RAIB
Rail Accident Investigation Branch

Rail Accident Report

Train dispatch accident at Elstree & Borehamwood station 7 September 2018

Report 03/2019
May 2019

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 2005.

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Preface

The purpose of a Rail Accident Investigation Branch (RAIB) investigation is to improve railway safety by preventing future railway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability. Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The RAIB's findings are based on its own evaluation of the evidence that was available at the time of the investigation and are intended to explain what happened, and why, in a fair and unbiased manner.

Where the RAIB has described a factor as being linked to cause and the term is unqualified, this means that the RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident. However, where the RAIB is less confident about the existence of a factor, or its role in the causation of the accident, the RAIB will qualify its findings by use of words such as 'probable' or 'possible', as appropriate. Where there is more than one potential explanation the RAIB may describe one factor as being 'more' or 'less' likely than the other.

In some cases factors are described as 'underlying'. Such factors are also relevant to the causation of the accident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, words such as 'probable' or 'possible' can also be used to qualify 'underlying factor'.

Use of the word 'probable' means that, although it is considered highly likely that the factor applied, some small element of uncertainty remains. Use of the word 'possible' means that, although there is some evidence that supports this factor, there remains a more significant degree of uncertainty.

An 'observation' is a safety issue discovered as part of the investigation that is not considered to be causal or underlying to the event being investigated, but does deserve scrutiny because of a perceived potential for safety learning.

The above terms are intended to assist readers' interpretation of the report, and to provide suitable explanations where uncertainty remains. The report should therefore be interpreted as the view of the RAIB, expressed with the sole purpose of improving railway safety.

Information about casualties is based on figures provided to the RAIB from various sources. Considerations of personal privacy may mean that not all of the actual effects of the event are recorded in the report. The RAIB recognises that sudden unexpected events can have both short and long term consequences for the physical and/or mental health of people who were involved, both directly and indirectly, in what happened.

The RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of any inquest or fatal accident inquiry, and all other investigations, including those carried out by the safety authority, police or railway industry.

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Train dispatch accident at Elstree & Borehamwood station, 7 September 2018

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Summary

At around 14:03 hrs on 7 September 2018, a passenger and her dog were involved in a train dispatch accident at Elstree and Borehamwood station. The dog's lead became trapped in the closed doors of a departing train, dragging the dog off the platform and leading to its death. The passenger was not injured but was very distressed.

The accident happened because the train driver did not observe the passenger in close proximity to the train, both before he decided to close the train doors and before he decided it was safe to depart from the station. An on-train CCTV system is provided to allow the driver to monitor the side of the train and the adjacent platform edge during the dispatch process.

The design of the door obstacle-detection system was such that a thin object, such as the dog's lead, could not be detected. As a result, the train was able to depart with the dog's lead trapped in the closed door.

As a result of this investigation, the RAIB has made two recommendations. The first is made to Govia Thameslink Railway. It relates to the development of suitable guidance to drivers on the time needed to safely observe the platform-train interface before and after closing the train doors, and enhancing its driver management processes by routinely monitoring the safety of train dispatch. The second recommendation is made to the Rail Delivery Group, in consultation with RSSB and train operators. It relates to investigating technologies to better assist train dispatch staff to detect people or items which may become trapped in train doors.

Introduction

Key definitions

1 Metric units are used in this report, except when it is normal railway practice to give speeds and locations in imperial units. Where appropriate the equivalent metric value is also given.

2 The report contains abbreviations, explained in Appendix A. Sources of evidence used in the investigation are listed in Appendix B.

The accident

Summary of the accident

3 At around 14:03 hrs on Friday 7 September 2018, a passenger and her dog were involved in a train dispatch accident at Elstree and Borehamwood station (figures 1 and 2). As the passenger was boarding the train, the doors closed trapping her dog's lead, while the passenger and the dog were left standing on the platform.

4 The train then departed, dragging the dog off the platform and into the gap between the platform and train. The dog suffered fatal injuries. The passenger was not physically injured but was very distressed by the accident. In slightly different circumstances, the passenger herself could have become trapped by the long scarf she was wearing.

