RAIB

Rail Accident Investigation Branch

Rail Accident Report

Passenger trapped and dragged at Notting Hill Gate station, 31 January 2018

Report 14/2018
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This investigation was carried out in accordance with:

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

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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 the words '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, the words '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.

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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Passenger trapped and dragged at Notting Hill Gate station, 31 January 2018

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Summary

At about 16:00 hrs on Wednesday 31 January 2018, 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 reached a maximum speed of 35 km/h before the emergency brakes were applied and the train stopped. The passenger was dragged for approximately 75 metres along the platform, and about 15 metres further into the tunnel. She suffered serious injuries and was taken to hospital, where she was treated for about a month. She has since been steadily recovering.

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. It is likely that the train operator did not perceive the passenger because of a number of interacting factors associated with the nature of his task which caused him to not consciously process the available information. The view on the in-cab CCTV monitor did not adequately assist him to detect that a passenger was trapped in the doors and he relied on other cues to depart rather than making a thorough check of the in-cab CCTV monitor.

The investigation identified a probable underlying factor associated with training programmes for train operators, concerning scanning techniques for in-cab CCTV monitors and awareness of the limitations of door-traction interlocks.

The RAIB has made five recommendations and one learning point, all addressed to London Underground. The recommendations concern the detection of objects by the train's door systems, how the design of the task, equipment and training can influence train operators' attention and awareness, and the use of emergency stop facilities on platforms. While there is no evidence that the train operator was impaired by drugs or alcohol, the learning point concerns the importance of following procedures for drug and alcohol testing where relevant.

Introduction

Key definitions

1 Metric units are used in this report, in accordance with normal practice on London Underground.

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

Acknowledgements

3 The RAIB would like to thank Prof Derrick Watson and Dr Kim Wade at the University of Warwick for their advice on the academic research about inattentional blindness.

The accident

Summary of the accident

4 At about 16:00 hrs on Wednesday 31 January 2018, 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 in west London (figure 1).

Figure 1: Extract from London Underground map showing location of accident (courtesy of Transport for London)

5 The train departed, and reached a maximum speed of 35 km/h before the emergency brakes were applied and the train stopped. The passenger was dragged for approximately 75 metres along the platform, and about 15 metres further into the tunnel.

6 The passenger suffered multiple bone fractures as well as a serious soft tissue injury to her right leg. She was taken to hospital and stayed there until she was discharged on 1 March 2018. She has since been steadily recovering.

7 Notting Hill Gate station was closed for about 90 minutes after the accident; severe delays and cancellations to the service continued until 22:30 hrs that evening.

Context

Location

8 Notting Hill Gate is an interchange station on the London Underground network serving the Central, District and Circle lines. While the District and Circle lines are part of the subsurface[1] network, the Central line runs in deep tube tunnels at Notting Hill Gate.

9 The accident occurred on platform 4, the westbound Central line platform, which is on the right-hand side of the train in the direction of travel. The entrance and exit for passengers is near the east (tailwall or rear) end of the platform.

10 Platform 4 incorporates a reverse curve (ie an 'S' bend; figure 2) and, because of this, is classified by London Underground as a 'category A' platform. Category A platforms are defined as those where the train operator is unable to see the entire platform-train interface without mirrors or monitors. This means that platform staff are needed to assist with train despatch if the platform is busy or if the monitors are inoperative. At the time of the accident, the platform was not busy enough to warrant platform staff being needed.

Figure 2: View from the east (tailwall or rear) end of platform 4 at Notting Hill Gate facing west, showing the reverse curve

[1] Subsurface lines were built using the 'cut and cover' method, and are nearer to ground level than deep tube lines.

Organisations involved

11 London Underground Limited (LUL) is the infrastructure owner, maintainer, operator and employer of the staff involved in the accident.

12 LUL freely co-operated with the investigation.

Train involved

13 Train running number 141 was a westbound Central line service, which began its journey from Hainault at 15:05 hrs. It was running approximately on time, with its next timing point after Notting Hill Gate being White City (three stations later), where it was due just after 16:06 hrs. The train had been held at Marble Arch (three stations before Notting Hill Gate) for about two minutes to regulate the service.

14 The train was formed of 1992 tube stock, operating as an eight-carriage train made up of four two-carriage units (the incident unit number was 93158). The passenger became trapped at the rearmost set of double doors on the fifth carriage.

15 On the Central line, trains are normally controlled by Automatic Train Operation (ATO), which automatically accelerates and brakes the train for signals and station stops. ATO provides the capability to minimise gaps between trains and achieve a business target of 30 trains per hour through the central area during peak times.

16 In normal service, the ATO system relies on a train operator in the leading cab of the train carrying out station duties, which primarily involves checking in-cab CCTV monitors for potential issues at the platform-train interface, and initiating despatch of the train (see paragraph 36). Between stations, the train operator is expected to monitor the ATO system and remain vigilant for any obstruction on the track. It is possible for train operators to take control and drive the trains manually, but in this mode it is not possible to operate such an intensive service. For this reason, manual driving is normally only done at weekends.

People involved

17 The passenger was 78 years old at the time of the accident; she is a resident of the Shepherd's Bush area in west London. She is a regular user of public transport in London but prefers to use the subsurface lines or buses rather than the Central line at Notting Hill Gate.

18 The train operator joined LUL in September 1998, originally as a guard on the Northern line. The following year, he became a train operator on the Northern line. He transferred to the Central line in October 2004 and became qualified as a train operator on 1992 stock in June 2005.

19 His most recent competence review before the accident was in October 2017, as part of his regular competence management cycle. He received consistently good feedback from his assessors, and had no previous incidents or disciplinary problems on his record. He had received five commendations since becoming a train operator for contributions towards improving operations.

20 The train operator underwent an occupational health examination (which included an eyesight test) in February 2017 and was deemed fit to continue normal duties. He also completed a medical questionnaire as part of his competence review in October 2017. His last eye test with an optician was in December 2016, which the optician noted was valid for two years. He uses glasses to correct a mild short-sightedness, and stated that he was using these appropriately on the day of the accident (removing them to view the in-cab CCTV, since the glasses were for distance vision).

The sequence of events

Events preceding the accident

21 The train operator began his shift at Hainault depot in north-east London at 14:38 hrs. His first duty was to take train 141 westbound from Hainault at 15:05 hrs. The journey from Hainault to Notting Hill Gate was relatively uneventful.

22 At 15:58 hrs, the passenger entered Notting Hill Gate station and made her way down two escalators to platform 4. She was wearing a coat and carrying a canvas tote-style bag, which contained books and belongings, over her right arm.

23 The train emerged from the tunnel and entered platform 4 at 15:59:52 hrs[2]. The passenger arrived at the tailwall end of the platform (paragraph 9) about ten to fifteen seconds later, while the train was slowing to a stop. She walked forwards along the platform towards the middle of the train.

24 The train stopped at 16:00:12 hrs, and the train operator immediately opened the passenger doors. The doors took about three seconds to open fully, and then remained open for about nine seconds before the train operator initiated the door close sequence. This sequence takes about five seconds, beginning with a warning alarm (about two seconds) followed by the movement of the doors closing (about three seconds). The doors were fully closed at 16:00:28 hrs.

