Rail Accident Investigation Branch

Rail Accident Report

Passenger trapped and dragged at Ealing Broadway
24 November 2024

Report 01/2026
March 2026

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC
- the Railways and Transport Safety Act 2003
- 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.

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

Any information about casualties is based on figures provided to 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. 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.

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 Ealing Broadway 24 November 2024

Contents

Summary

At around 00:09 on Sunday 24 November 2024, a passenger at Ealing Broadway station was dragged along the platform by a westbound Elizabeth line train.

The train's doors had closed on the passenger's hand as they attempted to board. The train then departed with the passenger's hand still trapped in the doors. This resulted in them being dragged on foot for about 12 metres along the platform, before being pulled free by another passenger and a member of platform staff. It is probable that the passenger sustained a minor injury in the accident, but RAIB has been unable to contact them following the accident to confirm this.

The accident occurred because the driver closed the doors while passengers were still leaving and boarding the train, and because the passenger attempted to board while the doors were closing. The train's door system did not detect the presence of the passenger's hand, and the train driver was not aware that the passenger's hand was trapped before initiating the train's departure.

An underlying factor was that measures used by MTR Elizabeth line to control the risks of passengers being trapped and dragged at Ealing Broadway station were not effective. Additionally, a possible underlying factor was that Network Rail did not conduct a thorough risk assessment for the replacement and relocation of a waiting room building.

Although not directly contributing to the accident, RAIB observed that safety-critical communications between the member of platform staff involved, the train driver, the signaller and the duty control manager did not result in a shared understanding of what had taken place. The effectiveness of the public address system available to staff on platform 3 was also reduced by poor connectivity of the handheld device. In addition, RAIB identified missed opportunities for MTR Elizabeth line to ensure their internal investigation recommendations were being assigned, managed and tracked through to completion. Finally, the standards for the testing and commissioning of driver only operation (DOO) CCTV do not mandate the requirement to introduce a realistic platform environment during testing.

As a result of this accident, RAIB has made five recommendations. The first to the new operator of the Elizabeth line, GTS Rail Operations, is to improve how the risks of trap and drag events are understood and controlled. The second is for Transport for London to look to enhance the views of the platform-train interface captured on DOO CCTV and presented to train drivers. The third recommendation asks Transport for London to evaluate technological options which may further reduce the risk of a passenger becoming trapped and subsequently dragged by a departing train on the Elizabeth line. The fourth recommendation asks the Rail Safety and Standards Board to ensure the rail industry standard for DOO CCTV incorporates latest practice. The final recommendation is for Network Rail to ensure any changes made to infrastructure on Elizabeth line station platforms have been evaluated and managed appropriately to ensure they do not impact the safety of railway operations and passenger safety.

RAIB has also identified two learning points. The first concerns the importance of effective safety-critical communications. The second concerns the importance of the final safety check for drivers and ensuring sufficient time is allocated to checking that the platform-train interface is safe.

Introduction

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 and acronyms, which are explained in appendix A. Sources of evidence used in the investigation are listed in appendix B.

Timings

3 The timings used in this report relating to the movement and operation of the train involved in the accident are based on RAIB's analysis of the various data sources. The timestamps used by those systems for which data is available have been synchronised with one of the station CCTV cameras on platform 3.

The accident

Summary of the accident

4 At around 00:09 on 24 November 2024, a passenger on platform 3 at Ealing Broadway station (figure 1) was dragged along the platform by a train. They remained on their feet after the train departed, with their hand trapped in its doors. The driver of the train involved, train reporting number 9N68, the 23:28 Elizabeth line service from Abbey Wood to Maidenhead, was initially unaware that a passenger was trapped or that they were being dragged.

