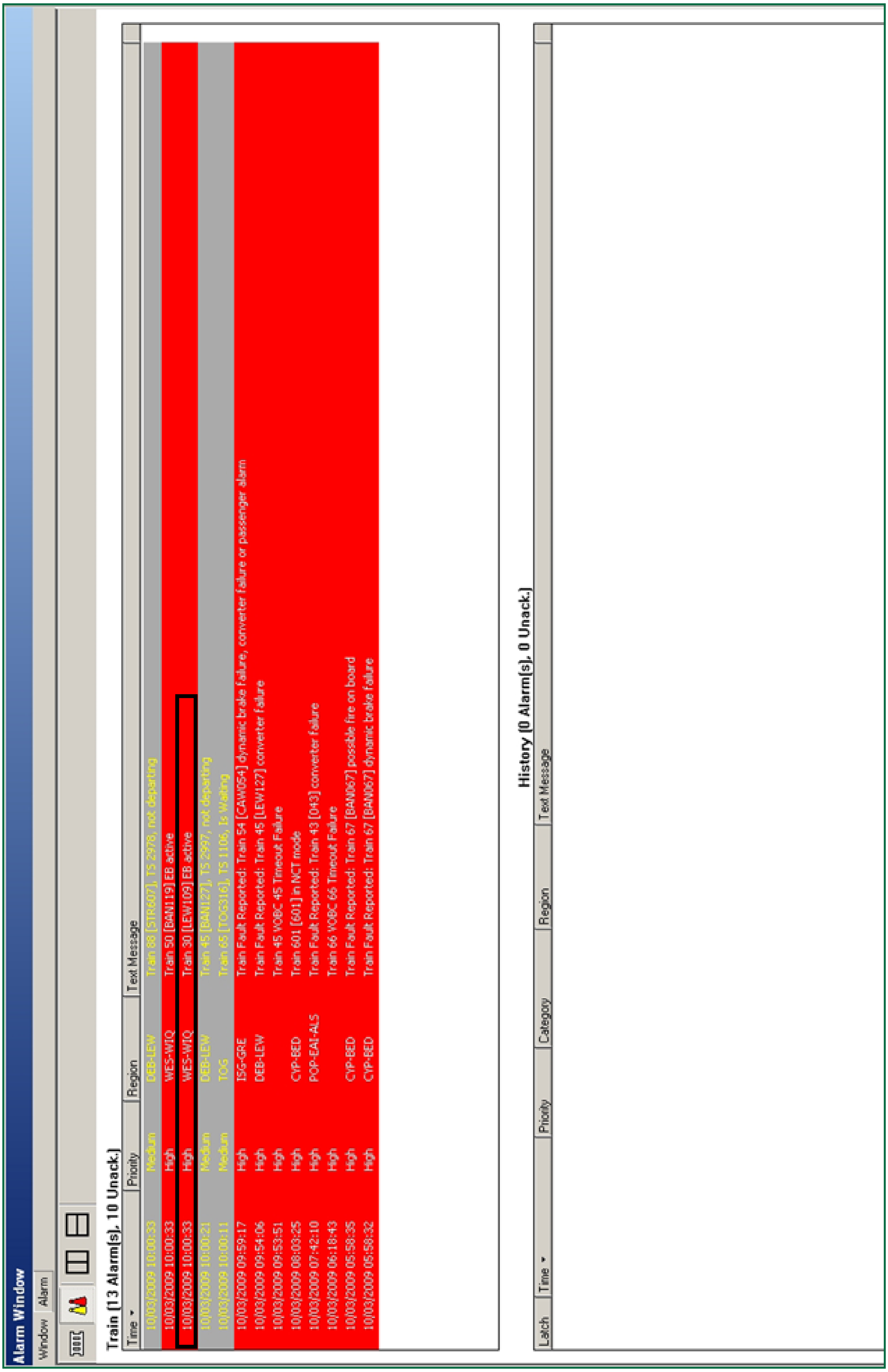

Figure 7: Alarm overview screen at 10:00:33 hrs displaying only high priority train alarms

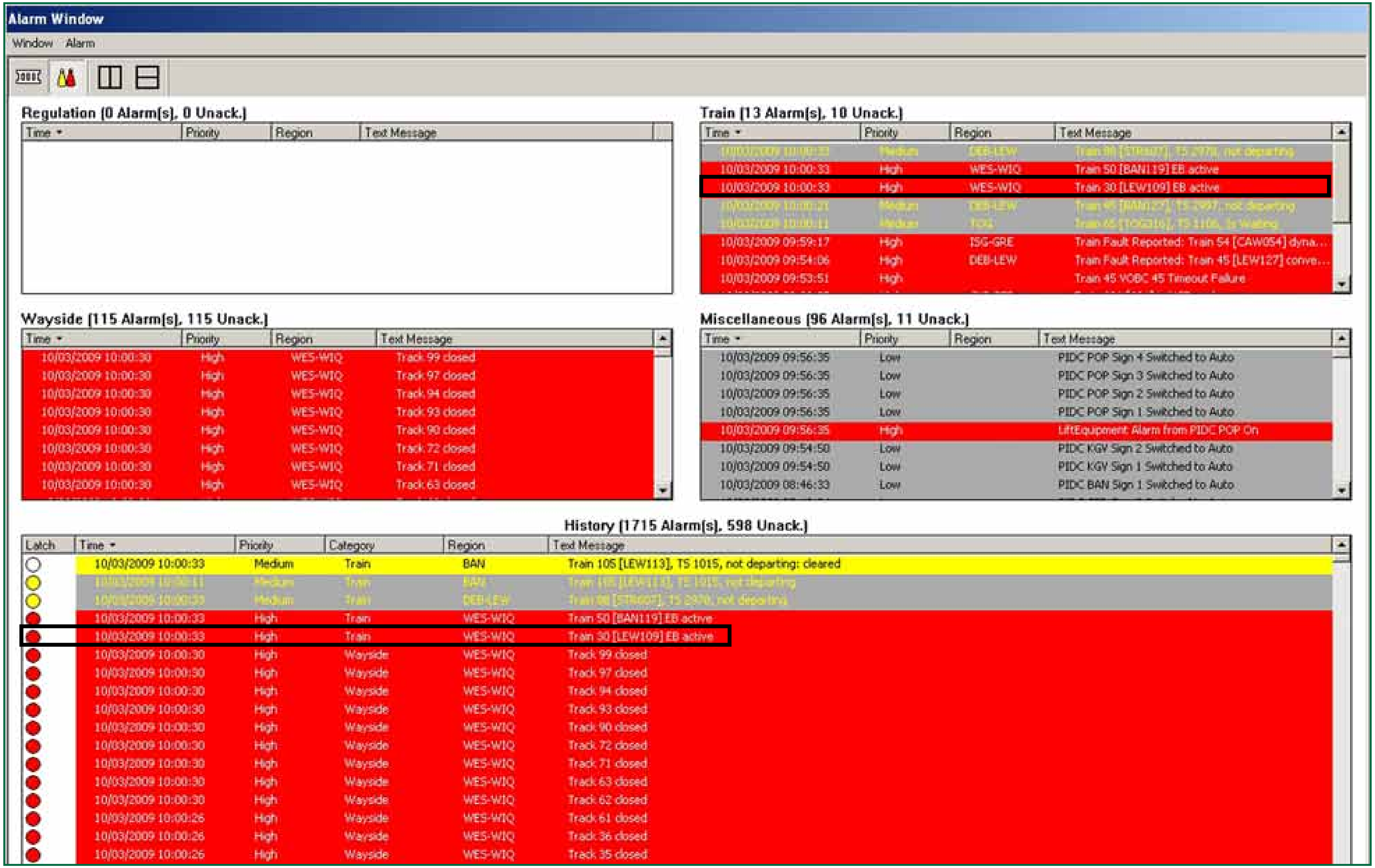

Figure 8: Alarm overview screen at 10:00:33 hrs displaying all alarms

86 The RAIB has analysed the alarms on 10 March 2009 from 09:00 hrs until the derailment at 10:02 hrs. During that hour, a total of 1500 alarms (from all categories) are recorded by the system and potentially could have been displayed to the controllers. Of these 1500, 520 were categorised as high priority.

87 There are no procedures or instructions to controllers on what their actions should be on receiving alarms; whether they be high, medium, low or of any particular category.

1125 points auto-reverse function

88 Before 2 March 2009, 1125 points had only been able to operate when either they were:

- requested to move by the VCC system as part of an ATO route;
- requested to move individually by a controller; or
- operated by maintenance staff on site as required.

89 The software controlling 1125 points was altered as part of a major modification of the system coinciding with the re-opening of Tower Gateway station at 05:30 hrs on 2 March 2009. This was after engineering works had been completed as part of the three-car upgrade project (paragraph 41). This modification introduced a new *auto-reverse* function for 1125 points.

90 This meant that 1125 points would automatically move into the reverse position provided all the following conditions were met:

- the points did not form part of an ATO route that had been set across them;
- the points were not reserved by the controller; and
- the points were not locked by a train occupying the block directly over them.

91 This change to the operation of the points had not been communicated to the control centre managers or controllers. No formal communications or instructions of any type on this subject had been issued to either the managers or to the controllers at the control centre.

92 According to witness evidence, following the commissioning on 2 March, some of the controllers began to notice that 1125 points were behaving differently. On the weekend of 7/8 March, one of the controllers on shift officially reported this as a 'fault' to the signalling maintenance division of Serco Docklands.

93 Serco Docklands technicians investigated the 'fault' and could not find anything wrong with 1125 points set-up or operation at site. The technicians had also not been made aware of the change to the operation of 1125 points.

94 The controller involved in this derailment had learnt about 1125 points auto-reversing during informal conversations with his colleagues on the day before the derailment.

95 A controllers' handover sheet (that is exchanged between controllers at shift changes) was completed by the night shift of 9/10 March and handed to the controller on the morning of 10 March. The controller did not read the entry that had been made about 1125 points on that sheet and in fact did not read any information within the handover sheet because he was immediately concerned with the ongoing signalling system failures and problems at that time and was too busy to read the sheet.

The operational restrictions list

96 The DLR Operational Restrictions List is a document managed and controlled by a Serco Docklands Projects Engineer. He collates railway data such as speed restrictions (as well as other operational restrictions) from source documentation[9] and enters the data onto the list. This includes details of alterations made by Thales Rail Signalling Solutions Inc. as part of the staged implementation of the signalling alterations. This list is issued to the control centre for action by the controllers and their managers.

97 The change to the operation to 1125 points was not entered onto the Operational Restrictions List (paragraph 162). Witness evidence indicates that the Serco Docklands Projects Engineer was aware of the change to 1125 points but did not make an addition to the Operational Restrictions List because he judged (based on his experience and knowledge) that the auto-reverse function would not affect the existing operating procedures of the control centre.

Other information

98 The two controllers who manage and oversee the operation of the railway have one radio between them to communicate with the passenger service agents. Usually this radio is switched to 'loudspeaker', so that both controllers can listen to the same conversation. However there is only one handset with a microphone for use by one controller at a time.

Emergency shunt operation procedure for trains

99 The movement of trains in emergency shunt mode is governed by the Serco Docklands Operations Manual (Trains) procedure: SOP/M-4.01, 'Emergency Shunt Operation'. At the time of the derailment, version J dated September 2008 was in use. Extracts from this procedure can be found at appendix D.