25 The door close warning alarm surprised the passenger because she expected the train to remain in the station for a longer time. She quickly approached the rear double doors of the fifth carriage of the train to try and board. As the doors were closing, she had her bag ahead of her, which swung the bag forwards into the carriage. The doors then fully closed, trapping the bag along its top edge, just below the handles. Two other people on the platform approached the passenger, apparently trying to help, before the train moved off. One of them raised their hand just before the train started moving.

26 Data downloaded from the train's on-board recorder (which has a certain level of tolerance in its timings[3]) shows that the train operator attempted to start the train at about the time that the doors closed (this involves pressing and holding two buttons together for about three seconds). However, the train's safety circuits had not detected that all the doors were closed, and so prevented the train from moving. Five seconds later, the train operator again tried to start the train, and this time it started moving at 16:00:35 hrs.

Events during the accident

27 As the train moved off, the passenger was unable to free herself. Within four seconds, she had fallen down and was being dragged along the platform. Someone on the train who was next to the door tried to open the doors by hand, but was unable to do so. Several other people on the platform visibly reacted to what was happening.

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[2] These timings are derived from station CCTV footage.

[3] The data recorder samples events at a rate of once per second, and so if a number of events occur simultaneously, then they may be queued on the recorded output, leading to some uncertainty in their timings. Furthermore, the data recorder and the station CCTV are not synchronised with each other.

28 About 10 seconds after the train started moving, and when it had travelled 56 metres, the train's data recorder logged three events in quick succession: a passenger emergency alarm activated in the fifth carriage, the train operator applied the emergency brake, and the train detected that a door had opened in the fifth carriage (probably a partial opening resulting from the passenger being dragged). Due to the tolerance in data recording on the train and the close time spacing in which these events occurred, it is not possible to determine their actual order, but they all had the effect of applying the emergency brakes on the train.

29 At 16:00:47 hrs, after travelling about 75 metres, the passenger was dragged into the tunnel. The train stopped six seconds later, having travelled 99 metres. Evidence suggests that the passenger became separated from the bag at some point in the tunnel, as she was later rescued by the emergency services from a point about 15 metres inside the tunnel.

Events following the accident

30 The train operator made a mayday call to Central line control at 16:01 hrs. During this call, he told control that something had been dragged along by his train, he had made an emergency stop, and he had received a passenger emergency alarm. Following the call, the train operator made his way back through the train to determine what had happened. This led him to realise that the passenger had been dragged into the tunnel and was under the train.

31 Meanwhile, a member of the public used the help point[4] on the platform near the location where the passenger had tried to board the train. Several people ran towards the tunnel headwall, and one of them used the help point there.

32 The first member of LUL staff arrived on the scene at 16:04 hrs. LUL then called the emergency services at 16:05 hrs, and London Fire Brigade, British Transport Police and London Ambulance Service arrived at the tunnel headwall between 16:13 hrs and 16:18 hrs.

33 The train operator gave a statement to the British Transport Police and was later escorted home by LUL staff in the interests of his welfare. Because of this, he was not tested for drugs and alcohol as required by LUL's processes. However, the British Transport Police noted that there was no indication of intoxication nor statement of impairment on the part of the train operator.

34 The emergency services began to extract the passenger from under the train. This process took about an hour, due to difficulties working in the confined location within the tunnel. At 17:20 hrs, the passenger was taken from the station by ambulance to hospital, where she arrived at 17:35 hrs.

35 A relief driver moved the train away from Notting Hill Gate at 17:24 hrs and took it to the LUL depot at Ruislip, where it was quarantined for examination by the RAIB. Notting Hill Gate station reopened at 17:37 hrs, after LUL staff had checked that the station cameras which generate the pictures on the train in-cab CCTV monitors were properly aligned and working correctly.

[4] Help points provide communication with the station supervisor.

Key facts and analysis

Background information

Central line despatch processes

36 Central line train operators are responsible for carrying out the train despatch process at stations (paragraph 16). They monitor people on the platform from the time the train enters the station until the last carriage has left, opening and closing the passenger doors and, when it is safe to do so, initiating the train's departure.

37 LUL's rules[5] for train despatch state that the train operator must:

a. *check the station starting signal is clear*

b. *check the entire platform train interface*

c. *close the doors and check the doors closed visual*

d. *check the entire platform train interface again*

e. *check that the station starting signal is still clear*

f. *make a final check of the platform train interface*

g. *start your train*

h. *check the in-cab monitors as your train leaves the platform.*

38 The cab display and control panels on 1992 stock (figure 3) include buttons for opening and closing the doors on each side, a pair of buttons for starting the train, and a CCTV monitor to view images of the platform-train interface.

39 The primary display panel (figure 4) includes the following features:

a. a 'doors closed' visual indicator (blue light, top centre), commonly known as a 'pilot light', which shows that a door interlock circuit has detected that all the doors are closed and, therefore, that the train can be moved (see paragraph 49);

b. a countdown to departure display, which takes its input from the signalling control centre and is set automatically depending on prevailing service conditions (typically it starts at 20-30 seconds); and

c. a pair of start buttons which must be simultaneously pressed and held for at least two seconds to start the train.

40 The train operator uses images on the CCTV monitor to check the platform-train interface during train despatch. The CCTV monitor displays images from station cameras, which are transmitted to the train from around the moment it enters the station until the last carriage has left the platform. At most stations, the screen is divided into four images to cover the full length of the train and the platform edge (as shown in figure 5). However, some stations require more images due to platform curvature (for instance, Bank and Stratford stations use eight images). At platform 4 at Notting Hill Gate, there are five images arranged as shown in figure 6. The three images on the left-hand side look towards the front of the train; the two images on the right look towards the rear.

[5] London Underground Operational Standards Rule Book 8: Managing the platform train interface (issue 2).