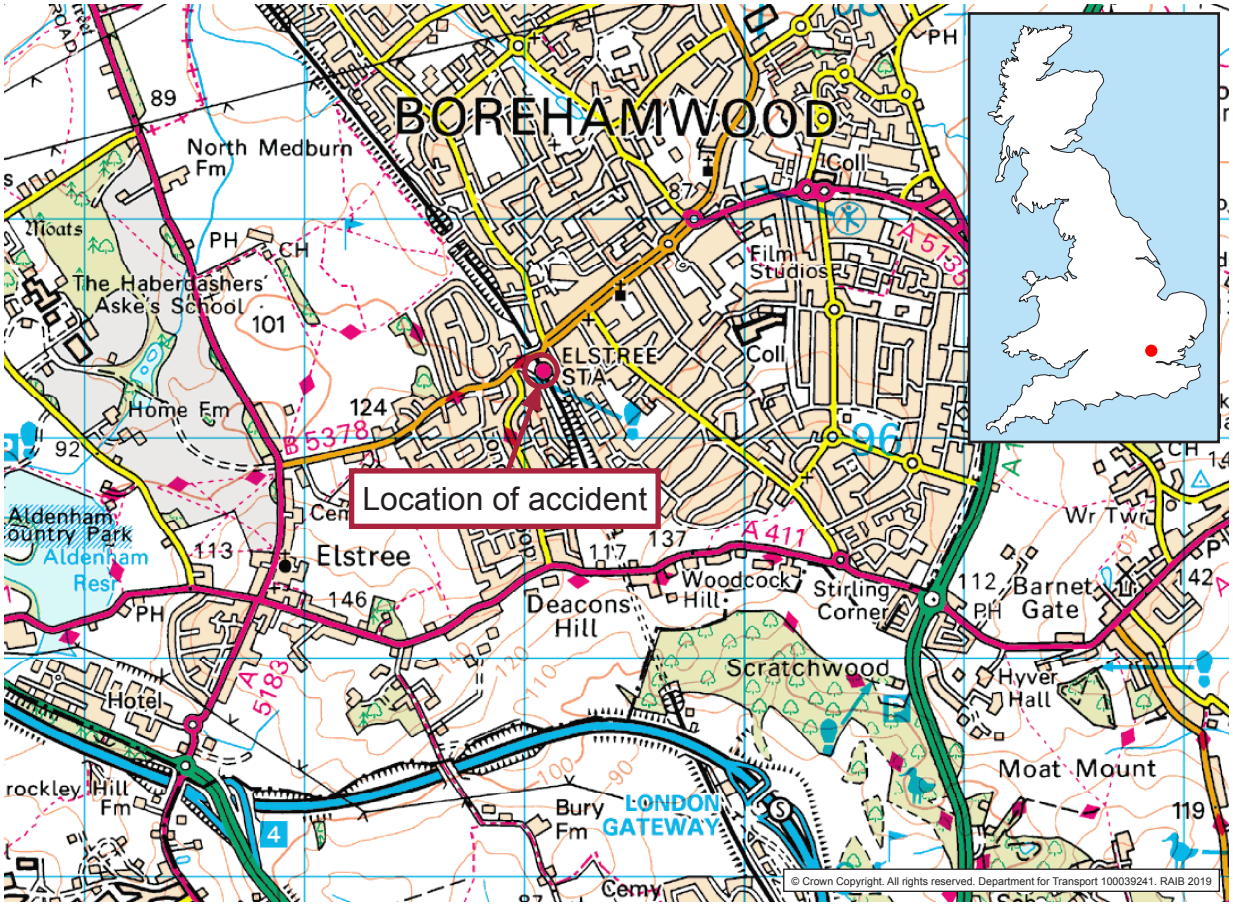

Figure 1: Extract from Ordnance Survey map showing location of accident

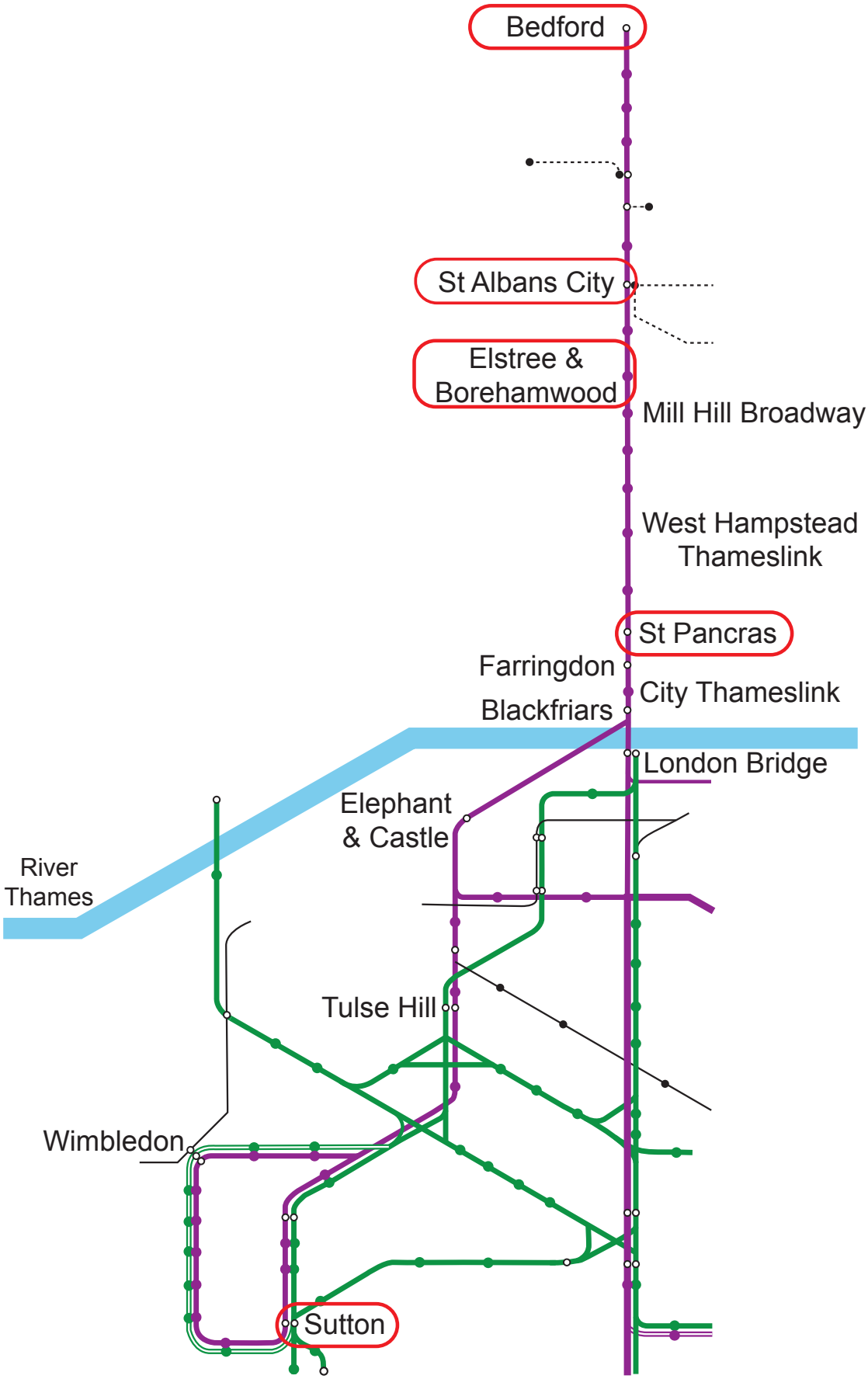

Figure 2: Location of Elstree and Borehamwood station in relation to London St Pancras and other railway locations referenced in this report. The Thameslink route is shown in purple, certain other railway routes are shown in green.

Context

Location

5 Elstree and Borehamwood station is located on the Midland Main Line that runs between London, Bedford, the East Midlands and Sheffield. The station is located 12 miles and 770 yards (20 km) north of a datum located at London St Pancras station. The station has four platforms. Platforms 1 and 2 are used by all trains which are timetabled to stop at Elstree and Borehamwood. Platform 1 (figure 3) serves the up[1] slow line, and platform 2 serves the down slow line. Platforms 3 and 4 serve the fast lines which are normally closed to the public by means of barriers; no trains are timetabled to stop at these platforms. The station building adjoining platform 1 provides access to the platforms and houses the ticket office.

Figure 3: View looking north along platform 1 showing the location of the accident (red arrow)

6 All trains which call at Elstree and Borehamwood station are dispatched (paragraph 37) using Driver Only Operation (DOO)[2]. On class 700 trains (the type involved in this accident), the driver views the side of the train and the adjacent platform edge by means of an in-cab Closed Circuit Television (CCTV) system. Such trains do not carry a guard, and the station staff are not involved in the train dispatch process.