100 The actions to be taken by the controller include the requirement to 'reserve a route' for emergency shunt moves. The reservation of a route requires that any points in that route must be set and locked in their correct position.

Implementation of the emergency shunt procedure

The control centre controller

101 The procedure for operating in emergency shunt mode requires the passenger service agent to check that the point position indicator is showing the correct indication before the train proceeds towards the points. However, in this instance (paragraph 56) the controller instructed the passenger service agent to check the point position indicator **and** the position of the points.

[9] Source documentation encompasses VCC and SMC computer consolidated operating notes, version description documents, software release notifications, and other documentation associated with the control of software and hardware design.

102 The controller did not reserve the route for train LEW109 as required by the relevant procedure. Witness evidence indicates that this was because he had assumed that the train was occupying the axle counter block extending across the junction and it was therefore unnecessary to reserve 1125 points (since the occupation of the block would have prevented the points from moving).

103 He had not selected the block occupancy display and subsequently lacked information on the blocks occupied by trains. He was therefore unaware that train LEW109 was not occupying the block containing 1125 points. This meant that the points were free to move to the reverse position.

104 When the passenger service agent on board train LEW109 had been given permission to move forwards in emergency shunt mode, the controller immediately contacted another train (BAN119) in the delta area. The distraction caused by this other train is likely to have caused the controller to overlook the fact that 1125 points had not been reserved in the normal position, and that they subsequently changed to reverse. It was not until the train was nearing 1125 points (and at about the same time that the control centre controller completed his radio communication with train BAN119) that he noticed that the points were incorrectly set for train LEW109.

105 By the time that the controller was able to make radio contact with the passenger service agent on board train LEW109, the train was derailing.

106 The controller was not aware of train CRO513 approaching or stopping at Poplar station. He did not notice that this train had sent an ATO route towards West India Quay and that the green dot indicating reservation on 1125 points (which had appeared 10 seconds after the same green dot indicating reservation from train LEW109 had disappeared) was now related to train CRO513 and not train LEW109.

The passenger service agent

107 The emergency shunt procedure (paragraph 99) states that the passenger service agent should, when approaching points, check that the point position indicator is correctly illuminated for the required move.

108 When train LEW109 was stopped by the application of the emergency brake, the front of the train was 21.1 metres from the 1125B point position indicator. Tests conducted by the RAIB showed that in this position, the white arrow displayed on the point position indicator was visible from the front of the train. However, as the train restarted, the point position indicator became unlit because the VCC system had automatically called 1125 points reverse (paragraph 60).

109 The passenger service agent had understood that, when driving in emergency shunt mode, he should stop his train and contact the control centre if a point position indicator on his route was unlit. However, in this instance he stated that he had no recollection of seeing 1125B point position indicator and what it was displaying.

110 The passenger service agent did not stop his train at the unlit point position indicator.

111 Although the emergency shunt procedure does not specifically state that the passenger service agent should check that the switch toes of points are correctly set for the route of his train, passenger service agents are trained to identify the position of the points before travelling through them (paragraph 180).

112 The passenger service agent driving train LEW109 did not notice that 1125 points were incorrectly set for his train.

Signalling equipment

Points and point position indicators

1125 points

113 The type of points involved are known as 'clamp lock'. Clamp locks are machines operated by hydraulic pressure that mechanically lock, and detect, both open and closed *switch rail* positions.

114 Clamp lock type points were introduced onto British Rail infrastructure in the 1970s and are still in use by Network Rail today.

1125B point position indicator

115 1125B point position indicator is approximately fifteen years old. It is a signal that uses a separate 12 V, 50 W halogen lamp to illuminate each of the two possible indications: a white arrow when points are detected in the normal position and a red bar when the points are not detected in the normal position.

116 The status of lamps is monitored by the SMC system in the control centre.

117 Following the derailment, the RAIB found that the lamp associated with the illumination of the red bar indication was not functioning because one of its connection pins was corroded (figure 9a).

Figure 9a: Lamp from 1125B red bar indicator

Conspicuity of 1125B point position indicator

118 Figure 9b shows 1125B point position indicator when unlit. This photograph was taken on 10 March 2009 at 14:15 hrs. The rear of derailed train LEW109 can be seen alongside the indicator.

Figure 9b: 1125B point position indicator when unlit

Figure 9c: 1125B point position indicator displaying a red bar

119 Figure 9c shows 1125B point position indicator displaying a red bar. This photograph was taken on 10 March 2009 at 15:20 hrs after the lamp pins had been cleaned and the lamp inserted back into the indicator.

120 The point position indicator applying to moves across the same points but in the opposite direction (1125A, see figure 2) was also unlit on 10 March 2009 when it should have been displaying a red bar. Further investigation of this indicator on site revealed that it too had corrosion on one of the pins of the lamp creating a high resistance in the electrical circuit.

121 Following the derailment on 10 March, the 1125B point position indicator was removed from site for further testing. A replacement indicator (of the same type) was installed and photographed with a white arrow displayed. Figure 10 shows the 1125B indicator, displaying a white arrow, as viewed from a test train that was located at the approximate position occupied by train LEW109 after the emergency brakes had applied.

122 From figure 10 it can be seen that 1125B point position indicator is installed at a low level, with the top of the indicator approximately 0.3 metres above running rail height, and is on the left-hand side of the right-hand curve into West India Quay station.

123 There is no evidence to suggest that sunlight either behind or reflecting onto the front of 1125B point position indicator could have made the white arrow difficult to see.

124 There is no evidence that the location of the original point position indicators (including 1125B point position indicator) were evaluated in accordance with any formal process when they were installed approximately 15 years ago.

Figure 10: 1125B point position indicator displaying a white arrow and viewed from a stationary train in approximately the same position as train LEW109 was after emergency braking

Visibility of 1125 switch toes from an approaching train

125 Observations made by the RAIB show that on the approach to 1125 points (following the route that train LEW109 took) it is possible to see the position of the switches of the points from about 46 metres before reaching the toe of the points. At a speed of 9 km/h, this distance would be covered in 15 seconds and a train could be stopped well within that distance under normal braking.

126 The photograph at Figure 11 was taken at the point where an RAIB inspector, and the test train passenger service agent, could clearly discern the position of the switches. The *wheel flange* gap is on the right-hand side in this photograph, as the points are set in the normal position (the flange gap is 55 mm wide). During the derailment, the points were set reverse and the gap would have been on the opposite side at the switch toes.

Maintenance and inspection regimes

127 At the time of the derailment, 1125 points were maintained at 6 weekly intervals by teams of technicians who undertook their visits at night when passenger trains were not running. The maintenance visits also included the three associated point position indicators; 1125A, B and C. The maintenance of the points involved checking (which included the points being moved between the normal and reverse positions) and repairing as necessary.

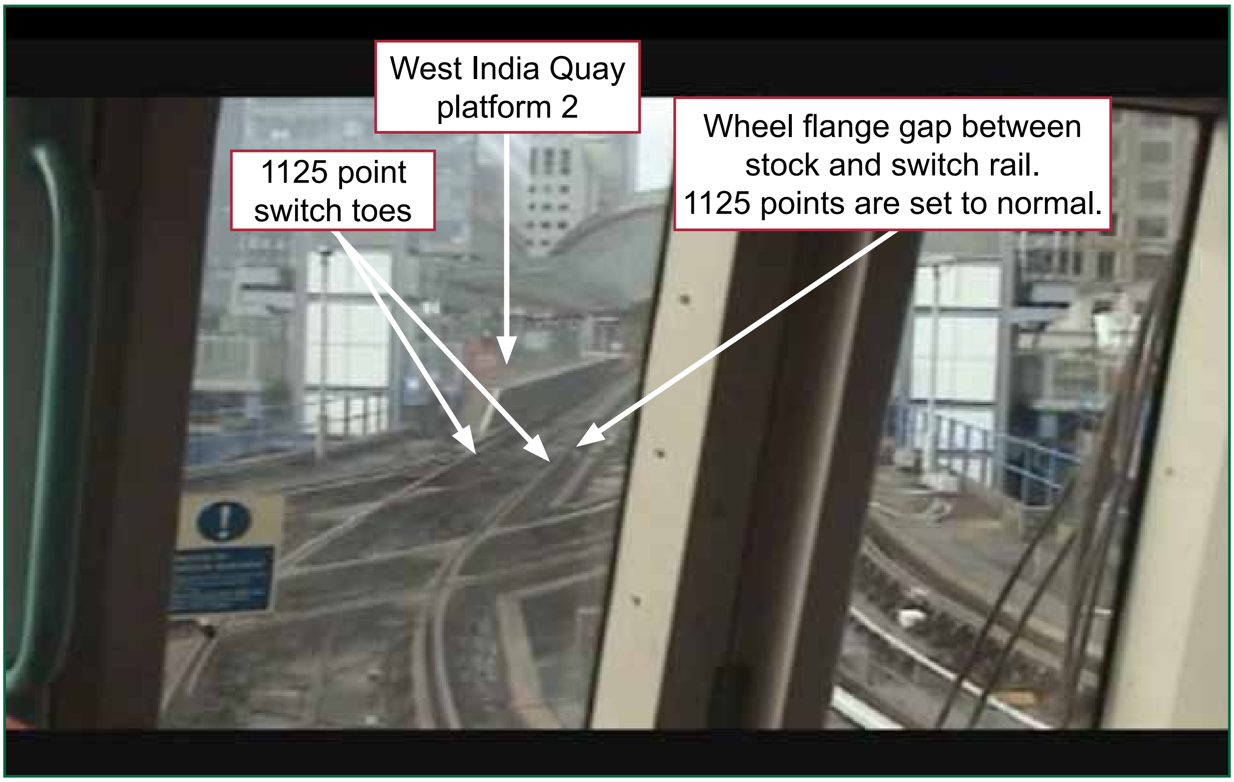

Figure 11: 1125 points set normal showing position of switch rails. Photograph taken from a test train approaching West India Quay, platform 2

128 Although point position indicators were checked as part of the point maintenance visit, evidence suggests that not all of the possible point position displays were viewed by the technicians. The maintenance results sheet for the maintenance visit only has one yes/no box stating: ‘Point Indicators Checked’. There is also a comments section on the sheet for the technician to write any notes or comments about the tests or any of the results found.

129 Before the derailment, 1125 points were last maintained on 5 February 2009. Although the tick box related to the checking of the point position indicator had been marked as ‘y’, there were no comments on the sheet in respect of any of the point position indicators. Prior to the visit by technicians on 5 February, 1125 points and the associated point position indicators had been tested on 14 January 2009 and 19 December 2008. On the 19 December visit, a point position indicator lamp holder had been replaced, and this was stated in the comments box. However, the exact indicator and the exact lamp position were not identified on the sheet.

130 Following the maintenance visit of the 5 February, and at some time before the incident on 10 March, 1125B point position indicator had a red bar lamp failure which resulted in the indicator being unlit when 1125 points were set in the reverse position,

131 The maintenance teams were unaware that lamps in 1125B and 1125A point position indicators had failed. The frequency of their maintenance visits was 6 weekly and the next planned visit was on 19 March 2009.

132 The state of the lamp pin (paragraph 117) suggests that 1125B point position indicator ‘red bar’ lamp had not been working for some time prior to the morning of 10 March 2009.