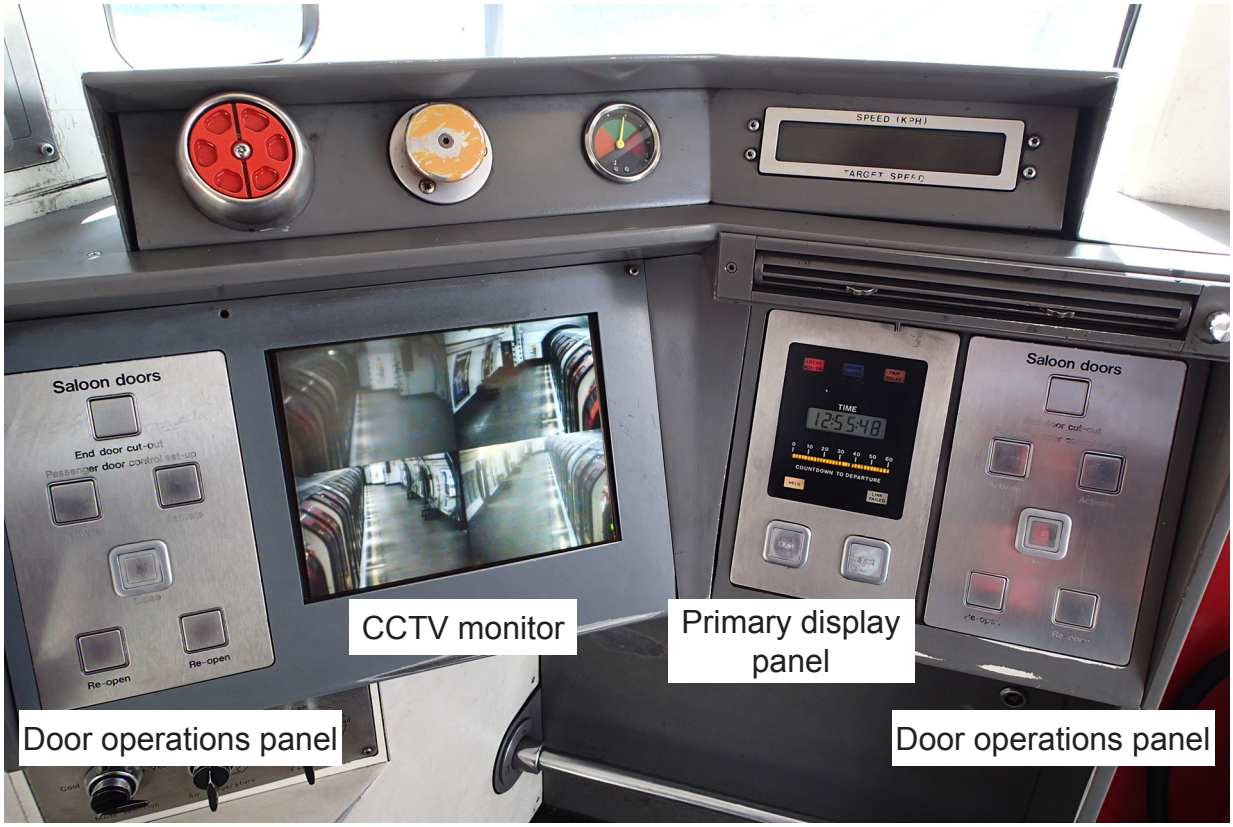

Figure 3: 1992 stock cab display and control panels. The panels to the left and right are for door operation on each side of the train, there is a 12.1 inch LCD monitor to display platform CCTV images, and a primary display panel. NB: For illustration, RAIB has superimposed a typical platform image on the CCTV monitor display, as the original photograph showed a blank display.

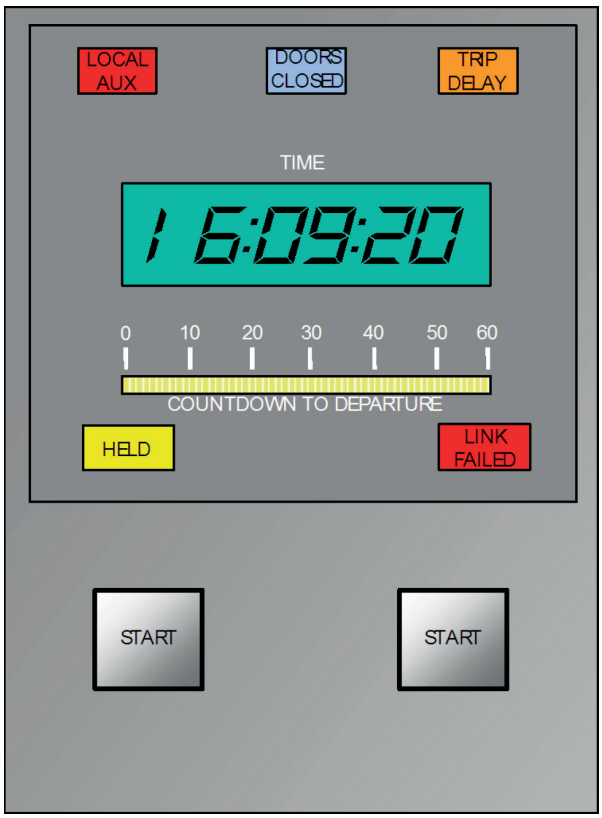

Figure 4: Schematic representation of the primary display panel (courtesy of LUL)

Figure 5: Typical arrangement of in-cab platform CCTV images on the Central line (numbers denote the ordering of images from front to rear of the train)

41 LUL's current standard[6] for in-cab, platform CCTV monitors, sets out specific requirements for a clear view of the complete critical area of the platform-train interface under all conditions at all times. This includes the configuration of cameras, the arrangement of images on the monitor (with no more than four images per display screen) and visibility requirements for the displayed image. The specified optimum viewing angle for a target object shall be at least 54 minutes of arc[7] at the driver's eye point, and shall never be less than 42 minutes of arc (the absolute limit of discernibility is defined in the standard as 20 minutes of arc). The same specified object should occupy at least 13.2% of the screen height for a four-way split screen. However, 1992 stock pre-dates this standard and the standard is not applicable retrospectively. LUL stated that the specification for the in-cab platform CCTV monitors on 1992 stock is no longer available.

[6] London Underground Category 1 Standard 1-150: Telecommunications – OPO CCTV (issue A1, February 2011).

[7] At a viewing distance of one metre, 54 minutes of arc is equivalent to an image 15 mm high/wide.

Figure 6: Arrangement of in-cab platform CCTV images at Notting Hill Gate platform 4 (numbers denote the ordering of images from front to rear of the train)

Identification of the immediate cause

42 **The train departed with a passenger trapped in the doors.**

Identification of causal factors

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

- the passenger's bag became trapped in the doors as she attempted to board the train (paragraph 44);
- the train was able to depart with a bag trapped in the doors (paragraph 48); and
- the train operator was not aware of the trapped passenger before initiating the train's departure (paragraph 53).

Each of these factors is now considered in turn.

How the passenger became trapped

44 The passenger's bag became trapped in the doors as she attempted to board the train.

45 The passenger was intending to travel to Shepherd's Bush from Notting Hill Gate, and wanted to move forward along the train to be better placed for the exit at Shepherd's Bush. When she noticed the doors were closing, she quickly approached the rear double doors of the fifth carriage. LUL expects passengers to stand clear of closing train doors, and announcements to this effect are often made on trains and on platforms. At the time of the accident, there was no member of platform staff in attendance (paragraph 10), so while the only available announcement would have been from the train, it can be heard from the platform while the doors are closing.

46 As the passenger led with her arm to try and board the train, her bag swung into the carriage, where the top of the bag became trapped in the closing doors (figure 7, left image). Witness evidence and station CCTV images suggest that the handles were twisted around her wrist. Tests conducted by the RAIB, using an identical bag and a 1992 stock train, showed that this would have made it very difficult to free herself (figure 7, right image). Because there were books and other belongings in the portion of the bag that was inside the train, it would also have been virtually impossible to pull the bag out of the doors.

Figure 7: Image from station security camera (left) and RAIB reconstruction (right) showing the bag trapped in the doors

47 The passenger stated that she thought the train doors would re-open, as she has seen this happen to other people on previous occasions. However, it is not clear whether this expectation was based on her experience with London Underground's subsurface lines (paragraph 17), where the trains use a more sensitive door system that would have detected her bag (see paragraph 52). Nevertheless, similar expectations by members of the public have been observed in previous RAIB investigations[8]. Research conducted by RSSB[9] found that 58% of passengers believe that, if obstructed, train doors will automatically re-open like lift doors.