7 To the south of Elstree and Borehamwood station are the Elstree tunnels. The tunnels are 1058 yards (967 metres) long, and the northern portal is 12 miles and 120 yards (19.4 km) from London St Pancras station.

Organisations involved

8 All regular train services using Elstree and Borehamwood station are operated by Govia Thameslink Railway (GTR).

[1] Trains travelling south towards London are described as travelling in the up direction.

[2] This is sometimes referred to as Driver Controlled Operation (DCO). However, DOO is the term used by the railway rule book GE/RT8000, module SS1, and is used throughout this report.

9 GTR manages Elstree and Borehamwood station and employs the station staff. GTR is also the employer of the train driver involved in the accident.

10 The train involved was built and maintained by Siemens. The train is owned by Cross London Trains Ltd.

11 Network Rail employs the signaller at West Hampstead signal box, which controls the operation of trains through Elstree and Borehamwood station. The actions of the signaller had no bearing on the accident.

12 All of these organisations freely co-operated with the investigation.

The train involved

13 The train service involved was 9O47[3], the 13:52 hrs service from St Albans City to Sutton, running via the Thameslink route through central London (figure 2).

14 Train 9O47 was formed of an eight coach class 700 Electric Multiple Unit (EMU)[4] (figure 4), unit number 700060. This unit was first accepted into traffic by GTR on 2 July 2018[5]. By the date of the accident, it had covered approximately 19,000 miles and therefore had not yet reached the 20,000 mile interval for its first planned maintenance intervention since delivery.

Figure 4: A class 700 EMU of the type involved in the accident

[3] An alphanumeric code, known as a 'train reporting number', is allocated to every train operating on Network Rail infrastructure.

[4] An EMU is an electric train consisting of one or two or more vehicles semi-permanently coupled together that can marshalled with other similar trains to make a formation that has a driving cab at both ends.

[5] The entire Thameslink service which serves Elstree and Borehamwood station has been operated by class 700 EMUs since the summer of 2017. Prior to that, the class 319 EMUs that operated the DOO services had used platform mounted CCTV monitors to aid train dispatch.

Staff involved

15 The train driver involved has been operating DOO trains on the Thameslink route from Bedford into central London since 2003. He held all of the necessary competencies for his role and, with one exception discussed later at paragraph 80, all of his competency assessments were up-to-date.

16 At the time of the accident, there were two members of GTR station staff at Elstree and Borehamwood. One was a sales assistant, who normally works in the ticket office, and the other was a platform assistant, who normally works on the platform assisting customers. A third member of GTR staff, a revenue control officer who would normally staff the ticket barriers located within the station building, arrived at Elstree and Borehamwood on train 9O47 (the train involved in the accident).

External circumstances

17 The weather at the time of the accident at Elstree and Borehamwood station was dry and bright; it had no bearing on the accident.

The sequence of events

Events preceding the accident

18 At 09:00 hrs on the day of the accident, the driver booked on for duty at GTR's Bedford depot. On that day, he was rostered as 'spare', meaning he had no planned driving duties but could expect to be deployed to cover for other drivers who may have become unavailable.

19 He spent the morning carrying out administration work at the depot and was then advised by his supervisor that he was required to operate train 9O47. He caught the 11:35 hrs train from Bedford to St Albans City and then took a lunch break.

20 Unit 700060 had previously operated a service which terminated at St Albans City. It was taken by another driver into a carriage siding to the north of the station, where it was reversed[6], and then returned to St Albans station to form train 9O47.

21 The driver involved in the accident took over train 9O47 at St Albans City station. The previous driver had noted a concern regarding a control screen in the cab[7] and there was a brief discussion between the two drivers about this. As a consequence of this discussion, train 9O47 departed from St Albans at 13:54 hrs, two minutes behind schedule.

Events during the accident

22 The passenger arrived at Elstree and Borehamwood station a few minutes prior to the arrival of train 9O47. She was using a walking aid[8] and was accompanied by her dog which was on a lead. She had two bags with her. She is a frequent user of the station, familiar with the station environment, and was travelling to London St Pancras to meet a relative.

23 When the passenger arrived at the station, the sales assistant and the platform assistant were servicing the ticket vending machines located at the front of the station. From this location, they had no view of the platforms.

24 Train 9O47 arrived at Elstree and Borehamwood station at 14:02 hrs, still running two minutes behind schedule.

25 The passenger was standing on platform 1, towards the south end of the platform. When train 9O47 arrived, she headed towards the leading door of the fifth coach in the train. This was door B[9] of coach number 406060. The passenger chose that door because she knew that it would align with a raised section of the platform at London St Pancras, and this would ease her disembarkation.

26 CCTV evidence from the train shows that the passenger arrived at the door 13 seconds after the train came to a stand. She then started to board the train.

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[6] The previous train service arrived at St Albans City from the south. It was therefore necessary for the train to reverse directions. This was done by the previous driver walking from the cab at the northern end to the cab at the southern end of the train whilst the train was in the carriage siding.

[7] The screen in question was not one of the screens used to display the DOO CCTV door images.

[8] The walking aid is a medium sized four-wheel unit used by the passenger to aid balance when walking. It also enables the passenger to sit when necessary.

[9] Each coach of a class 700 train has four pairs of sliding doors; these are identified as doors A, B, C and D.

27 The passenger initially placed a bag and the lead of her dog onto the floor of the train, and then prepared to board the train herself with her dog. However, the train doors then started to close. As the doors closed, the dog's lead became trapped with the dog remaining on the platform. The passenger was also still on the platform, in close proximity to the train but now separated from one of her bags. She was wearing a scarf around her neck at the time and CCTV images indicate there was also the risk that the scarf could have become trapped in the closing doors.

28 As soon as the doors had closed, the passenger attempted to raise the alarm by waving and shouting. However, the train departed from the station dragging the dog, by its trapped lead, off the platform and into the gap between the platform and train.

29 The passenger, who was now in a state of considerable distress, went back to the station building, where she met the sales assistant and the platform assistant, who had just completed their duties with the ticket vending machine. The passenger told them what had happened. The revenue control officer, who had just alighted from the rear coach of 9O47, was unaware of the accident until he arrived at the station building.