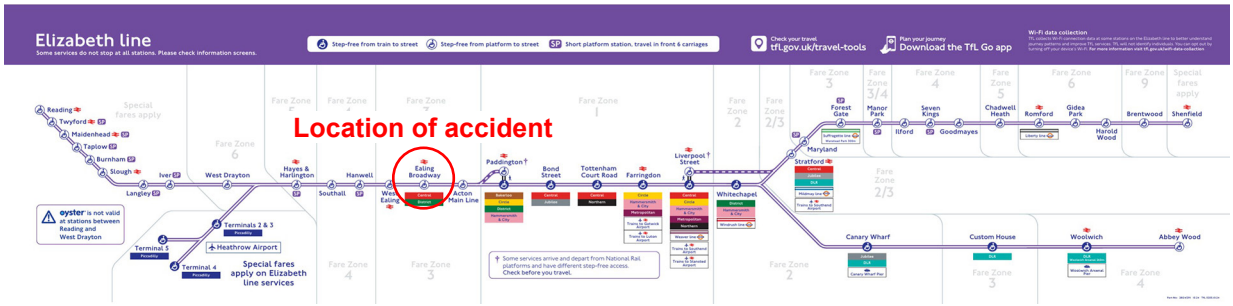

Figure 1: Extract from Elizabeth line map showing location of accident at Ealing Broadway station (courtesy of Transport for London).

5 The passenger was dragged about 12 metres along the platform and was then pulled free by a member of platform staff and another passenger before the train stopped. The train reached a maximum speed of 4.7 mph (7.6 km/h) during the accident.

6 The passenger probably sustained a minor hand injury due to the accident. However, RAIB has been unable to establish the extent of any injuries they sustained (see paragraph 24).

7 The train remained at platform 3 following the accident and subsequently departed Ealing Broadway around 28 minutes late.

Context

Location

8 The Elizabeth line was built by Crossrail Ltd. Construction of the line started in 2009, and the central section opened in May 2022. MTR Elizabeth Line (MTREL) began operating services at Ealing Broadway in May 2018, initially with class 360 rolling stock, and then transitioned to class 345 rolling stock.

9 Ealing Broadway station is an interchange station located in the London Borough of Ealing, west London (figure 2). The station serves the Elizabeth line, London Underground (District and Central lines) and the mainline railway (Great Western Main Line). The mainline railway station was originally opened in 1838.

Figure 2: Extract from Ordnance Survey map showing location of Ealing Broadway station.

10 The accident occurred on platform 3, which serves the Down Relief line. The platform is 226 metres in length and is broadly straight. Although the Down Relief line can be used by other services, including freight trains, it is predominantly used for westbound Elizabeth line services from London Paddington towards Heathrow, Maidenhead and Reading stations (figure 3).

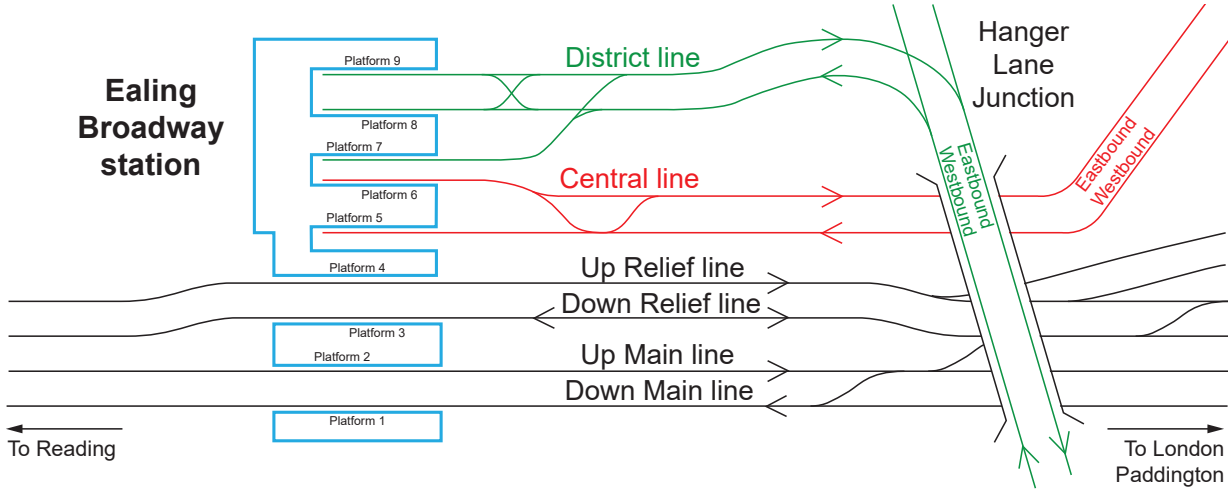

Figure 3: The track layout at Ealing Broadway station.