The capability of the train

48 **The train was able to depart with a bag trapped in the doors.**

49 The door system on 1992 stock incorporates an interlock with the train's traction system, such that the traction power cannot be applied if the doors are not fully closed (eg because of an object trapped between the doors). The system is designed to detect an object of a minimum thickness between about 6 mm and 8 mm when the doors are closing. The thickness of the bag at the point where it was trapped was about 3 mm.

50 The RAIB examined the door maintenance history of the unit involved in the accident. This showed that a scheduled maintenance check had been completed on the day of the accident, just before the train left the depot on its journey to Notting Hill Gate. The checks included door interlock and gap tests, which were all found to be within the above specifications.

51 Post-accident door testing on the unit involved in the accident, carried out by LUL and witnessed by the RAIB, also showed that the door concerned met the specifications. Evidently, the thickness of material on the part of the bag that was trapped in the doors was not sufficient to break the door interlock circuit as designed. This was confirmed in further tests conducted by the RAIB with an identical bag on a different 1992 stock unit (figure 7), in which the door interlock was obtained (ie it would have been possible to start the train) with the bag trapped in the doors in a similar way.

52 For comparison purposes, the RAIB repeated the tests with the bag on a more modern 'S' stock unit, which has been used on London Underground's subsurface lines since 2010. The S stock door system incorporates a more sensitive object detection mechanism, and in this case the bag did not allow the interlock circuit to make, which would have prevented the train from starting.

[8] For example RAIB report 04/2016, 'Passenger trapped in train doors and dragged at Clapham South station, 12 March 2015'; RAIB report 12/2016, 'Passenger trapped and dragged by a train at Hayes & Harlington station, 25 July 2015'.

[9] Optimising door closure arrangements to improve boarding and alighting. RSSB project T1102. 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'.

The actions of the train operator

53 **The train operator was not aware of the trapped passenger before initiating the train's departure.**

54 The train operator's account of his despatch process at Notting Hill Gate was consistent with LUL's rule book process (paragraph 37). He recalled seeing people walking towards the exit at the rear of the platform at Notting Hill Gate, but thought they were not getting on the train. He did not recall seeing the passenger before the train departed. He stated that he saw that the pilot light was illuminated and so pressed the start buttons, checking the CCTV as the train departed. He then noticed what he stated looked like a coat caught on the outside of the train and applied the emergency brake.

55 The fact that the train operator did not perceive the passenger on the in-cab CCTV monitor before starting the train is likely to have occurred due to a combination of the following:

- the nature of the train operator's task had caused him to not consciously process the available information (paragraph 56);
- the view of the person on the in-cab CCTV monitor did not adequately assist the train operator to detect that a passenger was trapped in the doors (paragraph 62); and
- the train operator relied on other cues to depart rather than a thorough check of the in-cab CCTV monitor before starting the train (paragraph 68).

Each of these factors is now considered in turn.

The nature of the train operator's task

56 Trains running with an active ATO system present a train operator with relatively low workload (compared to manual operation), and repetitive actions at stations. Research conducted by the Transport Research Laboratory for RSSB[10] showed that, under such circumstances, it is possible for people to enter an automatic mode of responding, associated with faster reaction times but reduced attention and more errors. Witness evidence suggests that the ATO train operator's task can require effort to maintain attention, and that it can result in a reliance on the ATO system.

[10] Assessing cognitive underload during train driving: A physiological approach (CUPID). Published project report PPR749 (2015).

57 An analysis of data from train 141's journey indicates that the train operator involved in the accident could have been affected by this phenomenon. The time interval between pressing the 'close doors' button and the 'start' buttons is highly consistent (at 8-10 seconds) across the journey from Hainault. Given that the doors take about three seconds to close, this leaves 5-7 seconds to check the monitor and the starting signal (paragraph 37) before starting the train. This is relatively short compared to recommended values from RSSB research[11] of 10.5 seconds for four images and 12 seconds for six images (there are five images on the monitor at Notting Hill Gate). However, this research and its recommendations were set in the context of the mainline railway, where there are different influences on performance (for instance, on older mainline trains platform monitors are external to the train cab).

58 Moreover, on two occasions during the journey, the train operator pressed the start buttons before the ATO system would allow the train to move (at Chancery Lane, when the system did not have an authority to move, and at Notting Hill Gate, when the doors were not detected as closed). An additional data sample collected by LUL showed that this action is relatively unusual amongst other train operators, with an observed frequency of 0.09%. There is no alert to the train operator from the system if they attempt to start the train before all door interlocks are made.

59 Taken together, and given the train operator's length of service, these findings suggest that he may have been processing information automatically, relying on his own experience of the time between closing doors and departing, with little conscious attention to the task.

60 A related phenomenon, known as 'inattentional blindness', can occur in this type of visual search task when actual targets (ie people trapped in doors) are relatively rare or unexpected. Research in this field shows that even for trained and experienced operators, about one-third can fail to notice a target[12], despite the fact that they may be looking directly at it[13]. This also seems to be associated with faster reaction times, due to a lower threshold for deciding that there is no target present when targets are rarely present[14]. Furthermore, the task is made more difficult when non-targets (ie other people on the platform) are visually similar, because the operator becomes accustomed to ignoring these[15].

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[11] RSSB research report T535 'Assessing the impact of increased numbers of CCTV images on driver only operation of trains' (2005).

[12] Simons, D.J. & Schlosser, M.D. (2017). Inattentional blindness for a gun during a simulated police vehicle stop. Cognitive Research: Principles and Implications, 2(37).

[13] Hout, M. C., Walenchok, S. C., Goldinger, S. D., & Wolfe, J. M. (2015). Failures of perception in the low-prevalence effect: Evidence from active and passive visual search. Journal of Experimental Psychology: Human Perception and Performance, 41(4), 977-994.

[14] Wolfe, J.M., Horowitz, T.S. & Kenner, N.M. (2005). Cognitive psychology: Rare items often missed in visual searches. Nature, 435, 439-440.

[15] Andrews, L.S., Watson, D.G., Humphreys, G.W. & Braithwaite, J.J. (2011). Flexible feature-based inhibition in visual search mediates magnified impairments of selection: Evidence from carry-over effects under dynamic preview-search conditions. Journal of Experimental Psychology: Human Perception and Performance, 37(4), 1007-1016.

61 LUL's risk assessments are based on historical frequency data of 0.6667 trap-and-drag incidents per year across the entire network. The train operator had never been involved in such an incident before, although he had experienced several false alarms with other objects (eg newspapers) trapped in doors. The task therefore fits the criteria for inattentional blindness in that targets are relatively rare compared to non-targets.

Images on the in-cab CCTV monitor

62 The passenger's position on the platform, at the rear double doors of the fifth carriage, put her within the coverage of the CCTV camera feeding the image in the lower-left quadrant of the train operator's monitor (image 3 in figure 6). This camera looks forward along the train and covers an area from about halfway along the sixth carriage to around the front of the fifth carriage. The passenger would have been located towards the background of this image. She would not have been visible in the next image further forward along the train (image 2 in figure 6).

63 The RAIB estimated the viewing angle of the passenger's image on the monitor at the driver's eye point to be about 100 minutes of arc, and that the image height would have occupied 13.2% of the screen height. While these values are within LUL's current standard requirements for discernibility, they are approaching the minimum limits set out in that standard (paragraph 41).