Events following the accident

30 The station staff reported the accident to the Network Rail signaller at West Hampstead, to GTR Control and to subsequent stations on the journey of train 9O47. The passenger caught the next available train to London St Pancras.

31 Meanwhile, the train driver was initially unaware that an accident had taken place as he drove train 9O47 towards London. While en-route, he was informed by a passenger on the train, who had witnessed the latter stages of the accident, that a passenger had become separated from her bag while trying to board the train.

32 The Network Rail signaller at West Hampstead also contacted the driver using the cab radio system to inform him of the report he had received from the station staff at Elstree and Borehamwood, regarding a dog being trapped in the doors of train 9O47. During the next station stop at Mill Hill Broadway, the driver left his cab and checked the train, but could find nothing amiss. The dog was subsequently found in Elstree tunnel (paragraph 35) and so there was nothing to be seen by the driver at Mill Hill Broadway, which is to the south of Elstree tunnel.

33 Train 9O47 continued on its journey, as booked, to Sutton (figure 2) where it was timetabled to arrive at 15:17 hrs and then form 9O48, the 15:19 hrs service back to St Albans City.

34 By this time, the passenger had met GTR staff at St Pancras giving GTR's control staff a more complete view of what had happened at Elstree and Borehamwood station. A decision was taken by GTR to remove the driver from duty. Train 9O48 was cancelled and the driver took the empty train to Smithfield Sidings, located in central London. The driver then travelled back as a passenger to his depot at Bedford where he was met by his manager.

35 The dog was recovered from Elstree Tunnel by Network Rail staff, and returned to the passenger at her request. The dog was wearing a body harness, which was recovered with the dog. The dog's lead, which had been clipped to the harness, was never found despite an extensive search.

36 The train was taken to the Siemens maintenance depot at Three Bridges. The door systems, including the DOO CCTV system, were tested. No defects were found.

Key facts and analysis

Background information

DOO train dispatch process

37 The railway rule book GE/RT8000, module SS1 'Station duties and train dispatch' Issue 5, December 2017, section 3.8, sets out the following procedure for train drivers when dispatching their train from an unstaffed platform[10] under DOO conditions:

- Check that the platform starting signal, if there is one, is showing a proceed aspect.
- Check the whole length of the train to make sure that it is safe to close the doors, using the monitors or mirror, if provided.
- Close the doors. Check that the external orange hazard lights have gone out, and, where appropriate, the traction interlock light[11] is illuminated. Drivers must not rely only on the external orange hazard lights or the traction interlock light as an indication that it is safe to start.
- Carry out the 'train safety check', using the monitors or mirror, if provided, by making sure that:
  - the train doors are properly closed;
  - nobody is trapped in the doors, for example by clothing; and
  - nobody is in contact with the train.
- Start the train only if it is safe to do so.

38 If train drivers are unable to carry out the train safety check from the driving cab because of defective DOO equipment or poor visibility, the rule book at the time of the accident required that they must position themselves on the platform to carry out the train safety check.

DOO equipment on class 700 trains

39 Each coach on a class 700 train is fitted with exterior mounted CCTV cameras, one on each side (figure 5). These provide an external image of the doors, the side of the vehicles and the adjacent platform edge.

40 The CCTV images are displayed to the driver on two monitor screens in the cab, located to the left side of the driving position (figure 6). On an eight-coach class 700 train, four images, one for each coach, are displayed on each of the screens (figure 7). Each image measures 104 mm horizontally by 87 mm vertically. A 'heartbeat' indicator displayed on the screen confirms to the driver that the images are 'live' and that the screens have not 'frozen'.

[10] The station staff at Elstree and Borehamwood are not involved in the train dispatch process. Therefore, the platform is regarded as unstaffed from a train dispatch perspective.

[11] On a class 700 train, this traction interlock light is a blue 'halo' indicator on the cab desk (figure 8).

Figure 5: Exterior mounted CCTV camera (circled) on a class 700 coach

Figure 6: The cab desk of a class 700 train

Figure 7: The screens displaying images from the externally mounted CCTV cameras. The red box shows the position of the image showing the fifth coach (involved in the accident). Images shown are not at Elstree and Borehamwood station.

41 Door controls are provided in the driver's cab (figure 8). They are duplicated on each side of the cab, and control the doors on the respective side of the train. Two buttons[12], marked 'release doors', must be pressed simultaneously to allow the doors to be opened[13]. Doors are closed using a single push button. A 'doors locked' indication is provided to advise the driver when the doors are locked and the 'traction interlock' has been achieved. The traction interlock system detects when the doors are closed and locked and prevents the driver applying power to move the train unless both conditions have been met.

42 The CCTV screens become operational as soon as the driver releases the doors. Images cease to be displayed as soon as the train reaches a speed of 3 km/h as it departs a station. This is in accordance with clauses 3.1.9 and 3.1.10 of RIS-2703-RST 'Rail Industry Standard for Driver Only Operated On-train Camera / Monitor Systems', Issue 1, June 2014[14].

[12] The 'two button' control is to mitigate the risk of opening the doors on the wrong side of the train. This is in accordance with guidance contained in Rail Industry Standard RIS-2747-RST 'Functioning and Control of Exterior Doors on Passenger Vehicles'.

[13] The train doors can operate in a number of different modes. The exact effect of pressing the door release buttons varies between modes. At Elstree and Borehamwood, pressing the buttons enabled passengers waiting on the platform (or those on the train wishing to alight) to open doors using push-buttons provided at each door.

[14] In September 2018, RSSB (paragraph 53) published research (reference T1059) which proposes that the point at which such screens cease to display images is subject to risk assessment. The document may be found at https://www.rssb.co.uk/Pages/research-catalogue/T1059.aspx.