Reporting of point position indicator failures

133 Before May 2008, the reporting of point position indicator failures to the signalling maintenance teams had been undertaken weekly by the control centre controllers. This had involved the controllers analysing the relevant alarms logs and preparing a list for the maintainers to work from. Maintenance technicians would then repair the failed indicators as soon as possible.

134 From June 2008 (and at about the same time that the new SMC system was commissioned) the exchange between controllers and maintainers of point position indicator alarm logs began to decline. By August 2008, the exchange of data had completely stopped.

135 There is no Serco Docklands procedure or instruction that lays down the type of alarm log data that is to be provided to maintainers by the control centre staff.

136 Serco Docklands has a procedure SOP/M-3.08, 'Service Bulletins, Traffic Notices, Emergency Notices and Restrictions' (December 2008), which requires 'any member of staff observing a condition which may adversely affect the safety of customers or the movement of trains is to contact the control room technician immediately to report the circumstances'. However, this was not generally used by passenger service agents to report any unlit point position indicators that they may have observed during normal ATO operations. The reporting of point position indicator failures by passenger service agents to controllers was therefore undertaken on an ad-hoc basis. Although some reports of lamp failures exist and were indicated as being repaired, no records of indicator failure reports exist for 2009. Some of the lamp indicator failures that had occurred in 2008 had taken over a year to be repaired.

137 Evidence about the length of time before the indicators were repaired shows that they were seen as non-safety critical. Witness evidence also suggests that the safety critical nature of point position indicators (when part of the railway was operating in emergency shunt mode) was not recognised by staff up to the level of senior management within Serco Docklands.

LED type point position indicators

138 Serco Docklands has an annual maintenance plan which encompasses signalling and telecommunications. This plan is issued to Docklands Light Railway Ltd for their review, comment and approval.

139 In the annual maintenance plan dated April 2008 Serco Docklands had identified that all depot and main line point position indicators were:

> '….life expired and requiring replacement. The signals are poor in sunlight and a direct cause of signals passed at danger (SPAD). New LED signals are both lower in maintenance and SPAD mitigation. The point position indicators are very difficult to read, again causing difficulty for the train operator.'

140 By the time of the derailment, Docklands Light Railway Ltd had not approved the purchase and installation of new LED type point position indicators.

Signalling problems in the delta area

141 As described in paragraph 48, signalling problems on 10 March 2009 had caused certain tracks to show as 'closed' when they were in fact clear of trains. This had caused an emergency brake application on any ATO trains that were within the track limits at the time.

142 The problems were being caused by a design error which had been made by Thales Rail Signalling Solutions Inc. in connection with the current programme of railway upgrades. This meant that the physical removal of an axle counter took place without the functions of the axle counter being disabled in the software. The result was that an adjacent axle counter generated an unexpected count. This was seen by the VCC system. If the discrepancy persisted for a certain time (which it sometimes did), then the system would occupy other tracks in the area to protect ATO trains.

143 This fault had been identified in late 2008, and at the request of Serco Docklands, Thales Rail Signalling Solutions Inc. began investigating the reasons for it in January 2009. The investigation was still in progress at the time of the derailment. Shortly afterwards Thales Rail Signalling Solutions Inc. and Serco Docklands identified that the interaction between the disconnected axle counter head and the system software had not been fully understood at the time the disconnection was made. On 31 March 2009 Thales Rail Signalling Solutions Inc. corrected the fault by fitting a dummy axle counter head, and the problems with unexpected axle counts ceased.

144 The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) contain provisions for the safety management systems of a company to include arrangements on how safety verification will be managed by the duty holder. Docklands Light Railway Ltd, as the infrastructure manager under ROGS, carried out audits of the design process (including verification) used by Thales Rail Signalling Solutions Inc.

Changes to DLR assets

145 Thales Rail Signalling Solutions Ltd and Thales Rail Signalling Solutions Inc. have been jointly working on the planning and delivery of staged alterations to the DLR signalling systems as part of various projects, including the three-car project over the two years preceding the incident. The signalling alterations involve both hardware (trackside equipment etc) and software (VCC and SMC systems) alterations and system interface design work, and were designed by Thales Rail Signalling Solutions Inc.

146 In order to control the risk generated by changes to railway assets, Serco Docklands produced a procedure entitled 'Asset Change Control Procedure', SP315, Version 1, dated April 2008. This version was current at the time of the derailment. The document should have had a Docklands Light Railway Procedure number, but this was left blank.

147 The front cover of the document stated it was jointly owned by the Safety and Assurance Director of Serco Docklands and the Chief Engineer of Docklands Light Railway Ltd.

148 The document had been produced by an engineer within Serco Docklands as part of its safety management system. This was done in recognition of Serco's role, as the *transport undertaking*, under the provisions of the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS).

149 The purpose of asset change control is to ensure that railway operations and maintenance can be undertaken safely and that all changes to the assets, including provision of new assets, are made under controlled conditions. The procedure identified how change should take place during initial design, detailed design, operations and maintenance preparation, implementation, operation and close-out.

150 The procedure was consulted on within Serco Docklands and briefed to all relevant staff. The briefings were completed by June 2008.

151 During various drafting stages of the document, Serco Docklands and Docklands Light Railway Ltd did not conclude their discussions and consequently Docklands Light Railway Ltd did not sign up to the procedure and process. Nevertheless, Serco Docklands decided to use the document as its method of controlling change, but Docklands Light Railway Ltd did not, and did not implement any formal process for managing change on the railway.

152 Procedure SP315 came into use during April 2008. At that time, some of the design for the 3-car project had already started. As a result Serco Docklands engineers were unable to use those parts of the procedure corresponding to initial and detailed design reviews. When the design notification documentation was finally received by Serco Docklands, it instigated the procedure and produced the relevant paperwork.

153 Serco Docklands had not been issued with the initial requirements specifications for the various stages of the three-car upgrade project that were produced by Docklands Light Railway Ltd. This made it difficult for Serco Docklands engineers to confirm the content of the documentation that was sent to them and whether it was compliant with the initial specification.

154 Procedure SP315 was applicable to the management of the provision of an auto-reverse function on 1125 points (paragraph 89).

Asset Change control procedure (SP315)

How the procedure should work

155 For each stage of the signal alterations, Thales Rail Signalling Solutions Inc. should produce a suite of documents (known as the source documentation) that should be issued to its client, Docklands Light Railway Ltd (paragraph 149).

156 Docklands Light Railway Ltd should then review this documentation and submit it to Serco Docklands for its review.

157 Serco Docklands engineering should initially produce an asset modification notice[10]. This notice should be exchanged between Serco Docklands and Docklands Light Railway Ltd and records the approval, feedback and review history from each of the phase reviews. Serco Docklands should also review whether other stakeholders (eg the control centre) should be involved in the review of the documentation.

[10] An asset modification notice should describe a summary of the proposed change, the documentation provided and who will be the review team.

How the procedure actually worked for the three-car upgrade project

158 Thales Rail Signalling Solutions Inc. produced a suite of documents (the source documentation) and these were issued (via email) from Thales Rail Signalling Solutions Inc. in Canada to Thales Rail Signalling Solutions Ltd in the UK. At the same time, these documents were also copied to engineers in both Docklands Light Railway Ltd and Serco Docklands engineering and projects divisions. Docklands Light Railway Ltd (the client) did not undertake a formal review of these documents.

159 The source documentation included a version description document for the software release that described the new auto-reverse function at 1125 points. This version description document was issued on 16 January 2009 to engineers within Docklands Light Railway Ltd, Serco Docklands and Thales Rail Signalling Solutions Ltd.

160 The source documentation also included a document entitled 'consolidated operating notes'. These 'notes' are issued (to Docklands Light Railway Ltd, Serco Docklands and Thales Rail Signalling Solutions Ltd) where the software subject to release has safety restrictions, shortfalls in specified functionality and / or which require operational workarounds.

161 In the case of 1125 points, consolidated notes were issued to all parties, but they did not include a reference to 1125 points becoming auto-reverse.

162 Serco Docklands' project division reviewed the source documentation and created an asset modification notice (the SP315 process required that this be undertaken by the engineering division). The project division submitted the notice to Serco Docklands engineering division for review. The engineering division checked the asset modification notice to see if the projects division had followed the correct process, but did not check the engineering content as required by procedure SP315.

163 Witness evidence suggests that staff within the engineering division were unsure of the procedure governing asset change control and had believed that the project division would continue to produce the asset modification notices for further phases of the work. They also believed that the project division would inform the control centre of any changes, if required, via the operational restrictions list. This was not the case: operational restrictions, such as speed restrictions were communicated in this way, but other changes were not.

164 In the case of the introduction of the auto-reverse function at 1125 points the project division staff had not considered the control centre to be a stakeholder because they believed that the auto-reverse function would not affect the control centre operational procedures.

165 Serco Docklands' project division used to send details of software changes to the control centre by means of informal emails. This informal arrangement stopped in early 2008 and no other procedure for information transfer existed.

The train

The emergency driving position

166 When a passenger service agent is required to drive a train in emergency shunt or ATP manual modes, they must open a control desk at the front of the train passenger compartment to reveal the driving controls and instruments.

167 The main control desk is on the left-hand side of the train, in the direction of travel, although there is another desk on the right-hand side that houses other equipment.

168 The passenger service agent involved in the driving of train LEW109 was standing at the control desk at the front of the train. There were no restrictions to the visibility of trackside equipment and infrastructure from the passenger service agents driving position.

On Train Data Recorder

169 The RAIB carried out an analysis of the OTDR from both cars. Due to a computer fault (in connection with the OTDR system) on board car 86, no data was recorded by the OTDR during the period of the derailment.

170 Car 86 had also been incorrectly set up with the identity of car 84. This was an error during a previous maintenance or repair activity. This would not have had any effect on the ability of the OTDR system to record and download data.

171 The OTDR recorder is checked every night by technicians as part of the daily checks undertaken on each train. Serco Docklands does not keep records of this check, so there is no evidence of whether it was carried out on the evening of 9 March 2009.

172 However, the OTDR readings from car 30 (the trailing car) captured the actions of the passenger service agent and how the train was being driven.

The track

173 The relative weight (and hence axle load) of a DLR train is light compared with the weight of a comparable passenger train on Network Rail infrastructure. DLR trains were constructed to similar specifications to trams and consequently are classed as being lightweight vehicles.

174 As the train approached 1125 points in the trailing direction the flange of the right-hand wheel of the first bogie hit the back of the switch rail where it was hard against the *stock rail*. The flange was unable to ‘push through’ and split the switch rail from the stock rail because of the light weight of the train in relation to the force exerted by the clamp lock points (3.3 kN). As a result, the flange climbed the rail, rode along the top of the stock rail and dropped off into the gap between the right-hand rail and the derailment containment kerb. Figure 12 shows the derailment path of the two axles across the right-hand stock rail.