64 It is also possible that the view of the passenger was obscured by other people on the platform at the moment when the train departed. Because the in-cab monitor images are not recorded, the RAIB created a virtual model of the perspective from the relevant camera based on a site survey and reconstruction, as well as images that were recorded from station security cameras. The model shows that, at the time the train departed, there was a person on each side of the passenger, potentially blocking the train operator's view of her. However, about seven seconds before departure, when the train operator initially tried to start the train (paragraph 26), there was a clear view of the passenger (figure 8).

Figure 8: Virtual model of the perspective from the relevant platform-train interface camera showing the view seven seconds before departure (left image) and one second before departure (right image). NB: these represent the image that would have been displayed in the lower-left quadrant of the train operator's in-cab monitor.

65 The investigation also examined the number and arrangement of images on the monitor, but the evidence is equivocal as to whether this could have affected the train operator's perception. LUL's current standard for platform-train interface CCTV sets out several requirements taking into account the visual information requirements of the train operator, which the Central line configuration does not meet (because it pre-dates that standard; paragraph 41). For instance, there should not be more than four images on a single screen, and the images from any cameras facing backwards should be inverted horizontally so as to display the platform side consistently across all images. Comparable standards for the mainline railway[16] further require that all cameras should face in the same direction, and that the arrangement of images on the monitor should be logical and sequential (eg arranged so that they can be read in a Z-shape from top-left to bottom-right).

66 In terms of number of images, the main line standard RIS-2703-RST states that industry practice has been to provide two monitors capable of presenting four images each, but the standard allows for up to 12 images across two monitors, providing drivers are given sufficient viewing time. RSSB research (see footnote 10, page 22) supported this requirement, finding that detection of targets was not affected by the number of images (up to 12), as long as drivers were given enough time to properly search the images after the doors have closed and interlock has been obtained (up to 16 seconds for 12 images). The research also noted that image layout can have a significant effect on detection reliability, although there are important differences between the operating environments of mainline and underground trains (paragraph 57).

67 The RAIB examined maintenance records for the CCTV system at Notting Hill Gate, obtained data[17] on previous reports of CCTV problems across the underground network, and conducted its own observations of the in-cab CCTV images on the Central line. Although several instances of problems were recorded (eg 16 maintenance issues raised at Notting Hill Gate between September 2016 and March 2018, predominantly concerning image quality or camera alignment), there is no evidence of a fault with the CCTV system on platform 4 on the day of the accident. Before the accident, the most recent maintenance issue raised for platform 4 was on 23 October 2017, associated with the image splitting unit, which was rectified on the same day.

Other cues to depart

68 The RAIB has ruled out mobile phone use and fatigue as factors influencing the train operator's performance, but there is some evidence that he relied on other cues to depart rather than a thorough check of the in-cab monitor before starting the train.

[16] Network Rail standard NR/L2/TEL/31111, Design and Installation Requirements for Driver Only Operation (Passenger) Systems (Issue 3, 2 July 2011); RIS-2703-RST Rail Industry Standard for Driver Only Operated On-train Camera / Monitor Systems (Issue One, June 2014).

[17] From CIRAS, the Confidential Incident Reporting and Analysis Service (www.ciras.org.uk).

69 After the accident, the train operator stated that he could not understand why the pilot light was illuminated with something trapped in the doors. This implies a potential dependence on the door interlock and a lack of awareness about its limitations, which the investigation found may be widespread (see paragraph 74). It is also consistent with the conclusion that the train operator was processing information automatically (paragraph 59), in this case depending on the pilot light to determine when to press the start buttons.

70 The primary display panel in the cab includes a countdown to departure display (paragraph 39b), which provides a visual and auditory prompt to train operators regarding appropriate departure time. Although the train operator involved in the accident said that he did not prioritise the countdown display, it was one of the aspects that he regularly monitored during the train despatch process. The countdown display therefore competes for attention with the other tasks during train despatch, including the in-cab CCTV monitors.

71 The train operator was also aware of the general impact that station stopping times have on following trains, and said that he was conscious of keeping the service running on time. To achieve this, he preferred to start the departure sequence before the countdown display reached zero. This is reflected in the total stopping time for train 141 at Notting Hill Gate, which was the shortest of 16 trains sampled (at 23 seconds, against an average of 32 seconds). In the context of time required to scan multiple images (paragraph 57), this could imply an inadequate check of the in-cab CCTV monitor.

Identification of underlying factor

Training

72 **LUL's training programme for train operators does not adequately prepare them for some of the particular demands associated with train despatch, especially when operating in ATO mode. It is probable that this factor was linked to the cause of the accident.**

73 The RAIB has found no evidence that train operators on the Central line are consistently or formally advised on a technique for scanning the images on the in-cab CCTV monitor, in order to optimise the check of the platform-train interface. The ATO training handbook for the Central line reinforces the Rule Book procedure (paragraph 37), which requires train operators to switch attention between (primarily) the starting signal and the in-cab CCTV monitor, and supplements it with a check of the countdown display. In May 2010, instructors were also briefed on a recommended procedure for dividing attention between the in-cab CCTV monitor, the pilot light, the starting signal and the track ahead. However, none of this specifically addresses the arrangement of images on the monitor. The LUL standard for in-cab platform CCTV monitors does state that train operators should scan the images in sequence from front to rear of the train, while training programmes for more modern rolling stock include scanning patterns tailored to the arrangement of images in those cabs. However, there is no evidence that such training extends to train operators of 1992 stock.

74 Evidence suggests that there is little awareness among LUL staff[18] that the door interlock might not detect small objects trapped in the doors (see paragraphs 69, 91 and 92). Training handbooks for Central line stock imply on several occasions that the pilot light will only illuminate if all the doors are closed and that it will only be possible to move the train if it is safe to do so. Although LUL told the RAIB that instructors do cover the limitations of the interlock during classroom and depot training, it could produce no substantive evidence that this is the case.

75 LUL's training and procedures for ATO on the Central line rely, in part, on the train operator's vigilance in responding to emergencies, without recognising the impact of automation on an operator's attention (paragraph 56). Recently, LUL has introduced training in non-technical skills for all new train operators, which includes techniques such as risk triggered commentary to maintain concentration. Whilst recognising the potential value of such techniques in mitigating the effects of vigilance degradation, the RAIB's view is that these problems should be addressed at their source (ie through task design), to facilitate better integration of the human and machine elements of the system (as referred to at paragraph 56).

Factors affecting the severity of consequences

Stopping the train

76 **None of the platform emergency stop plungers (PESPs) were used.**

77 Platform emergency stop plungers (PESPs) are provided on the Central line and Victoria line (which also uses ATO) to allow customers and staff on a platform to stop a train in an emergency while the train is leaving or entering the platform. When operated, they have the effect of applying the emergency brakes on the train. The PESPs were provided at the time the Central line was equipped with ATO in the 1990s, as part of the upgrading project.

78 There are five PESPs provided along the length of platform 4 at Notting Hill Gate, one of which is situated on the platform wall directly opposite the door that the passenger used (figure 9). However, none of these were activated during the accident (some people did use a passenger help point after the train had stopped; paragraph 31).