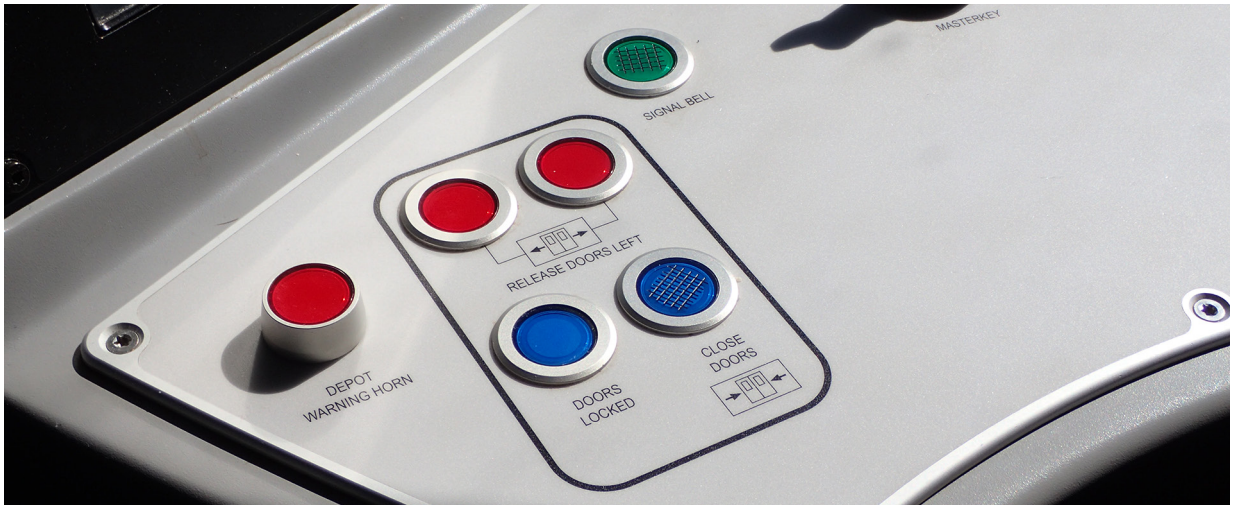

Figure 8: The door controls provided on the cab desk of the class 700 train

DOO dispatch of trains at Elstree and Borehamwood station

43 DOO has been the means of train dispatch operation at Elstree and Borehamwood station since the railway from London St Pancras to Bedford was electrified in the early 1980s.

44 Rail Industry Standard RIS-3703-TOM 'Passenger Train Dispatch and Platform Safety Measures', Issue 3, September 2017 requires that a 'Platform Train Interface Risk Assessment' is carried out for each platform in use by a train operator.

45 GTR had carried out such a risk assessment for platform 1 at Elstree and Borehamwood station in October 2017, with a subsequent review in April 2018. This assessment had been carried out in response to the exclusive use of class 700 trains on the route. The assessment included consideration of the door obstacle detection system and the risk of thin objects becoming trapped in the doors. The documented control measure for such risks was 'Vigilance of driver during the dispatch process. If driver considers someone may be trapped in doors they should investigate before proceeding'. GTR's assessment concluded that no revised control measures were required.

Identification of the immediate cause

46 **The train departed while the passenger was attempting to board with her dog and walking aid.**

Identification of causal factors

47 The accident occurred due to a combination of the following causal factors:

a) the train driver was unaware of the passenger and her dog when he closed the doors and dispatched the train (paragraph 48); and

b) the train's traction interlock system allowed it to depart with the dog's lead trapped in the doors (paragraph 69).

Each of these factors is now considered in turn.

The actions of the train driver

48 **The train driver was unaware of the passenger and her dog when he closed the doors and dispatched the train.**

49 Testing of the CCTV system carried out after the accident by Siemens (paragraph 36) indicated that it was working as expected. Siemens reported to the RAIB that there is no known system failure mode which could have provided false or misleading images to the driver. The RAIB's inspection of the recorded CCTV images found that the passenger was clearly visible, standing in close proximity to the train (figure 9).

Figure 9: The image of the passenger standing by the train as shown to the driver on the train's CCTV system. The image shown to the driver measured 104 mm horizontally by 87 mm vertically.

50 The driver stated that he recalled looking at the CCTV screens in the cab prior to applying power and departing Elstree and Borehamwood station, but he had no recollection of seeing the passenger or her dog in the monitors.

51 The investigation identified a number of factors, some or all of which may have played a part in the driver not seeing the passenger:

a) the short time taken to check the platform-train interface during the dispatch process (paragraph 52);

b) reliance on the door interlock system (paragraph 57);

c) distraction (paragraph 60);

d) fatigue (paragraph 62); and

e) levels of human reliability in carrying out this task (paragraph 64).

Each of these factors is now considered in turn.

Time taken to carry out the final train safety check

52 Data from the train's on-train data recorder (OTDR) and CCTV evidence showed that:

- the train came to a stand at 14:02:59;
- the passenger and her dog reached the train door and commenced boarding 13 seconds after the train had stopped;
- the driver pressed the 'door close' button in the cab 20 seconds after the train had stopped;
- the traction interlock was achieved 4.9 seconds later; and
- the train's combined power-brake controller was moved to a 'driving' setting 6 seconds after the door close button was pressed.

According to the rule book (paragraph 37), the 'train safety check' can only be carried out once the doors are closed and the traction interlock has been achieved. The above timings show that the maximum time available for the driver to have carried out the final train safety check was 1.1 seconds.

53 RSSB[15] research reference T535[16] recommends that, for an eight coach train (such as the one involved in the accident), 13.5 seconds should be allowed for the task of carrying out the 'train safety check' in order to ensure reliability in making a full and safe inspection of the CCTV images.

54 The RAIB carried out analysis of OTDR data taken from 64 previous station stops by the same driver, which indicated that the average time available for his final train safety checks was 2.8 seconds. The RAIB also analysed records from six other GTR drivers, taken after this accident, over comparable routes (note that the timings after the accident may have been affected by the other drivers' knowledge of it). The average time available for the final train safety check by those drivers was 3.3 seconds.

[15] RSSB is a not-for-profit company owned and funded by major stakeholders in the railway industry and which provides support and facilitation for a wide range of cross-industry activities. The company is registered as 'Rail Safety and Standards Board' but trades as 'RSSB'.

[16] RSSB report T535 'Assessing the impact of increased numbers of CCTV images on driver only operation of trains' (2005). Available at https://www.rssb.co.uk/Pages/research-catalogue/T535.aspx.

55 These average times are typical of those noted by previous RAIB investigations. The RAIB's investigation into an accident at Brentwood[17] involving a DOO eight-car train determined an average time for the final train safety check of around two seconds. The investigation of a dispatch accident at West Wickham[18], also involving a DOO eight-car train identified that drivers were taking between one and seven seconds for their final safety check. All of these times are significantly shorter than the time recommended by the RSSB research.

56 Train 9O47 was running two minutes late when it made the stop at Elstree and Borehamwood station. Although the driver was aware that his train was running late, the RAIB found no evidence that this was linked to the short final safety check.