Organisations involved

11 At the time of the accident MTREL, which was owned by MTR Corporation (Crossrail) Limited, operated the Elizabeth line under the Crossrail Concession Agreement. MTREL operated the line under a contract with Transport for London (TfL) until May 2025. MTREL also operated the Elizabeth line control room, from the rail operating centre (ROC), in Romford. The control room monitors and controls the entire Elizabeth line.

12 GTS Rail Operations Limited is a joint venture between Go Ahead Group, Tokyo Metro and Sumitomo Corporation. It took over the concession operating the Elizabeth line under a 7-year contract with TfL in May 2025, after the accident.

13 Crossrail Ltd was jointly sponsored by TfL and the Department for Transport (DfT). The company was established in 2001 to build the new railway, now known as the Elizabeth line.

14 Network Rail owns and maintains the track infrastructure that the Elizabeth line trains operate on at Ealing Broadway, and the associated platform substructures. It also owns the public address system, repairs station CCTV, and operates the Thames Valley Signalling Centre, which controls signalling on this part of the Elizabeth line.

15 Rail for London (RfL) is a subsidiary of TfL covering its rail operations, including the Elizabeth line and London Overground. RfL has repair and maintenance responsibilities for the driver only operation (DOO) CCTV system at Ealing Broadway.

16 Bombardier Transportation (Bombardier) manufactured a fleet of 70 class 345 trains for the Elizabeth line between 2015 and 2019. In January 2021 Alstom acquired Bombardier Transportation.

17 All organisations involved freely co-operated with the investigation.

Train involved

18 The train involved was a class 345 ‘Aventra’ electric multiple unit (EMU) (figure 4) manufactured by Bombardier.

Figure 4: A class 345 train similar to the one in the accident (courtesy of srfurley, public domain, via Wikimedia Commons).

19 Among the systems relevant to this investigation, class 345 trains are equipped with the Train Protection and Warning System (TPWS), European Train Control System (ETCS), a Communications-Based Train Control system (CBTC) and the Global System for Mobile Communications for Railway (GSM-R, the mainline railway's radio system).

20 Class 345 trains comprise nine cars with a total train length of 205 metres. Each car is approximately 23 metres long, with a total train capacity of 1,500 passengers. In this report, car 1 refers to the leading car of the train, with other cars numbered sequentially, with car 9 at the rear.

Rail equipment/systems involved

21 Station CCTV located on platform 3 captures footage of the platform and waiting room areas in real time for security, crowd control, and emergency response management purposes. The train driver does not have a view of this CCTV on their in-cab monitors.

22 DOO CCTV is the camera system used for operating trains where the train driver has responsibility for opening and closing the doors and dispatching the train from a station. Platform-mounted DOO CCTV cameras are aligned to view the platform edge and transmit the images to monitors in the train cab (figures 9 and 18), to assist a driver to dispatch the train safely.

23 The PA system on platform 3 can play both automated audio and live messaging. Passenger announcements can be made over the PA system using a handheld device or from a desk microphone located inside the customer experience assistant office on the platform.

People involved

24 Although some details of the passenger involved in the accident were taken by staff working on the platform, RAIB has been unable to contact them since the accident, despite attempts to do so. CCTV shows they had been waiting with their companion in the passenger waiting room building on platform 3, before the train arrived. It is not known if they were a regular user of this service and station.

25 The driver of train 9N68 started employment with MTREL in 2020 and had 4 years' driving experience with MTREL on the Elizabeth line. Further details on the driver's training and competence history are provided in paragraph 128.

26 The customer experience assistant (CEA) had been employed by MTREL since September 2019, having initially started on a one-year apprentice programme. They had been working in their post at Ealing Broadway station for 4 years.