79 LUL's records for the past five years show no instances of PESPs being used on platform 4 at Notting Hill Gate. Its risk assessments for a trap-and-drag incident assume a high probability that neither customers nor platform staff will activate a PESP. LUL told the RAIB that misuse of PESPs following their original installation resulted in covers being added to the plungers to deter inappropriate activation, which has a significant operational impact. The covers have had a significant effect in reducing the number of activations.

[18] RAIB's reports on accidents at West Wickham (RAIB report 03/2016) and Hayes & Harlington (RAIB report 12/2016) found that there was a similar lack of awareness of this issue among staff on the mainline railway.

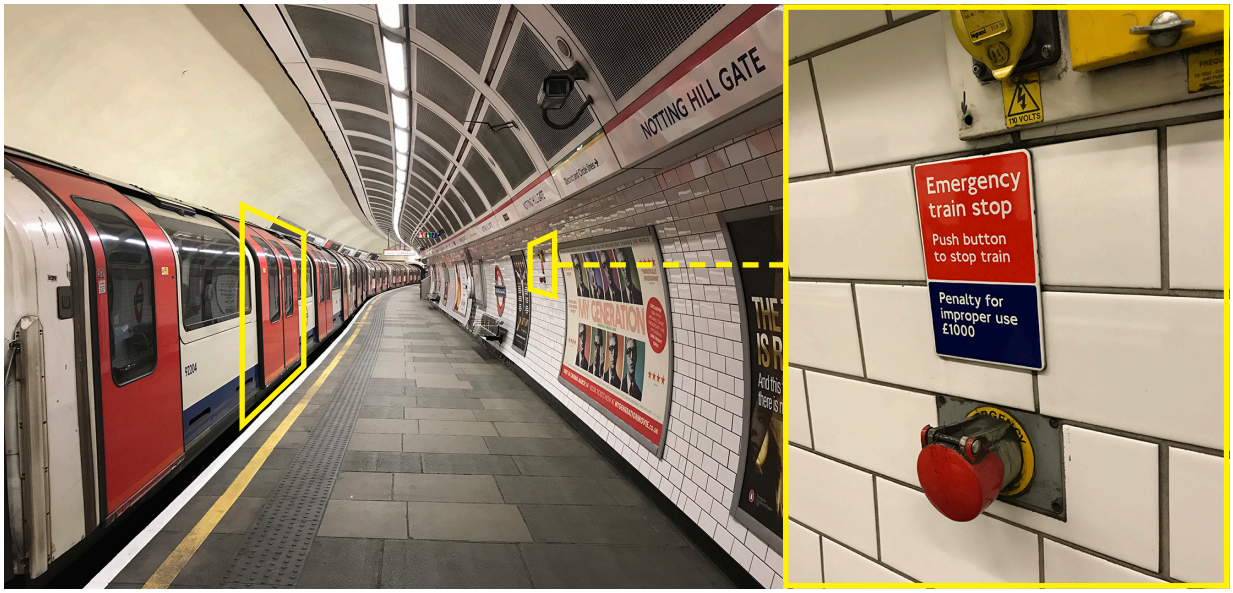

Figure 9: Image of the platform emergency stop plunger (PESP) in relation to the incident door (both highlighted), with a close-up view of the PESP

80 A passenger emergency alarm on the train was activated about 10 seconds after the train started moving.

81 On 1992 stock, one passenger emergency alarm (PEA) is provided at each door vestibule, on the pillar to the left of one set of doors. There is a label on the opposite corner stating the location of the PEA (figure 10). The door involved in the accident was one with a label (ie the PEA itself was on the opposite side of the train).

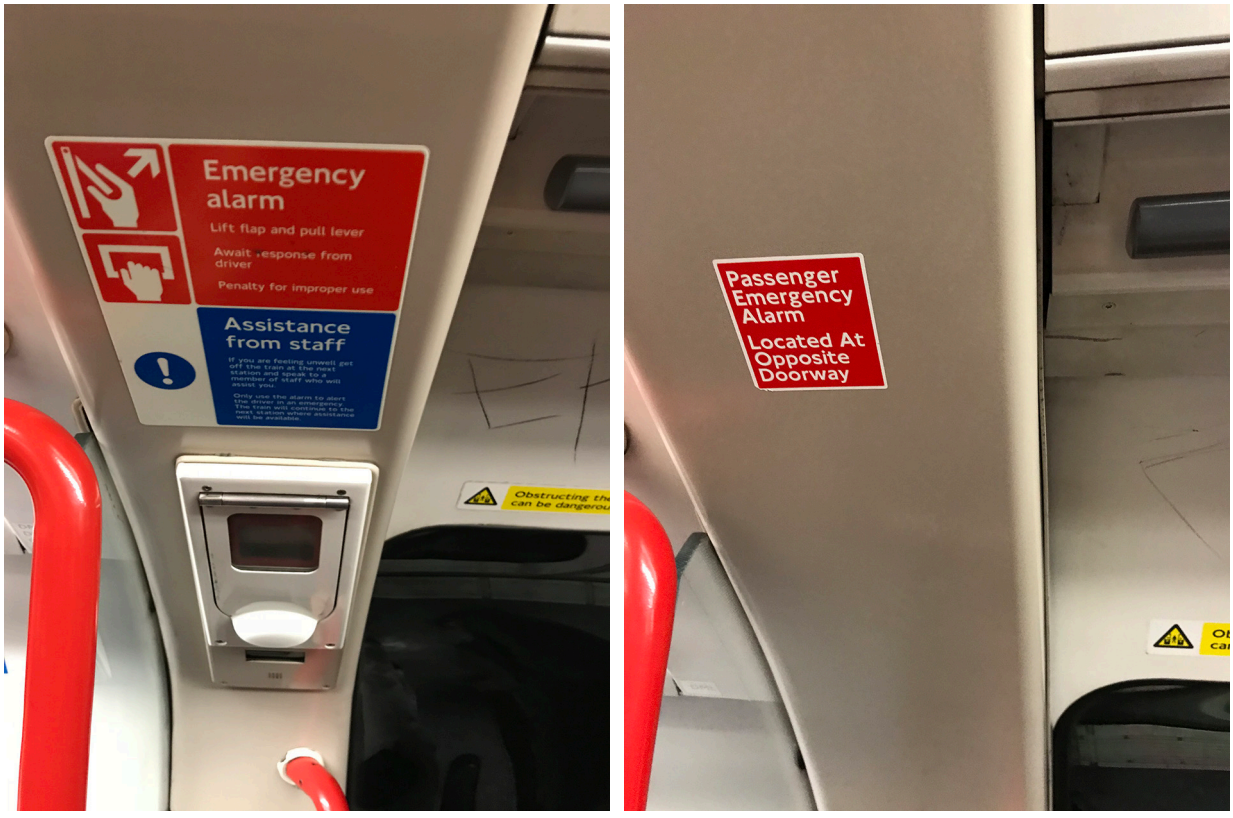

Figure 10: The passenger emergency alarm on 1992 stock (left), and the associated label on the opposite doorway (right). The incident door was fitted with a label, as shown in the right-hand image.