Reliance on the traction interlock system

57 The Professional Driving Policy document issued by GTR to its drivers includes an instruction that they must check that the traction interlock indicator (paragraph 41) has operated and that they must carry out effective visual checks prior to starting their train from a station. The driver had attended a training day on 17 September 2017 (paragraph 79) which had also conveyed this message.

58 Thin or flexible objects may become trapped in the doors from time to time, and the traction interlock may still be achieved. This is discussed further from paragraph 70. The driver told the RAIB that he had a clear understanding of the function of the traction interlock system, and that he was also aware of these limitations of the system.

59 The RAIB has found in previous investigations[19] situations where drivers appeared to rely on the operation of the traction interlock to the detriment of a thorough final visual check of the platform-train interface. Such reliance is a known phenomenon when people interact with what are generally highly reliable systems. It is therefore possible there was some partial or subconscious reliance on the system which resulted in the observed quicker, and potentially less thorough, final visual checks.

Distraction

60 The driver reported to the RAIB that he was having some family issues, and that these had caused him some anxiety in the past. Although he reported that he felt that these issues were not causing him any significant distraction at the time of the accident, the RAIB considers that it is possible that they may have affected his concentration at the time.

61 There is no evidence that the driver was distracted by a mobile device. He had two mobile phones with him at the time of the accident, a personal phone and one issued to him by GTR. The driver advised the RAIB that the phones were in his bag. Analysis of the records for these phones shows that no calls were made or received by either phone at or around the time of the accident.

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[17] RAIB report 19/2011, Passenger accident at Brentwood station, 28 January 2011, published 10 December 2014, paragraph 76.

[18] RAIB report 03/2016, Passenger trapped and dragged under a train at West Wickham, 10 April 2015, published February 2016, paragraph 93.

[19] For example, the accident at West Wickham.

Fatigue

62 The driver reported to the RAIB that he felt well rested at the time of the accident. That day was his second working day since a rest day. Prior to his rest day, the driver had worked for eight consecutive days, for a total of 68.8 hours. The driver's roster had been checked by the fatigue management system embedded within GTR's rostering process and deemed acceptable.

63 However, the RAIB notes that the time of the accident was immediately after the driver's lunch break, and coincided with a low point in normal circadian rhythms[20]. The driver had also spent the morning on tasks which required relatively low levels of concentration, and therefore had to increase his concentration levels significantly when he commenced driving train 9O47. Although there is no direct evidence to indicate that the driver was fatigued at the time of the accident, it cannot be discounted that he may have been feeling slightly sleepy at the time and less attentive than usual. Considering the very short time he took for the final safety check, even a slight loss in attention could have led to him missing the passenger in the CCTV image.

Human reliability for the task

64 GTR's risk assessment for the dispatch of trains from Elstree and Borehamwood station (paragraph 45) noted that the key risk control measure was the vigilance of the train driver.

65 There are three principal methods of dispatching trains from stations in use across the railway network. In addition to DOO (as at Elstree and Borehamwood), trains can also be dispatched by guards on the train, or by staff on the station platform. All these methods share a common risk in that they are critically dependent on the performance of the people involved.

66 During a typical year on the Thameslink North route (Farringdon to Bedford), there are approximately 800,000 train dispatches. RSSB research project T535 (paragraph 53) estimates that the achievable 'target detection reliability'[21] for an eight coach train is 93%. Statistically, this suggests that around 56,000 train dispatches (on the Thameslink North DOO operated route) could take place where an object (such as a person trapped in a door), which is visible to the driver, may be missed when visual checks of the platform-train interface are carried out.

[20] Circadian rhythms are the natural human sleep/wakefulness cycle. A 'circadian low', meaning that an individual can feel sleepy or inattentive, is a well-documented phenomenon in the early afternoon period.

[21] In T535, a 'target' is defined as 'any object or person in the visual field that the driver is expected to be able to detect and see'. This concept of target detection of reliability is therefore a measure of the occasions when a driver can be relied upon to detect such a target presented visually.

67 The number of reported[22] dispatch incidents is actually much less that this number; normally less than ten per year. Almost none of these reported events had a serious consequence. In the vast majority of cases when a person or an object becomes trapped when the doors are closed, they are seen before the train moves away from the station, and released. Although many dispatch errors go unnoticed or unreported (because there was no incident or accident), actual human reliability for the dispatch process may be better than the research suggests. Nevertheless, the nature of the task and natural variations in human performance will affect the integrity of current train dispatch processes. This accident (and others) demonstrates that the potential consequences of error are so serious that further technological assistance is merited.

68 Technology is now becoming available which can assist the human decision making process when dispatching trains, and which can detect when errors are made. Examples of these technologies include:

- Doors with 'sensitive edges' are fitted to some main-line trains[23] and also to trains operating on London Underground. Currently, such doors have obstacle detection capabilities similar to those of the class 700 trains (paragraphs 71 to 73). However, it is possible that future improvements to door technology may allow even thinner objects to be detected.
- Sensitive edge technology can be extended to provide an 'anti-drag' capability. This system can detect when a person or object, trapped in the closed doors, is being dragged by a departing train. Such technology is fitted to some trains[24] operating on the London Underground. In the case of the accident at Elstree and Borehamwood station, it is unlikely that such an anti-drag system would have detected the trapped dog lead. This is because such systems often have a 'dead band' close to the train floor[25] and the dog lead had been placed on the floor (paragraph 27).
- Machine vision systems are under development which have the potential to identify when people and their belongings are obstructing platform edge white lines, and hence alert train dispatch staff. It is possible that such a system would have detected the presence of the passenger and her dog in close proximity to the train at Elstree and Borehamwood station.

The train's traction interlock system

69 **The train's traction interlock system allowed it to depart with the dog's lead trapped in the doors.**

70 Each coach of a class 700 train is provided with four doorways, each of which has a pair of sliding doors. Each pair of doors is driven by an electric motor which is located in a space above the door opening. Obstacle detection is achieved by monitoring the current drawn by the electric motor. An obstruction causes an increase in the current. This is detected by the control system, which then causes the doors to re-open to release the obstacle.

[22] Reported to the RAIB, industry reporting systems and confidential reporting processes.

[23] Such as class 185 trains, see RAIB report 19/2014 Passenger incident at Newcastle Central station.

[24] Such as the 'S' stock trains operating on sub-surface lines and the 2009 tube stock operating on the Victoria line.