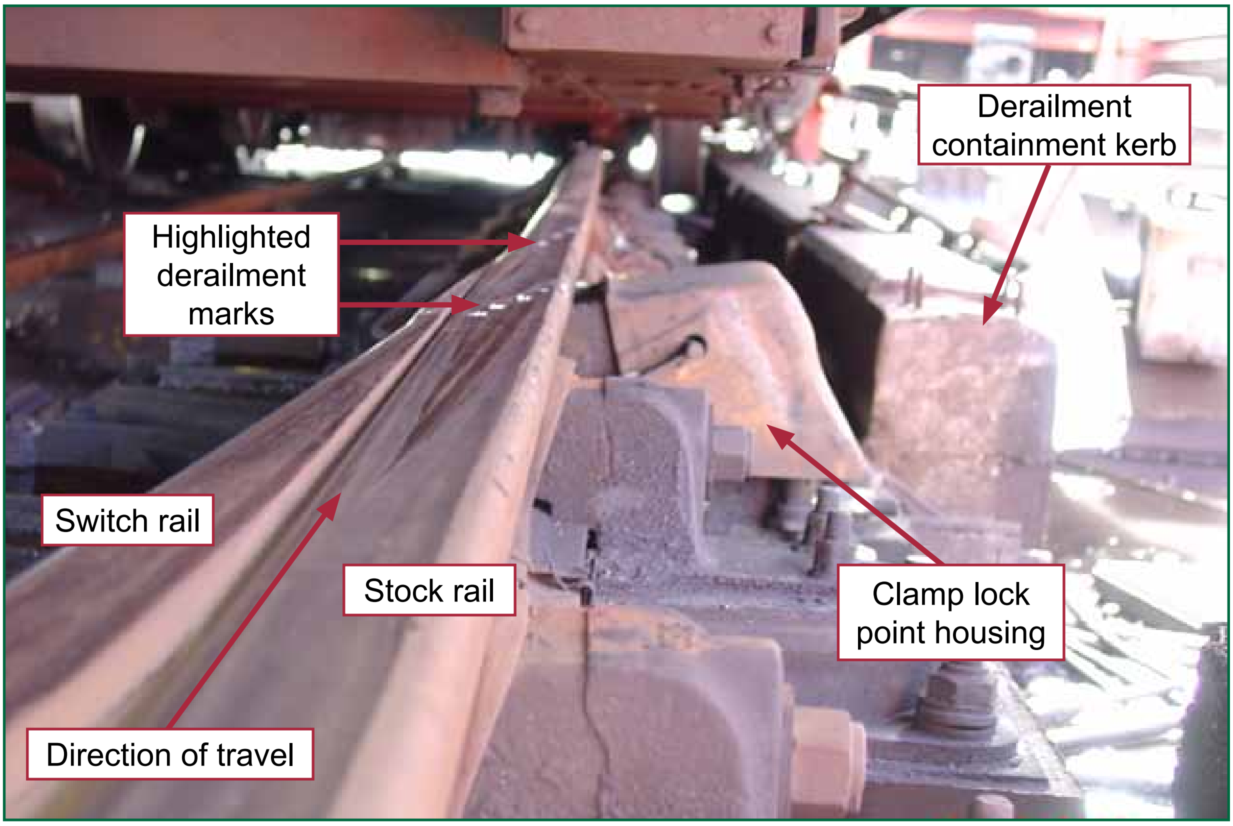

Figure 12: Picture of the derailment path and the derailed bogie of car 86 taken in the direction of travel. Note the highlighted derailment marks on the right-hand stock rail

Competence, training and fatigue issues

175 All staff involved in the derailment were qualified, according to Serco Docklands standards, for the work they were undertaking, and their certification was in order. The passenger service agent had not been involved in any previous safety related incidents, although the control centre controller had had one safety related incident in 2006 when a train had passed a signal at danger within a depot.

176 There is no dedicated training department at Serco Docklands. Training of Serco Docklands staff is done by members of staff carrying out the training role in addition to their normal 'day' job. Those members of staff undertaking training responsibilities are required to hold relevant National Vocational Qualifications and are released from their other duties to undertake the training. Training is scheduled each year and the plan is programmed into work shift patterns to ensure the appropriate release of trainers. The content of the training is specified by managers within Serco Docklands.

177 Serco Docklands did not formally monitor the quality of the training, or audit the trainers.

The passenger service agent

178 The passenger service agent had worked in this role for a year, and had been trained as a passenger service agent by Serco Docklands.

179 In the year between the completion of his training and the derailment, the passenger service agent had driven a DLR train in emergency shunt mode on average once a day.

Training

180 The passenger service agent had been trained to drive his train in emergency shunt mode in accordance with the emergency shunt operation procedure, SOP/M-4.01. Although this procedure does not specifically require it, the passenger service agent was also trained to identify the position of the points by checking the position of the switch rails before travelling through them.

181 The passenger service agent was also instructed that if a point position indicator was unlit, then this should be treated the same as a red bar and he should stop his train.

182 At the end of the training period, the trainee undertook both practical and classroom tests. This included testing the passenger service agent on his ability to recognise both trailing and *facing* points.

Work pattern

183 Immediately before the day of the derailment, the passenger service agent's work pattern had been:

- 10 March – 07:26 hrs to 15:28 hrs
- 8 and 9 March – off
- 7 March – 12:45 hrs to 01:07 hrs
- 6 March – 08:30 hrs to 19:50 hrs
- 5 March – 08:00 hrs to 19:50 hrs
- 4 March – 08:30 hrs to 19:50 hrs
- 2 and 3 March – off
- 1 March – 16:25 hrs to 00:58 hrs
- 28 February – 17:53 hrs to 01:58 hrs
- 26 and 27 February – 17:13 hrs to 01:43 hrs
- 24 and 25 February – off

184 The RAIB has calculated the passenger service agent's Fatigue Index value as 2.5[11]. This value was based on his work shift and rest day pattern above and indicates that the passenger service agent had not been exposed to a work pattern likely to cause abnormal fatigue.

185 No other factors have been identified that are likely to have caused the passenger service agent to be fatigued or subject to unusual levels of stress or distraction.

186 Following the derailment, the passenger service agent was *'for cause'* drug and alcohol screened, in accordance with his employer's post incident procedure. The results did not reveal the presence of either drugs or alcohol.

[11] The potential for fatigue arising from the above work pattern has been assessed using the Health and Safety Executive (HSE) Fatigue and Risk Index Calculator (version 2.2) available from www.hse.gov.uk. The output from the fatigue index is a measure of the probability of high levels of sleepiness. This is expressed as a value of between 0 and 100. A fatigue index of 20.7 corresponds to the average work shift and rest pattern, assuming typical values for the job type and breaks factor. A 'benchmark' fatigue score of between 30-35 for day or early shifts and 40-45 for night shifts relates to the probability of a person suffering high levels of sleepiness. The value given is an average for the whole duty not hour by hour. ORR guidance entitled, 'Managing fatigue in safety critical work', defines a night shift as a shift that usually starts between 22:00 hrs to 02:00 hrs and ends between 05:00 hrs to 08:00 hrs.

The control centre controller

187 The control centre controller who was involved in the operation of train LEW109 had worked in the control centre at Poplar for seven years. He had past experience as a passenger service agent on the DLR.

188 In the period preceding the derailment the controller had become accustomed to instructing passenger service agents to operate trains in emergency shunt mode during signalling problems, particularly in the area of the delta.

Training

189 The controller had been tested on procedures (including procedure, SOP/M-4.01) in the week before the derailment by his manager as part of a regular annual assessment of competence. He had passed the tests and was deemed competent.

Work pattern

190 Immediately before the day of the derailment, the controller's work pattern had been:

- 9 and 10 March (2 early shifts) – 05:45 hrs to 13:05 hrs
- 7 and 8 March – off
- 4 to 6 March (3 early shifts) – 05:45 hrs to 13:05 hrs
- 2 and 3 March (2 day shifts - training) – 09:00hrs to 16:00 hrs
- 25 February to 1 March – off

191 The RAIB has calculated the controller's Fatigue Index value as 7.7. This value was based on his work shift and rest day pattern above and indicates that the controller had not been exposed to a work pattern likely to cause abnormal fatigue.

192 No other factors have been identified that are likely to have caused the controller to be fatigued or subject to unusual levels of stress or distraction.

193 Following the derailment, the controller was 'for cause' drug and alcohol screened, in accordance with his employer's post-incident procedure. The results did not reveal the presence of either drugs or alcohol.

Previous occurrences of a similar character

194 There were four derailments of DLR trains on passenger lines during the 1990s: two in 1992 and two in 1995. A further derailment occurred on April 2008 at Deptford Bridge. However, none of these incidents occurred as a result of control centre operations or a train being driven in emergency shunt mode, and none resulted in passenger injuries.

195 However, in April 1991, a collision between two trains occurred at 1125 points. One of these trains was being driven in emergency shunt mode (vehicle 15) from Westferry to West India Quay and the other was in ATO mode (vehicle 18) and travelling from Poplar to West India Quay.

196 The passenger service agent on board vehicle 15 stopped his train 6.7 metres on the approach to 1125 points, which were set reverse for train 18. However, vehicle 15 remained foul of the line that train 18 was travelling on. Train 18 (which was travelling at 9 km/h) collided with train 15 at the junction. The trains did not derail and there were no passenger injuries.

197 At the time of this accident, the signalling system did not include point position indicators for trailing points. Therefore there was no indicator at 1125B points. Train 15 was in the process of being driven through 1125 points in the incorrect position for the train, and it was only the actions of the controller that subsequently prevented train 15 from potentially derailing at the points.

198 The report states:

'The incidence of Emergency Shunt working is a significant factor in the safety of operation of DLR. It arises mainly from equipment failure and progress is being made in reducing this problem. However, higher service levels increase the opportunity for failures and periodical changes in track or vehicle equipment sometimes temporarily introduce new failures.'

199 The report states the contributory causes of the derailment as:

'Unreliability of signalling equipment leading to a need for emergency shunt operation, and

the absence of 'flank' protection in the signalling system at West India Quay junction for trains proceeding in Emergency Shunt Mode.'

200 The report included nine recommendations arising from the collision. The only recommendation that relates to the incident of the 10 March 2009 was:

'A Management action plan be instituted to reduce the need for, and monitor the extent of, Emergency Shunt operation.'

201 This recommendation was completed by June 1991. The majority of the other recommendations in the report became irrelevant when the signalling system of the DLR was completely changed in 1995 to a SelTrac system (paragraph 33).

202 There have been no further collisions on the DLR system since the above incident in April 1991.

Near miss on the approach to West India Quay station on 23 April 2009

203 On 23 April 2009, a DLR train was being driven in emergency shunt mode between Westferry station and West India Quay station, on exactly the same route as train LEW109 on 10 March. Despite 1125 points having been reserved in the normal position by the controller, they automatically moved into the reverse position. The controller stopped the approaching train before it had reached 1125 points by pushing the emergency button to de-energise the conductor rail. The train did not derail and no collision occurred.

204 On leaving Westferry station, the train had stopped communicating with the VCC system and become a timed out and *non-communicating tracked* train. A control centre controller correctly followed procedure SOP/M-4.01, 'Emergency Shunt Operation' and reserved 1125 points in the normal position and gave the passenger service agent authority to move.

205 As the train moved forward, it crossed over a loop boundary and the system automatically cancelled the reservation on 1125 points. 1125 points then automatically reversed. The loop boundary was approximately 250 metres away from 1125 points.

206 Although Thales Rail Signalling Solutions Inc. had informed both Docklands Light Railway Ltd and Serco Docklands of the design feature, none of the engineers from the two companies understood the source documentation. Subsequently, no information was passed onto the control centre and operating procedures had not been updated.

207 Serco Docklands have since amended their procedures on how controllers should reserve points to prevent this particular scenario happening again (paragraph 268).