82 According to witness evidence, someone on the train standing at the set of doors tried to force the doors open by hand to assist the passenger, but was unable to do so (paragraph 27). Although this person did not activate the PEA, someone else in the carriage did, because the train's data recorder showed that this occurred 10 seconds (or 56 metres) after departure, and about two seconds (19 metres) before the passenger entered the tunnel. The PEA activation, along with other events occurring at about the same time (paragraph 28), had the effect of applying the train's emergency brake.

83 **The train operator did not apply the emergency brake until about 10 seconds after the train started moving.**

84 Train operators are required to check the in-cab CCTV monitors as the train leaves the platform (paragraph 37h). During train 141's departure from Notting Hill Gate, the train operator noticed what appeared to him to be a coat caught on the outside of the train, and he applied the emergency brake (paragraph 54).

85 Research by the Transport Research Laboratory[19] suggests that, amongst car drivers, most react to an unexpected event within about two seconds. Given that the train operator took action about 10 seconds after departure, this suggests that he noticed the passenger about eight seconds after the train started moving.

86 The RAIB's reconstruction showed that the incident door becomes visible in image 2 (with reference to figure 6) on the in-cab CCTV monitor about four seconds after departure, and in image 1 about eight seconds after the train starts moving. Although the passenger may also have remained visible in image 3 during this time, she would have been less conspicuous in that image as she was receding into the background.

87 The RAIB considers that, given the influences on the train operator's decision that it was safe to depart in the first place (paragraphs 53 to 71), he would not expect to see a problem on the monitors during departure (a phenomenon known as 'confirmation bias'[20]). LUL's risk assessments assume a high probability that a train operator will not see a person caught in the doors who is being dragged along the platform.

88 In a previous RAIB investigation (see paragraph 94c), the report noted that since it is not always possible to observe the entire platform-train interface on London Underground (ie when it is busy), train operators are trained to look for unusual behaviour of other people on the platform as signs that indicate a possible problem. At Notting Hill Gate, several other people clearly responded to what was happening, as recorded by station security cameras which face towards the back of the train. However, the train operator's view of the dragged passenger was from different cameras facing forward, and so the reactions of these people would have been less obvious as they were facing away from the relevant cameras.

[19] Coley, G., Wesley, A., Reed, N. and Parry, I. (2008). Driver reaction times to familiar but unexpected events. TRL report PPR 313. Wokingham: Transport Research Laboratory.

[20] See eg Kahneman, D. (2011). Thinking, Fast and Slow. London: Penguin Books.

Observation

Post-accident drug and alcohol testing

89 **While there is no evidence that the train operator was impaired by drugs or alcohol, the RAIB observes that LUL did not follow its own processes for testing staff involved in a serious incident.**

90 LUL's processes state that post-incident drug and alcohol testing should occur as soon as possible after a dangerous operational incident. However, after the accident at Notting Hill Gate, the train operator gave a statement to the British Transport Police and was later escorted home by LUL staff in the interests of his welfare. The British Transport Police noted that there was no indication of intoxication nor statement of impairment on the part of the train operator.

Previous occurrences of a similar character

91 LUL's records show two incidents on the Central line between 2013 and 2015 involving someone becoming trapped in the train doors and the train starting to move. These occurred at Mile End on 17 February 2014, and at Ealing Broadway on 6 March 2015. After the incident at Ealing Broadway the station supervisor reportedly stated that normally the train is unable to depart with something trapped in the doors which, while true, is consistent with the view that many staff are unaware of the limitations of the door interlock (paragraph 74).

92 As part of this investigation, the RAIB made a public appeal for witnesses with information relevant to the accident to come forward. One witness reported a related incident in early February 2018 at Oxford Circus on the Central line, in which the coat of a person on the train was trapped outside the doors of the train as it arrived. The witness spoke with another train operator later in the journey at Ealing Broadway, and again the train operator could not explain how the train was able to depart with something trapped in the doors.

93 Another witness reported an incident which occurred at about 08:20 hrs on 13 October 2016 at Bank station, in which they were trapped in the doors while trying to alight from a Northern line train (another type of ATO train) and dragged a short distance. The train was very busy with passengers disembarking over a period of about 28 seconds; the witness was the last of these and the doors started to close before they were able to get off the train. LUL's report of the incident attributed the cause to 'customer action', concluding that boarding was already complete and that the person was late in trying to alight. The RAIB has reviewed the circumstances of this incident and observes that there was no clear gap between previous passengers disembarking and the witness' attempt to alight.

94 The RAIB has previously investigated three similar incidents on London Underground:

- Passenger trapped in a closed train door, Tooting Broadway, Northern line, London Underground, 1 November 2007 (RAIB report 17/2008).
- Passenger dragged a short distance by a train at Holborn station, 3 February 2014 (RAIB report 22/2014).
- Passenger trapped in train doors and dragged at Clapham South station, 12 March 2015 (RAIB report 04/2016).

95 Two of these incidents (Tooting Broadway and Clapham South) involved ATO train stock. Taken together, these investigations identified factors similar to those present in the Notting Hill Gate accident. In total, the RAIB made three recommendations as a result of these investigations, one of which is relevant to the Notting Hill Gate accident (see paragraph 102).

Summary of conclusions

Immediate cause

96 The train departed with a passenger trapped in the doors (paragraph 42).

Causal factors

97 The causal factors were:

a. The passenger's bag became trapped in the doors as she attempted to board the train (paragraph 44, no recommendation).

b. The train was able to depart with a bag trapped in the doors (paragraph 48, **Recommendation 1**).

c. The train operator was not aware of the trapped passenger before initiating the train's departure (paragraph 53). This is likely to have occurred due to a combination of the following:

i. The nature of the train operator's task had caused him to not consciously process the available information (paragraph 56, **Recommendation 2**).

ii. The view of the person on the in-cab CCTV monitor did not adequately assist the train operator to detect that a passenger was trapped in the doors (paragraph 62, **Recommendation 3**).

iii. The train operator did not conduct an adequate check of the in-cab CCTV monitor (paragraph 68, **Recommendation 4**).

Underlying factor

98 The underlying factor was:

a. LUL's training programme for train operators does not adequately prepare them for some of the particular demands associated with train despatch, especially when operating ATO stock. It is probable that this factor was linked to the cause of the accident (paragraph 72, **Recommendation 4**).

Factors affecting the severity of consequences

99 Factors that affected the consequences of the event were as follows:

a. None of the platform emergency stop plungers (PESPs) were used (paragraph 76, **Recommendation 5**).

b. A passenger emergency alarm on the train was activated about 10 seconds after the train started moving (paragraph 80, no recommendation).

c. The train operator did not apply the emergency brake until about 10 seconds after the train started moving (paragraph 83, **Recommendations 2 and 3**).

Additional observation

100 While there is no evidence that the train operator was impaired by drugs or alcohol, the RAIB observes that LUL did not follow its own processes for testing staff involved in a serious incident (paragraph 89, see paragraph 111 and **Learning point 1**).

Previous RAIB recommendation relevant to this investigation

101 The following recommendation, which was made by the RAIB as a result of a previous investigation, has relevance to this investigation. Note that for the purposes of this report, this review is limited to investigations of incidents on London Underground infrastructure, and does not include mainline or tramway incidents of a similar nature that the RAIB has investigated.