[25] BS EN 14752:2015 'Railway Applications – bodyside entrance systems for rolling stock' permits such a 'dead band' to extend up to 40 mm above the coach floor.

71 At the time the class 700 trains were procured, the passenger doors were required to comply with railway group standard GM/RT2473 Issue 2, dated June 2013[26]. The relevant requirements of this document are that the door system should:

- be able to detect the presence of an object at least 30 mm thick at the door's mid-point; and
- allow a 10 mm thick object to be withdrawn from the mid-point of the closed doors with a force of 150 Newtons or less.

72 The RAIB tested the door involved in the accident and found that the doors complied with the requirements of the standard. The doors were able to detect a rigid object down to 7 mm thickness. The tests confirmed that when an object was detected, the doors opened and then re-closed.

73 The tests also confirmed that a thin object, less than 7 mm thick, could become trapped in the doors and not be detected by the door system. Although the dog's lead was never recovered (paragraph 35), it was almost certainly thinner than the door system was able to detect. Therefore, the driver was able to close the doors and achieve traction interlock with the dog's lead remaining trapped in the doors.

74 It was not possible during the investigation to carry out a quantitative test of the force required to pull a thin object (such as the dog lead) from the doors. This was because the specified 10 mm thick object (paragraph 71) was consistently detected by the door system, causing the doors to open. However, it was found that considerable strength was needed to extract a trapped thinner object[27]. It is unlikely that the passenger would have been able to pull the dog's lead from the closed doors had she attempted to do so.

75 CCTV evidence shows that the passenger placed her bag onto the train (paragraph 27) just inside the train door. There is a 'light beam' detection device fitted within the doorway close to floor level, to prevent doors closing onto passengers when set to close automatically (eg after a certain time to maintain internal temperature). Interrupting the light beam prevents the doors closing. However, once the driver commands the doors to close, the light beam device is automatically switched off to prevent problems caused by passengers standing within the train but inadvertently obstructing the light beam, and preventing the driver closing the doors. Therefore, although it is possible that the passenger's bag may have interrupted the light beam when it was placed on the train, any such obstruction of the beam would not have prevented the doors closing once the driver activated the doors to close.

[26] This document was superseded by RIS-2747-RST Issue 1 with effect from 04/03/2017.

[27] A luggage strap was used in the tests to simulate the dog lead.

Identification of underlying factors

Competence Management System

76 GTR's driver competence management system did not include monitoring whether the time taken by drivers for the final train safety checks was sufficient.

77 The driver of train 9O47 was experienced and regarded by his employer as a very competent driver. There was nothing in his records to indicate that GTR had any concerns about his performance.

78 GTR manages the competence of its drivers using a competence management system (CMS). The CMS is a rolling two-year programme, which includes:

- practical assessments, where driving is observed by an assessor travelling in the cab;
- OTDR checks, where OTDR data is analysed by an assessor;
- classroom training and briefing;
- rules assessment; and
- simulator days, where a driver's response to a variety of simulated events is assessed.

79 With the exception of an OTDR check (paragraph 80), the driver was in-date for all his assessments. His last practical assessment had been carried out on 12 December 2017. A training day held on 16 September 2017 had included a training film advising of the risks of thin objects becoming trapped in the doors[28].

80 The driver was due for an OTDR assessment between April and June 2018. However, this assessment was not carried out when it was due because GTR had suffered from a significant shortfall of driver numbers at the time of the introduction of a new timetable in May 2018. As a short-term response to the shortfall, many of the driver managers who would normally carry out training and assessment work were re-deployed to train driving duties.

81 GTR carried out a risk assessment at the time to validate the deferral of these OTDR checks. That assessment was used to justify the deferral for drivers categorised as low-risk. The driver involved in this accident was, based on his previous good record, placed into this low-risk category.

82 GTR's driver competency assessors were not provided with any specific criteria or guidelines for analysing an OTDR record for a driver. Therefore, it is unlikely that even if the 2018 OTDR check had been carried out as planned, any issues with performing the final train safety check too quickly would have been identified.

83 OTDR checks are not the only means of monitoring a driver's DOO dispatch process. Alternatives can include scrutiny of CCTV recordings from trains and stations and obtrusive or unobtrusive monitoring from station platforms and on-board trains.

[28] This film included a scenario which was based on the RAIB's West Wickham investigation (paragraph 87).

Observation

Alcohol and drugs testing

84 Although there is no evidence to indicate that the driver was impaired by alcohol or drugs at the time of the accident, he was not tested for the presence of these substances following the accident. This lack of testing was contrary to GTR's processes for the management of operational incidents. The driver was seen by GTR managers on his return to the depot at Bedford. No concerns were raised about possible impairment.

Previous occurrences of a similar character

85 The RAIB has previously investigated several accidents in which people or objects have become trapped in the closed doors of trains departing from stations. Those involving main-line trains dispatched under DOO conditions are described in the following paragraphs.

86 On 25 July 2015 a passenger was dragged along the platform at Hayes and Harlington station, London (RAIB report 12/2016), when a train from Oxford to London Paddington departed while the passenger's hand was trapped in a door. The passenger, who had arrived on the platform as the doors were about to close, had placed her hand between the closing door leaves. The train driver, using platform-mounted CCTV, did not detect that the passenger was trapped and moved the train off, dragging the passenger along the platform.

87 On 10 April 2015 a passenger was dragged along the platform at West Wickham station, south London (RAIB report 03/2016), when a train from London Cannon Street to Hayes (Kent) departed while her backpack strap was trapped in the doors of the train. The passenger was not seen by the train driver. As the train moved off, she fell onto the platform and then through the gap between the platform and train, suffering life-changing injuries. The backpack strap became trapped when the train doors closed unexpectedly and quickly while she was alighting.

88 On 28 January 2011 a passenger alighting from the last coach of a train at Brentwood station fell, head first, between the side of the train and the platform (RAIB report 19/2011). Another passenger who had alighted from the same train saw her begin to fall and was able to hold on to one of her legs. The driver of the train, using platform-mounted CCTV, did not see this happen and the train departed from the station with the passenger still in the gap between the train and the platform. The passenger sustained injuries to her leg and head in the accident.

89 On 15 February 2006 a member of the public was standing on the edge of the platform at Huntingdon station seeing a passenger off when he became trapped by his coat in a door of the train (RAIB report 11/2007). As the train departed the man ran, and then was pulled along the platform, before falling down the gap between the train and platform edge. The man sustained serious injuries to his left arm and hand.