208 The RAIB were not informed of the incident on 23 April 2009 (it was not required to be reported), but were informally made aware on 12 May.

209 The RAIB is not investigating this incident as both the cause and subsequent actions by Serco Docklands are clearly understood.

Safety management within the control centre

Breakdown of processes within the control centre

210 The RAIB has found areas of concern in the control centre during this investigation. These included:

- non-compliance with procedures;
- poor dissemination of information to operating staff; and
- inadequate reporting systems and processes.

211 However, the RAIB had already reviewed the management arrangements associated with the Serco Docklands staffed control centre at Poplar during its investigation into the derailment of a DLR train at Deptford Bridge on 4 April 2008. This report was published on 22 June 2009 (report 16/2009) after the incident at West India Quay.

212 The Deptford Bridge report made two recommendations (recommendations 5 and 7) to Serco Docklands which are relevant to the breakdown in operational processes found during this investigation. These recommendations are shown in full in this report under the heading 'Recommendations to address underlying factors' (paragraph 288) and the responses to them are given below.

213 The response to Recommendation 5 by Serco Docklands was:

- *Serco Docklands accepts recommendation 5*

  Action taken / in progress

  A review is underway of the management arrangements for monitoring audit and review of front line activities. Actions cover:

  1. *Development and implementation of active monitoring regimes in line with HS(G)254 – Developing Process Safety Indicators (see Recommendation 7 below);*
  2. *Development of second line audit protocols for the application and output of active monitoring regimes; and*
  3. *Management review of the monitoring and audit process.*

  Status

  Open: Completion of stages 1 and 2 due 30/09/09. Management review to be covered as part of the Serco Docklands Annual SMS Review which is an ongoing activity.

214 Recommendation 5, according to the most recent progress report from the Office of Rail Regulation (ORR), dated October 2009, remains open[12].

215 The response to Recommendation 7 by Serco Docklands was:

- *Serco Docklands accepts recommendation 7*

  Action taken / in progress

  As part of an overall review of monitoring, audit and review (see Recommendation 5) active monitoring regimes in line with HS(G)254 – Developing Process Safety Indicators, are being developed for all front line activities covering Control Centre, Customer Service, Engineering and Infrastructure Access Control.

  Status

  Open: Completion of development stage due 30/09/09.

216 Recommendation 7, according to the most recent progress report from the ORR, dated October 2009, remains open.

[12] The ORR defines an 'open' recommendation as one that has been passed to dutyholder for consideration and action where appropriate: however either the action has not yet been completed or feedback from the duty holder is awaited.

Analysis

Identification of the immediate cause[13]

217 The immediate cause of the derailment was that train LEW109 travelled through 1125 points in a trailing direction when the points were not correctly set for this movement.

Identification of causal[14] and contributory factors[15]

218 There were five principal factors linked to the derailment:

- the actions of the control centre controller;
- the actions of the passenger service agent;
- the unlit point position indicator;
- the unreliable operation of the point position indicator; and
- the unreliable operation of the signalling in the delta junction area.

The actions of the control centre controller

219 **There were two ways in which the actions of the controller were a factor in the causation of the derailment. These were:**

- **the controller did not reserve 1125 points in the correct position (i.e. the points remained free to move when commanded by the signalling system); and**
- **the controller did not intervene in time to stop the train as it approached the incorrectly set points.**

Non-reservation of 1125 points

220 Procedure SOP/M-4.01, 'Emergency Shunt Operation', required the controller to reserve 1125 points in the correct position for the passage of train LEW109 before authorising the passenger service agent to proceed in emergency shunt mode. He did not do so.

221 As a consequence, the points were free to move when commanded by the signalling system.

222 Had the points been reserved in accordance with the procedure, the signalling system would have been prevented from automatically changing the position of the points and the derailment would not have occurred. The non-reservation of the points is a causal factor in the derailment.

[13] The condition, event or behaviour that directly resulted in the occurrence.

[14] Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

[15] Any condition, event or behaviour that affected or sustained the occurrence, or exacerbated the outcome. Eliminating one or more of these factors would not have prevented the occurrence but their presence made it more likely, or changed the outcome.

223 The controller was aware of and understood procedure SOP/M-4.01, 'Emergency Shunt Operation'. The reason he did not follow the procedure was because he assumed that train LEW109 was occupying the axle counter block that extended over 1125 points and that the occupation of this block prevented the points from moving.

224 The controller's assumption relating to the position of the train was incorrect. In fact, train LEW109 was occupying the previous block that did not include 1125 points.

225 The incorrect assumption was linked to the information displayed to the controller on the line overview screen (paragraphs 76 to 81). Since he had elected not to display block occupancy on his screen he did not know which blocks were occupied by the train. If the block occupancy had been switched on, it is likely that he would have noticed that the block extending over 1125 points was not occupied and would have reserved the points before authorising the movement of the train in emergency shunt mode. The non-selection of the block occupancy 'on' option on the overview screen was a probable causal factor in the derailment.

226 The controller was accustomed to working without the block occupancy turned on because it simplified the overview display. There were no procedures or instructions to mandate that block occupancy should be turned on at times of degraded working. Although this was a contributory factor in the derailment, the RAIB has not recommended that guidance be given that block occupancy be turned on during degraded operations. This is because the block occupancy display is not essential when controllers comply with the requirement to reserve points for trains in emergency shunt mode.

227 When assessing the situation for train LEW109, witness evidence suggests that the controller may have been influenced by his recollection of a similar situation 2 ¼ hours earlier that same shift when another train (at 07:42 hrs) had been stopped in the same area due to a signalling failure (paragraph 77). In the earlier instance, the train had in fact been occupying the block that extended over 1125 points and the points did not move during the emergency shunt movement. However, since the block occupancy was turned off on the overview screen, the train appeared to be in the same situation as was later the case for train LEW109 and therefore the controller may have been influenced to repeat the actions he had previously taken for the earlier train. Had the block occupancy been turned on in both situations, he might have seen that the two situations were different, and possibly acted differently.

Intervention of the controller to stop the train

228 The controller did not intervene to stop the movement of train LEW109 until it was too late (paragraph 63). Had he intervened earlier (by contacting the passenger service agent to stop his train), train LEW109 could have been stopped before reaching the points. The controller's late intervention was a causal factor in the derailment.

229 However, the likelihood that he would notice and intervene in time was reduced by the distraction caused by dealing with another train that had also been affected by the signalling failure in the delta (paragraph 247). Although this was a contributory factor in the derailment, no recommendation is made since distraction of this type cannot be practicably avoided in a control room of this type. Intervention should not be necessary if the controllers follow the correct procedure, and it is also impracticable to expect controllers to watch all train movements on the DLR system.

230 When the controller noticed that 1125 points had moved to the reverse position (and were not set correctly for the route of train LEW109) he had to terminate the call he was making and then redial train LEW109. This introduced a further delay.

231 The information that was displayed to the controller was also subject to the inherent delay of the SMC system, which at the time of the derailment was of the order of 4 to 5 seconds.

232 The automatic reverse function of the points is neither causal nor contributory. This is because train CRO513 automatically called the route from Poplar into West India Quay four seconds after 1125 points auto-reversed. If this route had been called before 1125 points auto-reversed it would also have caused the points to move into the reverse position before the arrival of train LEW109.

The actions of the passenger service agent

233 **The passenger service agent did not stop at the unlit point position indicator, or recognise the point switches would derail his train.**

234 The passenger service agent fully understood the requirement to stop his train at an unlit point position indicator, and was instructed to do so by the controller when authorising the emergency shunt move. However, he did not do so.

235 1125 points moved into the reverse position at about the same time that the passenger service agent was starting his train in emergency shunt mode. Consequently, the point position indicator became unlit two seconds after the train had started to move. However, the passenger service agent did not notice that the point position indicator had become unlit and continued to drive towards the points.

236 The reasons for the passenger service agent not noticing that the point position indicator had become unlit cannot be determined with certainty, although this may be related to the conspicuity of the indicator (paragraph 118). However, the RAIB observed that a driver travelling around this tight right-hand curve will tend to look straight across the curve and towards the platform at West India Quay, thereby drawing his attention away from the location of the indicator.

237 Had the passenger service agent noticed that the point position indicator had become unlit and then stopped at the indicator to communicate with the control centre, it is probable that the controller would have been prompted to check the position of 1125 points and might have realised that they were not set for the correct route. That the passenger service agent did not stop at the point position indicator and communicate with the control centre controller is a possible causal factor in the derailment.

238 Although the passenger service agent fully understood the requirement to observe the position of switch rails, had been trained to do so (although trailing points had been given a much lower emphasis) and had been instructed to by the controller, he did not notice that the points were not set for his route. The reasons for this are unknown. The fact that the passenger service agent did not notice that the points were not set correctly is a causal factor in the derailment.

The unreliable operation of the point position indicator

239 **The fact that 1125B point position indicator was unlit was a probable causal factor in the derailment because the signal was less conspicuous than it would have been if it was displaying a red bar indication, and was therefore not seen by the passenger service agent.**

240 There are two factors that caused the point position indicator to be unlit:

- the lamp had a corroded connection pin; and
- the maintenance organisation was unaware of the unlit 'red bar' lamp and had not taken any action.

Both are contributory factors in the derailment.

Factors related to the unlit point position indicator

241 **The point position indicator was difficult to observe.**

242 Generally, a point position indicator is not particularly conspicuous when unlit, because of its overall design, including the indicator's dull exterior colouring. This was the case for 1125B indicator. The poor conspicuity of the signal was a contributory factor in the derailment.

243 The indicator was installed at a low level and on the left-hand side of a tight right-hand curve and in this position tended to disappear into the background of other similar coloured railway infrastructure equipment (figure 10). The location of the indicator was a contributory factor in the derailment.

244 Tests indicate that the existing filament type indicators (including 1125B) are also inconspicuous when lit, because of the low intensity of the lamps and dirt on the screen (figures 9c and 10). Although Serco Docklands had included the replacement of the older point position indicators with the LED type in the maintenance plan, this had not been approved by Docklands Light Railway Ltd at the time of the derailment on 10 March 2009 (paragraph 140). The lack of luminous intensity and not installing LED type signals were contributory factors in the derailment.

Corroded connection pin

245 Point position indicators are inspected by technicians as part of their 6 weekly visit, which is usually undertaken in the hours of darkness. It cannot be proved exactly when the 'red bar' lamp failed within 1125B point position indicator, but a more frequent and comprehensive level of maintenance (e.g. by taking each lamp out and checking for corrosion and checking all possible illuminations of the signal) would probably have detected corrosion and point position indicator failure. The low frequency of examination and maintenance was a contributory factor in the derailment.

Maintenance unaware of lamp failure

246 The signalling maintenance teams within Serco Docklands were unaware that the 'red bar' lamp had failed. A range of contributory factors to the derailment explain this. These were:

- The inadequate testing and low frequency inspection of point position indicators. This indicates that a low priority was assigned to point position indicators, and that Serco Docklands management were not aware of the extent of poor performance of this type of equipment;
- The requirement for passenger service agents to report failed point position indicators was carried out on an ad-hoc basis;
- There was a low level of unofficial reporting of failed point position indicators by passenger service agents, although some of them were logged by the control centre. Remedial action was often slow. However, no reports had been logged at the control centre since January 2009, and none relevant to 1125 points; and
- Details of unlit point position indicators (from the SMC system) were not exchanged between the control room and maintenance technicians. This was because:
  - o There was no process for the information to be provided;
  - o The control centre controllers had low awareness of point position indicator alarms. The alarm management system (as part of the SMC system) provided an excessive amount of data and did not highlight the importance of these alarms (further to this, the control centre controller involved in this incident choose to filter his alarms to only display those related to trains, which excluded point position indicators); and
  - o Maintenance visits to the control centre had lapsed. This reduced the opportunities for the exchange of unlit point position indicator data.