Previous recommendation that had the potential to address one or more factors identified in this report

Passenger trapped in train doors and dragged at Clapham South station, 12 March 2015, RAIB report 04/2016, recommendation 1

102 **The RAIB considers that more timely and effective implementation of work arising from recommendation 1 in RAIB report 04/2016 could have addressed the causal factors in this accident associated with the train operator's awareness of the person before initiating the train's departure.**

103 This recommendation read as follows:

Recommendation 1

London Underground should review the feasibility and effectiveness of measures to reduce risks associated with passengers being trapped in train doors and then dragged at the platform-train interface (PTI). The review should include measures already considered for all or part of the London Underground network, techniques already used by other railway operators, measures already considered by RSSB and measures made possible by the latest technology available when the review is undertaken. The review should include, but not be restricted to, consideration of:

- *improving detection of objects trapped in train doors;*
- *improving the ability of passengers to pull out objects trapped in doors (including by improving door seal arrangements);*
- *improving train operator views of the PTI at despatch (eg increasing the number of CCTV cameras, repositioning cameras and providing larger monitors);*
- *enhancing the methods available to staff performing SATS[21] duties when they need to alert train operators, or stop trains, in an emergency;*
- *using gap fillers or alternative means to reduce the gap between platforms and both moving and stationary trains;*
- *adapting platform markings to reduce passenger crowding close to trains/ doors; and*
- *raising passenger awareness of the safety risks associated with objects, fingers and hands becoming trapped in doors.*

[21] Station Assistant Train Services: a role which London Underground staff perform on busy platforms to assist train operators. It involves making announcements to improve passenger flow and signalling when the despatch process can be started.

The review should conclude with a time-bound, funded plan for progressing development of potentially viable measures. This should, if appropriate, include solutions which are only applicable to some parts of the London Underground network.

104 The Office of Rail and Road reported to the RAIB on 8 March 2017 that LUL had implemented this recommendation. The actions taken by LUL in response included the publication of a platform-train interface risk management strategy and the initiation of an extensive project to improve train operators' views from platform CCTV cameras (see paragraph 107). LUL also reviewed solutions for improving the detection of objects trapped in train doors and concluded that the best option would be to fit sensitive edge technology to any new train fleets (the costs of retrofitting such technology to existing fleets reportedly makes it impracticable).

105 Although the recommendation has been reported as implemented, the RAIB notes that the emerging project to improve platform camera views is still ongoing, with changes having been implemented at three high-priority platforms at the time of the accident at Notting Hill Gate. Nevertheless, platform 4 at Notting Hill Gate was not originally on the list of platforms to be addressed in this project.

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

106 LUL published its platform-train interface strategy on 17 June 2016 with a three-year target of zero fatalities and life-changing injuries, and 10% fewer customer injuries at the platform-train interface.

107 In response to recommendation 1 of the RAIB's Clapham South investigation (paragraph 104), LUL instigated a project (known as 'GAPS' – Getting Active about PTI Safety) to address obscured or oblique camera views for 95 priority platforms across the deep tube network. Possible improvements include relocating cameras and/or obstructions, adding new cameras or implementing a new CCTV solution. The 95 platforms were selected and prioritised through an initial assessment of all the CCTV systems, cross-referenced with the number of incidents on those platforms in the previous five years. Although platform 3 at Notting Hill Gate is on this list, platform 4 (where the accident occurred) was not originally included, but LUL has said it will add it to the list as a result of the accident. The project began in summer 2016 and is due to be completed in 2021.

108 At the time of writing, work has been completed on three platforms on the list, all on the Central line (Bank platforms 5 and 6, and Shepherd's Bush platform 1). Notably, the arrangement at Shepherd's Bush has changed from five images on the in-cab monitor (similar to Notting Hill Gate) to six images more evenly distributed on the screen.

109 Separately, there is a project to replace the platform cameras on all Central line platforms to remove obsolete technology and improve the quality of images on the in-cab monitors. This project is due for completion in December 2019.

110 On 6 March 2018, LUL realigned the images for two of the cameras at Notting Hill Gate platform 4 (relating to images 1 and 2 in figure 6), in response to a fault that had been reported the previous day. Although the realignment was intended to restore these images to a benchmark alignment, LUL assured the RAIB that the previous alignment (ie the one in use at the time of the accident) was fit for operational use. LUL's records show that all of the cameras at platform 4 were checked on the day after the accident, and were confirmed as meeting the benchmark alignment.

111 LUL issued a safety bulletin on 21 May 2018 reinforcing the requirement for drug and alcohol testing following an incident.

Recommendations and learning point

Recommendations

112 The following recommendations are made[22]:

1 *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 (paragraph 97b).

2 *The intent of this recommendation is to reduce the risk of train operators losing attention and awareness while operating ATO trains, by designing their task to be more compatible with human capabilities and limitations.*

London Underground should support train operators of ATO trains in maintaining attention and awareness by considering and, as appropriate, implementing task-related strategies that are based on established human factors knowledge and a review of current good practice (with specific reference to RSSB's ongoing project T1133[23]). Such strategies may include (but not be limited to) interspersing more regular periods of manual driving where feasible, introducing additional task-focused vigilance activities, or providing alerts if ATO start is attempted before the system is ready (paragraphs 97c.i and 99c).

[22] 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 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 RAIB's website www.gov.uk/raib.

[23] Evaluating prevention and mitigations to manage cognitive underload for train drivers. This project is due to be completed early in 2019.

3 *The intent of this recommendation is to optimise the views presented on in-cab CCTV monitors in order to minimise the possibility of a train operator being unaware of problems at the platform-train interface.*

London Underground should supplement the work of its GAPS project with additional objectives to review the presentation of images on platform monitors. The review should include consideration of the number and configuration of images displayed to the train operator, taking into account current standards and good practice (paragraphs 97c.ii and 99c).

4 *The intent of this recommendation is to improve the capabilities of train operators in making despatch decisions.*

London Underground should review its competence management programmes for all train operators in order to ensure consistency in training techniques for visual scanning of platform monitors, and awareness of the limitations of door interlock systems (paragraphs 97c.iii and 98a).

5 *The intent of this recommendation is to mitigate the consequences of incidents at the platform-train interface by improving staff awareness of the available means to stop trains in an emergency.*

London Underground should review the information provided to its staff about Platform Emergency Stop Plungers (PESPs) and implement measures to promote amongst staff the appropriate use of PESPs where they are available (paragraph 99a).

Learning point

113 The RAIB has identified the following key learning point[24]:

1 This investigation highlights the importance, for the long-term benefit and security of the people involved, of ensuring that company procedures for drug and alcohol testing are carried out on each occasion that they should be.

[24] '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

ATO	Automatic Train Operation
CCTV	Closed-Circuit Television
LUL	London Underground Limited
PEA	Passenger Emergency Alarm
PESP	Platform Emergency Stop Plunger
PTI	Platform-Train Interface
RAIB	Rail Accident Investigation Branch

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 data recorder;
- closed circuit television (CCTV) recordings taken from Notting Hill Gate station;
- site photographs and measurements;
- maintenance records;
- competence records;
- voice communication recordings;
- documented procedures, standards and risk assessments;
- historic incident data; and
- a review of previous RAIB investigations that had relevance to this accident.

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