90 The RAIB has also investigated two accidents[29] of this type involving trains dispatched by guards and two accidents[30] involving trains dispatched by platform staff. A safety digest[31] has also been published involving guard dispatch.

[29] RAIB report 19/2014 Passenger incident at Newcastle Central and RAIB report 22/2012 Fatal accident at James Street station, Liverpool.

[30] RAIB report 10/2013 Accident at Charing Cross station and RAIB report 09/2012 Person trapped in doors and pulled along platform at King's Cross station, London.

[31] RAIB safety digest 07/2018 Passenger trapped in train doors and dragged at Bushey station.

Summary of conclusions

Immediate cause

91 The train departed while the passenger was attempting to board with her dog and walking aid (paragraph 46).

Causal factors

92 The causal factors were:

a) the train driver was unaware of the passenger and her dog when he closed the doors and dispatched the train (paragraph 48, **Recommendations 1 and 2**).

b) The train's traction interlock system allowed it to depart with the dog's lead trapped in the doors (paragraph 69, **Recommendation 2**).

Underlying factor

93 GTR's driver competence management system did not include monitoring whether the time taken by drivers for the final train safety checks was sufficient (paragraph 76, **Recommendation 1**).

Additional observation

94 The driver was not tested for the presence of drugs or alcohol following the accident. This lack of testing was contrary to GTR's processes for the management of operational incidents (paragraph 84, **Learning point 1**).

Previous RAIB recommendations relevant to this investigation

95 The following recommendation, which was made by the RAIB as a result of a previous investigation, has direct relevance to this investigation.

Passenger trapped and dragged at Notting Hill Gate station, RAIB report 14/2018, 31 January 2018, Recommendation 1

96 A passenger became trapped in the doors of a London Underground train as she attempted to board a westbound Central line service at Notting Hill Gate station while the doors were closing. The train departed and the passenger was dragged for approximately 75 metres along the platform, and about 15 metres further into the tunnel. She suffered serious injuries. The accident occurred because the passenger's bag became trapped in the doors as she attempted to board the train, the train's door control system did not detect the presence of the bag trapped in the doors, and the train operator was not aware of the trapped passenger before initiating the train's departure.

97 Recommendation 1 of this report was as follows:

The intent of this recommendation is to reduce the risk of a train departing with something trapped in the doors, by improving the detection of small objects by the train's door systems.

London Underground should ensure that the door systems on its future rolling stock possess an improved capability to detect small objects, by reviewing available technology to achieve this (such as those used on its more recent fleets) and developing a process to implement solutions as appropriate

98 The RAIB has been informed by the Office of Rail and Road (ORR) that London Underground has not yet provided a formal response setting out how it intends to address this recommendation.

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

99 GTR has begun using OTDR records to evaluate the time being taken by drivers when carrying out the various elements of the train dispatch process. This aspect of the train driving task is now included in the feedback being provided to drivers following analysis of OTDR records.

100 RSSB has a current project which is planned to demonstrate an implementation of automatic driver competence indicators. This work encompasses the automated analysis of OTDR records.

Recommendations and learning point

Recommendations

101 The following recommendations are made[32]:

1 *The intent of this recommendation is to reduce the risk of a passenger trap and drag accident by enhancing driver management processes to include checks that drivers spend sufficient time observing the platform-train interface during the train dispatch process.*

Govia Thameslink Railway (GTR) should:

a) Develop suitable guidance to drivers on the time needed to safely observe the platform-train interface, both before closing the train doors and for the final train safety check after the doors have closed (this time is expected to vary with train length, platform passenger density etc.)

b) Enhance its driver competence management system by implementing a procedure to routinely monitor the safety of train dispatch, and take appropriate remedial action where necessary. The monitoring procedure should include (but not be limited to) consideration of:

- direct observation of the train dispatch process and the time taken before and after closing the doors;
- analysis of data from on-train data recorders to check sufficient time is spent in the final train safety check; and
- analysis of station and on-train CCTV.

This recommendation may be applicable to other train operating companies.

[32] 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 and Road to enable it to carry out its duties under regulation 12(2) to:

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

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

Copies of both the regulations and the accompanying guidance notes (paragraphs 200 to 203) can be found on the RAIB's website www.gov.uk/raib.

2 *The intent of this recommendation is to reduce the risk of trap and drag accidents at stations by identifying and assessing technology to support train dispatch staff in deciding when it is safe to dispatch the train and using this research to derive future design guidance and/or requirements.*

The Rail Delivery Group (RDG), in conjunction with RSSB, should:

a) Commission research into practicable ways of enhancing the detection of passengers and belongings that are trapped, or at risk of becoming trapped, in train doors during the dispatch process. A key objective of this research should be to assess the potential for new and emerging technology to support dispatch staff (such as drivers, guards and platform staff) in their decisions about when it is safe to dispatch trains. This should include consideration of:

- current requirements in standards and specifications;
- recent research undertaken on the subject;
- improvements to existing door control systems, such as door portal light beams and obstacle detection systems; and
- the potential use of image recognition systems to spot hazards during train dispatch.

b) If suitable design improvements or solutions are identified by the above research, RDG and RSSB should record and then disseminate the findings to relevant Standards Committees and industry groups with a view to their incorporation into future standards and specifications.

Learning point

102 The RAIB has identified the following key learning point[33]:

1 Railway industry duty holders should arrange for staff involved in accidents to be tested promptly for the presence of drugs or alcohol in accordance with defined procedures. Such testing can conclusively demonstrate whether or not a member of staff may have been under the influence of drugs or alcohol at the time an incident or accident.

[33] 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when the RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where the RAIB has not identified management issues that justify a recommendation) and the consequences of failing to do so. They also record good practice and actions already taken by industry bodies that may have a wider application.

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed Circuit Television
CMS	Competence Management System
DCO	Driver Controlled Operation
DOO	Driver Only Operation
EMU	Electric Multiple Unit
GTR	Govia Thameslink Railway
ORR	Office of Rail and Road
OTDR	On-Train Data Recorder

Appendix B - Investigation details

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

- information provided by witnesses;
- information taken from the train's on-train data recorder (OTDR);
- closed circuit television (CCTV) recordings;
- site photographs and measurements;
- testing of the train involved; and
- a review of previous RAIB investigations relevant to this investigation.

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