The unreliable operation of the signalling in the delta junction area

247 **The requirement for train LEW109 to proceed in emergency shunt mode arose from a failure of the signalling in the delta area. This was one example of a series of failures that had occurred that morning and on previous days since January 2009.**

248 These failures of the signalling equipment did not in themselves create a dangerous situation, since the operating procedures allowed for the safe operation of trains in these circumstances. However, repeated failures of this type contributed to a high level of distraction and workload for the controllers. The poor performance of the signalling system was a contributory factor in the derailment.

249 This unreliability arose from various track showing 'closed', due to the incorrect operation of axle counters in the delta. This was caused by a design error by Thales Rail Signalling Solutions Inc. (paragraph 142).

250 The cause of these reliability problems has been resolved since March 2009.

Underlying factors[16]

251 Paragraph 210 identifies deficiencies in the implementation of safety related processes in the control centre.

252 This investigation has also identified deficiencies in the overall Serco Docklands management of the control centre. In particular:

- line management was ineffective; and
- there was insufficient monitoring and review by the senior management team (these issues were discussed in the RAIB report on the derailment at Deptford Bridge on 4 April 2008 (report 16/2009), which was published on 22 June 2009).

253 The RAIB report into the derailment at Deptford Bridge concluded that the inadequate scope of management systems to monitor safety performance could have been avoided had a systematic process been implemented to identify appropriate 'process safety indicators'[17] and management systems, to give early warning of system failures before the derailment occurred.

254 The RAIB continues to consider that the management of safety on the DLR would benefit from the adoption of a performance measurement model similar to that outlined in the HSG 254[18] guidance. However, the development of suitable process safety indicators is conditional on a thorough understanding of risk and control measures.

Changes to DLR infrastructure

255 **Docklands Light Railway and Serco Docklands did not implement processes to satisfy themselves that changes to the infrastructure were being adequately controlled.**

256 Although the two organisations had discussed a way forward and Serco Docklands wrote a procedure, this was only implemented by Serco Docklands for its own use. However, Docklands Light Railway Ltd was however aware of its existence.

257 Serco Docklands staff, although briefed on the new procedure, did not fully understand how it should work and what other existing processes were to be stopped. Docklands Light Railway Ltd did not have any procedures or processes in place to manage the risk generated by changes to the railway's assets (paragraphs 155 to 165).

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[16] Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

[17] A 'process safety indicator' can be seen as broadly equivalent to a key performance indicator (KPI). However a process safety indicator is focussed on measuring those aspects of system performance that affect on the safety of a process.

[18] HSG 254, Developing process safety indicators, HSE Publications, October 2006 (http://www.hse.gov.uk/pubns/books/hsg254.htm).

Observations

Training and procedures

258 The testing of the knowledge of the passenger service agent in respect of trailing and facing point moves was limited. Although he was tested on this subject, both practically and theoretically, the training and testing material appeared to focus mainly on facing point moves. However, trailing moves (when the points are incorrectly set for the intended move) will lead to a derailment.

259 Passenger service agents are trained to check the display of point position indicators and, subsequently, the position of points before crossing them. Procedure SOP/M-4.01, 'Emergency Shunt Operation' states that only point position indicators should be checked. However, control centre controllers instruct passenger service agents to check that both point position indicators and points are showing and set correctly for their train.

260 As a result, there is a discrepancy between the emergency shunt procedure and what is taught by trainers to the passenger service agents and control centre controllers.

Conclusions

Immediate cause

261 The immediate cause of the derailment was that train LEW109 travelled through 1125 points in a trailing direction when the points were not correctly set for this movement, and derailed.

Causal and possible causal factors

262 Causal and possible causal factors were:

- the passenger service agent did not identify that the points were set reverse, and stop the train (paragraph 238, no recommendation);
- the passenger service agent did not see the unlit point position indicator and stop the train at the indicator (paragraph 237, recommendation 1);
- the control centre controller did not intervene to stop the movement of the train (paragraph 228, no recommendation);
- the control centre controller did not follow the emergency shunt procedure and reserve 1125 points in the correct (normal) position (paragraph 222, recommendation 5 linked to underlying factors);
- the control centre controller was not aware of the exact position of train LEW109 because he had the block occupancy switched off on his overview (paragraph 225, recommendation 5 linked to underlying factors); and
- the 'red bar' lamp in 1125B point position indicator was unlit (paragraphs 239 and 246, no recommendation - see paragraph 286 for actions taken).

Contributory factors

263 Contributory factors were:

- the control centre controller was distracted by having to give instructions to another train in the delta and did not notice that 1125 points had moved reverse (paragraph 229, no recommendation);
- the low maintenance frequency of point position indicators and the inadequate range of tests carried out (paragraph 245, no recommendation - see paragraph 285 for actions taken);
- the procedure for passenger sevice agents to report unlit point position indicators to the control centre was carried out on an ad-hoc basis (paragraph 246, recommendation 3);
- there was no process or procedure for the exchange of details of unlit point position indicators between signalling maintenance and the control centre (paragraph 246, no recommendation - see paragraph 285 for actions taken);
- the poor conspicuity of point position indicators when unlit (paragraph 241, recommendation 1);

- the corroded pin of the lamp inside 1125B point position indicator (paragraph 239, no recommendation - see paragraph 285 for actions taken);
- the maintenance organisation were unaware of the unlit 'red bar' lamp (paragraph 246, no recommendation. See paragraph 285 for actions taken);
- the poor sighting of 1125B point position indicator (paragraph 243, recommendation 1);
- the existing filament type point position indicators are not conspicuous when lit (paragraph 244, recommendation 4);
- the poor alarm management of the SMC system (paragraph 246, recommendation 2);
- the technical problems in the delta area were not quickly resolved (paragraph 248, no recommendation - see paragraph 284 for actions taken); and
- there was no procedure to mandate that block occupancy display should be turned on at times of degraded working (paragraph 226, no recommendation).

Underlying factors

264 The underlying management factors were:

- inadequate systems for monitoring and reviewing safety performance and for monitoring compliance with rules and procedures (paragraph 251, recommendation 5 in this report and recommendation 5 in the RAIB Derailment of a DLR train at Deptford Bridge (report 16/2009));
- the absence of Serco Docklands management systems that could systematically identify process safety indicators (paragraphs 246, 251 and recommendation 7 in the RAIB Derailment of a DLR train at Deptford Bridge (report 16/2009)); and
- Docklands Light Railway Ltd and Serco Docklands did not have adequate systems in place to satisfy themselves that changes to the infrastructure were being adequately controlled (paragraph 257, recommendation 6).

Additional observation

265 There was a discrepancy between the content of the Serco Docklands training material and the emergency shunt procedure. In addition, the presentation of material and the assessment of competence related to driving over points in emergency shunt mode was inadequate (paragraphs 258 to 260, recommendation 7).

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

Rail Accident Investigation Branch

266 The RAIB issued an *urgent safety advice* to both Serco Docklands and Docklands Light Railway Ltd on 29 May 2009 in connection with the derailment on 10 March and the near miss on 23 April 2009.

267 The urgent safety advice is shown in appendix C. The contents of this advice and the actions reported to have been taken by Docklands Light Railway Ltd and Serco Docklands is shown below.

Docklands Light Railway Ltd

268 Docklands Light Railway Ltd responded to the RAIB's urgent safety advice (appendix C) initially on 3 June and finally on 19 August 2009 as detailed below:

1. *Instruct Thales to remove the auto-reverse function from 1125 points at the earliest practical opportunity. The necessary changes to the software and its implementation should be the subject of risk assessment and adequate change control.*
    - o Docklands Light Railway Ltd commissioned a risk assessment of the advice which was carried out by engineers and operational staff from both Docklands Light Railway Ltd and Serco Docklands.
    - o The result was that 'there was no reasonable case for removing the auto-reverse flank protection facility on 1125 points'.
2. *Introduce change control systems for the design and operation of signalling and software, particularly so that all parties involved in the operation of the DLR are made aware, both formally and practically, of all relevant software changes in the VCC and SMC systems.*
    - o This advice was accepted by Docklands Light Railway and is currently being delivered in two phases: phase one is the conduct of an independent review and phase two is the implementation of recommendations arising.
3. *Review the current signalling software to ascertain if there are any other areas where Serco Docklands are unaware of its design and operation;*
    - o Docklands Light Railway Ltd, Serco Docklands and Thales have completed a joint review of signalling system limitations which have an effect on operations. No other limitations in the signalling system were found.

269 Docklands Light Railway Ltd and Serco Docklands are currently working on a project definition study for the replacement of point position indicators. As part of this study, Serco Docklands are tasked to conduct a full signal sighting programme consistent with best practice.

270 Further to paragraph 268, item 2, Docklands Light Railway Ltd have initiated three independent reviews, and recommendations arising in the area of asset change, change management and assurance have been implemented.

271 Docklands Light Railway Ltd has also written various business critical processes to implement their change management and assurance framework. These cover the following:

- Automatic train control system testing, acceptance and commissioning;
- Automatic train control system requirements management; and
- Design and Code (Automatic train control system software).

Serco Docklands

272 Serco Docklands responded to the RAIB's urgent safety advice (appendix C) on 8 June 2009 as detailed below:

1. *Modify its procedures so that, on receiving and accepting a change notice to the VCC and SMC systems, it briefs all relevant staff on the changes and consequences on the operation of the railway;*
   - o Serco Docklands believes that procedure SP315, 'Asset Change Control[19]' addresses the advice and therefore no modification to procedures is required. However, Serco Docklands also respond: 'We must however ensure that this process is adhered to and monitored effectively'.
2. *Review how the point position indicator alarms are effectively and regularly communicated from the Control to the signalling maintenance teams.*
   - o Serco Docklands responded: 'This process has already been changed and the signalling team leader checks the log personally in the control centre each week'.

3 *Improve the maintenance and repair of point position indicators to minimise the risk of Passenger Service Agents being faced with un-illuminated indicators.*
   - o Serco Docklands responded: 'The results sheet for points maintenance has been changed to include a diagram of a typical point position indicator so that the maintainer can indicate which routes have been checked rather that just a tick box… this has been briefed to the team'.
   - o 'In addition, a project to replace the current halogen type with LED type has been commissioned. The LED indicators will have a much longer life (paragraph 273).'

4. *Re-brief all Passenger Service Agents that they must not pass an un-illuminated point position indicator.*
   - o Serco Docklands respond: 'We believe that this was covered in an incident report to all staff which immediately followed the incident.'

[19] SP315 has now been transferred to the Working on the Railway Manual as PC-6.01, 'Asset Change Control'. The Working on the Railway Manual is the common rule book for DLR.

273 Serco Docklands had produced a 'Project Initiation Document' (PID) on 26 January 2009 entitled, 'Route Indicator and Point Position Indicator Replacement'. This document was subsequently issued to Docklands Light Railway Ltd.

274 The document describes the replacement of the indicators and the reasoning behind it, together with an impact assessment on normal DLR services and the associated costs. The document also states that:

275 'Before any signals are installed, a signal sighting committee will be convened to ensure that signals are placed in a position agreeable to both parties.'

276 Figure 13 shows a new LED type point position indicator displaying a white arrow pointing upwards. This photograph was taken inside an artificially lit building.

Figure 13: Picture of a new LED type point position indicator displaying a white arrow

277 The programme of fitment of the new LED type indicators is proposed to begin with the delta junction area. This will include all point position indicators associated with 1125 points (including 1125B) and also indicators associated with 1124 points. 1126A and 1126B LED point position indicators were installed in September 2008 (figure 2).

278 At the time of issue of this report, no LED type point position indicators for 1124 and 1125 points had been installed.

279 Following the derailment, Serco Docklands' control manager issued an instruction to all control centre controllers on setting up an emergency shunt route. This included additional commands that should be used in both the VCC and SMC systems. The instruction also requires that an independent check by another controller must be undertaken before an instruction to move a train is given.

280 Serco Docklands has rewritten procedure SP315, 'Asset Change Control Procedure', (now PC-6.01 (paragraph 272)), to incorporate comments from independent reviews undertaken by Docklands Light Railway Ltd in connection with this derailment. The procedure has become part of the Serco Docklands 'Working on the Railway Manual'. The manual is the rule book for the railway and applicable to Docklands Light Railway Ltd, the franchisee and all other concessionaires.

281 Serco Docklands reports that it has also taken the following actions in the control centre since the derailment at Deptford Bridge station on 4 April 2008 (RAIB report 16/2009):

- assigned a general manager to the control centre;
- established a process to review its operating procedures;
- established and conducted a plan to audit compliance with its procedures;
- more management presence, and feedback to staff on good and poor performance;
- improved over-sight presence in the control room with responsibilities including monitoring of communications and incident / event handling;
- implemented continuous audit / active monitoring on the application of the operational restriction list; and
- begun recruitment of an additional control centre team to provide additional flexibility and time for the above.

282 Serco Docklands reports that it has reviewed its competency management system to determine the adequacy of existing arrangements and to identify improvements. The outputs of its review since the derailment at Deptford Bridge station on 4 April 2008 (RAIB report 16/2009) are:

- identification of need to identify all training modules and bring under central control – this is being undertaken by a cross functional working group;
- identification of the need for a central training and development manager to oversee the application of the competency management systems – this is still the subject of ongoing discussions;
- identification of the need for dedicated trainers – this is still the subject of ongoing discussions; and
- identification of the need to produce competence models for modules of training to aid coordination and quality of material, trainers and delivery – this is being undertaken by a cross-functional group.

283 Serco Docklands also reports that it has re-organised its senior management team as part of an overall organisational review. The control centre is now under the control of the planning and performance director who is accountable to the executive and board for the performance of the control centre. This has included the creation of a new role of duty manager within the control centre. The duty managers' roles will be to:

- manage the operational service on shift to ensure safe and efficient operation, taking into account customers' requirements and performance targets;
- co-ordinate and direct control and operational resources in an effective way to ensure that train service variances are correctly and safely managed to minimise disruption and inconvenience to customers; and
- resolve any incident which occurs on the railway by co-ordinating and directing resources accordingly and liaise with external emergency services and other Serco Docklands departments staff as required to minimise service disruption.

Completed actions which address factors in the report so avoiding the need for the RAIB to issue a recommendation

284 In April 2009, Thales Rail Signalling Solutions Ltd fixed the problem of signalling failures in the delta junction area by putting a 'dummy' axle counter back into the vacant channel. A short piece of rail with an axle counter head (and associated equipment) was mounted to it.

285 Serco Docklands maintenance engineers now check with the control centre on a weekly basis to ascertain if any point position indicators have failed.

286 Serco Docklands have changed their results sheet for points maintenance to include a diagram of a typical point position indicator so that the maintainer can indicate which indications for each point position indicator have been checked.

287 In the light of these actions addressing the factors identified in paragraphs 248, 246 and 245, the RAIB has decided not to issue further recommendations to address these factors.

Recommendations

288 The following safety recommendations are made[20]:

Recommendations to address causal and contributory factors

1 *The intention of this recommendation is to assist passenger service agents to identify the indication (or the absence of it) displayed at point position indicators when driving their trains in a manual mode.*

Docklands Light Railway Ltd should establish criteria for the location of point position indicators. These criteria should form the basis of a review of the sighting of all point position indicators and subsequent improvements. This should include factors such as:

- the height and angle of the point position indicator above rail height;
- the position of the point position indicator in relation to the track alignment; and
- the conspicuity of point position indicators when unlit

(paragraphs 262 and 263).

2 *The intention of this recommendation is to improve the effectiveness of control centre controllers during degraded operations.*

Docklands Light Railway Ltd, in consultation with Serco Docklands, should review the alarm management systems in the SMC, and implement any enhancements necessary to maximise the effectiveness of controllers during degraded modes of operations. The review should include:

- the number of alarms generated and their value to controllers;
- how they are displayed;
- actions in response to the alarms;
- the filters available to the controllers; and
- control room procedures and guidance

(paragraph 263).

continued

[20] Those identified in the recommendations, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail Regulation to enable them to carry out their duties under regulation 12(2) to:

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 167 to 171) can be found on RAIB's web site at www.raib.gov.uk.

3 *The intention of this recommendation is to provide additional information to control centre controllers on unlit point position indicators in order that maintenance staff can be informed immediately.*

Serco Docklands should re-brief its staff on procedure SOP/M-3.08, 'Service Bulletins, Traffic Notices, Emergency Notices and Restrictions' to make clear that passenger service agents should report unlit point position indicators and that this information is passed by controllers to maintainers immediately (paragraph 263).

4 *The intention of this recommendation is to assist passenger service agents to identify the indication displayed at point position indicators when driving their trains in a manual type mode.*

Docklands Light Railway Ltd should replace all point position indicators with ones that are more conspicuous (when lit) as soon as reasonably practicable (paragraph 263).

Recommendations to address underlying factors

5 *The intention of this recommendation is to improve the effectiveness of control centre controllers during degraded operations.*

Serco Docklands should establish and implement management arrangements for monitoring and reviewing the performance of controllers in order to assess the levels of compliance with current procedures and implement a system to ensure appropriate actions are taken to address any deficiencies identified (paragraph 262).

6 *The intention of this recommendation is to establish a mechanism for Docklands Light Railway Ltd to satisfy itself that the risks associated with change to its infrastructure are being adequately controlled.*

Docklands Light Railway Ltd, in consultation with Serco Docklands should review and revise as appropriate its processes for ensuring adequate control of changes to the design and operations of the railway. This review should encompass:

- the management of interfaces between the operating railway, designers, installers and testers;
- that operational implications of design changes are correctly identified and understood; and
- methods of making all relevant parties, management and staff aware of changes to the method of working.

(paragraph 264).

continued

The following two recommendations were made by the RAIB as a result of the investigation into the derailment of a DLR train at Deptford Bridge on 4 April 2008 (recommendations 5 and 7, RAIB report 16/2009[21], published 22 June 2009):

'Serco Docklands should undertake a review of its management arrangements for the monitoring, audit and review of activities at the level of operational and engineering staff. The findings of this review should be translated into effective corrective actions where appropriate.'

'Serco Docklands should thoroughly and comprehensively identify safety process indicators covering the entire scope of its operation and implement suitable management arrangements covering the collection of data, monitoring and subsequent review. The guidance contained in HSG 254 in relation to leading and lagging performance indicators should be taken into account.'

These recommendations address the factors identified in paragraphs 252 and 253. They are therefore not remade so as to avoid duplication.

Recommendations to address other matters observed during the investigation

7 *The intention of this recommendation is to improve the effectiveness of all staff involved when operating in emergency shunt mode.*

Serco Docklands should carry out a review of training related to operations in emergency shunt mode and implement any enhancements necessary to maximise the effectiveness of the staff involved. This review should have the objective of:

- resolving the discrepancy between the emergency shunt procedure and the training;
- ensuring that the training and testing material includes suitable and sufficient information on 'trailing' points; and
- improving the arrangements for assessing staff competence for emergency shunt mode operations.

(paragraph 265).

[21] RAIB reports are available at the RAIB web site, www.raib.gov.uk

Appendices

Appendix A - Glossary of abbreviations and acronyms

ATO	Automatic Train Operation
ATP	Automatic Train Protection
CCTV	Closed Circuit Television
DLR	Docklands Light Railway
OTDR	On Train Data Recorder
ORR	Office of Rail Regulation
RAIB	Rail Accident Investigation Branch
ROGS	Railways and Other Guided Transport Systems (Safety) Regulations 2006
SMC	System Management Centre (computer system)
VCC	Vehicle Control Centre (computer system)

Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (*), have been taken from Ellis' British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com

ATP manual	A manual mode of driving DLR trains whereby the passenger service agent operates a joystick which draws electricity to power the motors to drive the train either forward or reverse. The train is restricted to speed limits set by the VCC system, but has full ATO protection.
Auto-reverse (points)	Points that will move automatically to their 'reverse' position when they are either: ● not called normal by a route; ● not locked by a train; or ● not physically prevented from moving into the reverse position.
Axle counter	A track mounted device that accurately counts passing axles. By using an *axle counter evaluator* to compare the number of axles entering and leaving a block section, the signalling system can determine whether the section is clear or occupied. In this respect it is analogous to a *track circuit*. Installation of axle counters is less involved than that for track circuits, and they function irrespective of rail head conditions, type of train, etc.*
Axle counter block	A section of physical track that is fitted with axle counters as the method of train detection.
Axle counter evaluator	An electronic processor that receives data from several axle counters and decides whether a section is clear on the basis of the number of axles counted into the section equalling (or not equalling) the number of axles counted out of the section.*
Block occupancy (SMC display)	Sections of defined physical track areas (blocks) whose boundaries do not coincide with track boundaries (as displayed on the SMC overviews) but will be indicated as closed tracks depending on which blocks are occupied. The display of trackwork through points reflect the occupancy status of blocks around them.
Bogie	A metal frame equipped with two or three wheelsets and able to rotate freely in plan, used in pairs under rail vehicles to improve ride quality and better distribute forces to the track.*
Code	Data that is transmitted wirelessly and constantly between the DLR train and the control centre (VCC) via an inductive loop cable that is laid in the *four foot*.
Concessionaires	Organisations that own the assets of particular areas of the Docklands Light Railway e.g. City Greenwich Lewisham Railway (CGLR) who own the area of DLR between Mudchute and Lewisham.

Conductor rail
An additional rail, generally of a unique section, used to convey and enable collection of electrical traction current at track level. Conductor rail systems carry voltages of the order of 600 - 1000 Volts, generally DC.

The DLR system uses one conductor rail located outside the running rail which is supported on brackets. The conductor rail is protected and covered by insulated material and the train uses *shoegear* that picks up the power from underneath the conductor rail.

Control centre controller
A person who monitors and controls the railway operations of the DLR from the control centre.

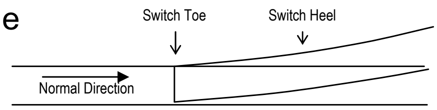
Disturbed (axle counter)
An interruption of the axle counter system's ability to record the passage of axles. Although the equipment has returned to working order it cannot determine whether the Track Section is occupied. This results in the computer based interlocking system having an undefined state.

Drag and Drop
An SMC method of using the 'mouse' for certain commands. e.g. train routing is performed by clicking on the train symbol, moving the pointing device to the desired track section or platform and releasing the button.

Emergency shunt (mode)
A manual mode of driving DLR trains whereby the passenger service agent operates a joystick which draws electricity to power the motors to drive the train either forward or reverse. The train is restricted to a maximum of 20 km/h.

Facing (points)
A set of points or set of switches installed so that:

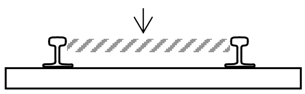
- two or more routes diverge in the direction of travel
- traffic travels from Switch toe to switch heel in the normal direction of traffic.*



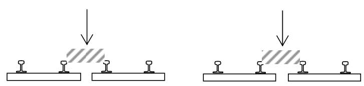
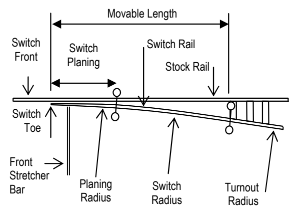
Flank protection
Arrangements for providing additional protection from unauthorised movements on converging lines by utilising other points in the junction.*

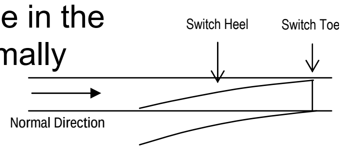
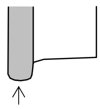
'for cause' screened
All those directly involved with an accident or incident should be 'for cause' screened for the presence of alcohol or drugs in line with either Railway Group Standard GE/RT/8070 or current industry good practice.

Four foot
The area between the two running rails of a standard gauge railway. The actual dimension of this space is 1435 mm (4' 8½").*



Lead emergency driving position (emergency driving position)
The position in which the passenger service agent would travel at the front of the train. The passenger service agent would be looking ahead to see if there were any obstructions on the track. He could stop the train by operating the emergency stop button on the console.

Loop boundary	The boundary between two sections of the same inductive loop. (see code).
Moving block	As opposed to fixed block where the signals are fixed trackside and only one train is allowed in one block at one time, moving block allows trains to travel closer together with a resultant greater capacity, less trackside equipment is used and there are less maintenance costs.
Non-communicating tracked (train)	A train that has lost contact with the VCC system, but is still being tracked.
Passenger service agent	A person who travels on every DLR train, normally undertaking ticket and revenue duties. This person can also be requested to drive the train, when required and also carry out a '*sweep*' of the track if necessary.
Point position indicator	An illuminated signal that can display either an arrow or a red bar symbol dependant on which way the points are set.
Point reservation	The act of securing a set of points in a particular position by either: ● Drag and Drop commands on the SMC; or ● VCC system commands.
Reserving (points)	See *Point reservation*
Shoegear	Equipment carried by a train and used for current collection on third rail systems. Shoegear comprises a cast iron shoe that is usually mounted on an insulating beam attached to the side of the bogies, close to rail level.*
Six foot	The colloquial term for the space between two adjacent tracks, irrespective of the distance involved.* 
Stock rail	The fixed rail in a switch half set. The other rail is the switch rail.* 
Sweep	A passenger service agent will check that the line ahead of the moving train is clear of obstructions by being at the lead emergency driving position and looking ahead. This train is known as the 'sweep' train and the action of the passenger service agent is known as 'sweeping'.
Switch rail	The thinner movable machined rail section that registers with the stock rail and forms part of a switch assembly.*
Switch toe(s)	The end of a switch rail that is first traversed by a rail vehicle negotiating a switch in a facing direction. Sometimes referred to as the switch tip.*

System mangement centre	A computer system located in the control centre which monitors and controls train regulation and traffic management and allows the controller to intervene as required. The SMC is directly connected to the VCC computer system.
Track circuit	An electrical or electronic device used to detect the absence of a train on a defined section of track using the running rails in an electric circuit.*
Transport undertaking	Any private or public undertaking the principal business of which is to provide rail transport services for goods and/or passengers, with a requirement that the undertaking must ensure traction.
Trailing (points)	A set of points where two routes converge in the normal direction of traffic, e.g. traffic normally travels from switch heel to switch toe. The opposite is facing points.* 
Troughing route	The designated cable management system laid alongside the railway made from pre-cast concrete troughs and removable lids.
Urgent safety advice	Urgent safety advice is issued by the RAIB to deal with matters of immediate concern, where it is necessary to prevent another accident being caused by the particular deficiencies that has been found or there is reason to suppose that these deficiencies are not a one-off and could happen elsewhere.
Vehicle control centre	A computer system located in the control centre which undertakes signalling safety interlocking functions. These include communications with all trains on the DLR system and the transfer of data to the SMC computer system.
Wheel flange	The extended portion of a rail vehicle's wheel that contacts the rail head and thus provides the wheelset with directional guidance.* 

Appendix C - Urgent Safety Advice

USA issued on 29/5/09 to Docklands Light Railway Ltd and Serco Docklands

RAIB SF-3.1.9.1
ISSUE : 2
27 OCTOBER 2005

URGENT SAFETY ADVICE

1. INCIDENT DESCRIPTION			
LEAD / INSPECTOR		CONTACT TEL. NO.	
INCIDENT REPORT NO	**0346**		10 March and 23 April 2009
INCIDENT NAME	West India Quay – Docklands Light Railway (DLR)		
TYPE OF INCIDENT	Derailment and near miss		
INCIDENT DESCRIPTION	On 10 March 2009, a DLR train was being driven in emergency shunt mode towards 1125 trailing points at West India Quay from Westferry. Although the points were physically set in the correct (normal) position, they were not reserved for the route of the train. The controller had given the train permission to move. The points automatically reversed in front of the train, which derailed as a result. On 23 April 2009, a similar set of circumstances arose. However, the controller on this occasion followed procedures and had also reserved the points in the correct (normal) position. Despite this the points auto reversed as the train approached. The controller noticed this, and stopped the train by switching off the traction power, preventing a possible second derailment. Analysis of the two incidents indicates that, as a train in emergency shunt mode passes over a boundary between two signalling interlocking systems approaching West India Quay, the reserving of the points will be lost, and 1125 points will automatically move to their reverse position.		
SUPPORTING REFERENCES	-		

2. URGENT SAFETY ADVICE	
USA DATE:	29/05 /2009
TITLE:	Software changes to signalling systems
SYSTEM / EQUIPMENT:	DLR System Management Centre (SMC) and Vehicle Control Computer (VCC) systems
SAFETY ISSUE DESCRIPTION:	1. Docklands Light Railway Limited (DLRL) are currently altering both the interlocking (VCC) and control (SMC) systems. 1125 points at West India Quay had been changed from ones that would only move when required by the VCC system or the controller, to ones that would automatically move to the reverse position (auto reverse) when they were not otherwise reserved by the SMC and VCC systems. Analysis of the two incidents indicates that, as a train in emergency shunt mode passes over a boundary between VCC interlocking systems approaching West India Quay junction, the reserving of the points will be lost, and 1125 points will automatically move to their reverse position. The change to make 1125 points auto reverse was not officially communicated by DLRL, or its software contractor, Thales, to the operator, Serco Docklands. DLRL, Thales and Serco Docklands Project Division had been involved in discussions about the change to 1125 points during design reviews. However, there was no formal change control process in DLRL, and the change to the operation of the points was not officially communicated within Serco Docklands; to either its Engineering or Operations Divisions, or to the control centre. 2. At all facing and trailing points on the DLR system, there are point position indicators (PPIs) which indicate the position that the points are set. These are viewed by train operators when driving in emergency shunt mode to ascertain if the points ahead are correctly set. There are three PPIs associated with 1125 points. On 10 March 2009, only 1125A PPI was working and the other two were not illuminated. This included the PPI that the incident train would have passed as it approached 1125 points. When PPI lamps are not lit, an alarm is sent to the SMC. A list of these PPI failures is exchanged weekly with the signalling maintenance teams who should then investigate the failures. A list of PPI failures had not been given to the signalling maintenance team since May 2008.
CIRCUMSTANCES:	See above
CONSEQUENCES	Apart from the derailed train there were no consequences from either incident. However, on the first occasion another train was approaching the points, and a collision could have resulted, whilst a second derailment was only prevented by the observation and swift reaction of the controller.

RAIB SF-3.1.9.1
ISSUE : 2
27 OCTOBER 2005

URGENT SAFETY ADVICE

REASONS FOR ISSUE:	In order to prevent a recurrence the RAIB advises that Docklands Light Railway Limited should: 1. instruct Thales to remove the auto reverse feature from 1125 points at the earliest practical opportunity. The necessary changes to the software and its implementation should be the subject of risk assessment and adequate change control; 2. introduce change control systems for the design and operation of signalling and software, particularly so that all parties involved in the operation of the DLR are made aware, both formally and practically, of all relevant software changes in the VCC and SMC; and 3. review the current signalling software to ascertain if there are any other areas where Serco Docklands are unaware of its design and operation. In addition, Serco Docklands should: 1. modify its procedures so that, on receiving and accepting a change notice to the VCC or SMC, it briefs all relevant staff on the changes and consequences on the operation of the railway; 2. review how the point position indicator (PPI) alarms are effectively and regularly communicated from the Control to the signalling maintenance teams; 3. improve the maintenance and repair of PPIs to minimise the risk of Passenger Service Agents being faced with un-illuminated PPIs; and 4. re-brief all Passenger Service Agents that they must not pass an un-illuminated PPI.

USA SIGN-OFF*			
INSPECTOR NAME:		**CI / DCI NAME:**	
INSPECTOR SIGNATURE:	ELECTRONIC COPY	**CI / DCI SIGNATURE:**	ELECTRONIC COPY
DATE:	29/05/2009	**DATE**	29/05/2009

Appendix D - Emergency shunt operation procedure (extracts)

The actions that should be undertaken by the two members of staff are as follows:

> *'When requested to operate in emergency shunt by the controller, the passenger service agent is to:*
>
> - *Move to leading emergency driving position in direction of travel.*
> - *selects emergency shunt.*
> - *uses radio when appropriate….*
> - *confirms location with controller using track section number and that emergency shunt has been selected.*
>
> *The controller is to inform the passenger service agent of:*
>
> - *starting point of move using track section number.*
> - *direction of travel.*
> - *termination point of move*
> - *operating mode to be selected at termination point.*
> - *the position and numbers of any points that are to be crossed.*
> - *reserves a route for the emergency shunt move by using the SMC / VCC commands for all points along the route. The points must be set, reserved and blocked using either the SMC '**Drag and Drop**' reservation command or the VCC Points Reservation Command.'*

The procedure continues to describe the process about exchanging and logging the instructions and then states:

> *'Having received permission, the passenger service agent commences movement following all details of instructions. On approaching points, the passenger service agent visually checks point position indicators, indication shows points set correctly for required move. If point position indicator indication is not for required move, the passenger service agent stops train and contacts control centre controller.*
>
> *If the passenger service agent attempts to drive in excess of 20 km/h and train emergency brakes, the passenger service agent is to return joystick to the full braking position before putting it back up to power.'*

The procedure also states:

> *'The passenger service agent makes every effort to maintain a speed between 15-19 km/h to reduce the chance of 'gapping' the train.'*

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