27 The Network Rail signaller, based at Thames Valley Signalling Centre, had enrolled as a signaller trainee in mid-2022 and was signed off as a competent signaller in January 2024.

28 The MTREL duty control manager (DCM) had 7 years' experience as a DCM and was based at Romford control room.

External circumstances

29 The accident occurred during the hours of darkness; however, the platform was illuminated by station canopy lighting. At the time of the accident, the weather was cold and wet, with light rain. External circumstances did not play a part in the accident.

Background information

Elizabeth line

30 Class 345 trains on the Elizabeth line operate in two modes: automatic train operation (ATO) and manual. ATO operation takes place within the CBTC central operating section of the railway (figure 5), where the train is automatically driven by the system. In ATO mode, the driver remains responsible for closing the train's doors, dispatch of the train, and initiating the train's start process when leaving a station. In manual mode, the driver is responsible for all train movements (accelerating and braking) under conventional (TPWS) and ETCS signalling, the opening and closing of the train doors and the dispatch process. There is no additional member of staff working on the train other than the driver.

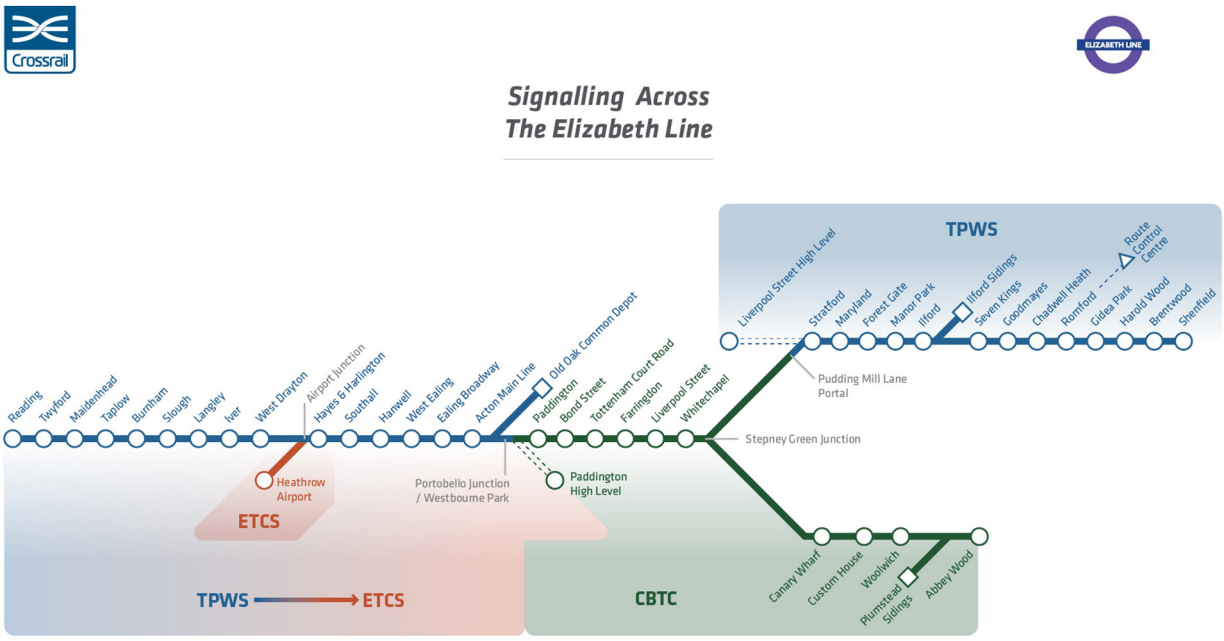

Figure 5: Map detailing the different operating sections of the Elizabeth line.

Changes to Ealing Broadway station

31 In May 2017, the DOO CCTV cameras for Ealing Broadway platform 3 were installed by Network Rail on behalf of RfL, with ownership and maintenance responsibilities transferred from Network Rail to RfL in 2018.

32 To ensure the installation of these cameras met the required Crossrail standard, a benchmarking assessment for the CCTV system was undertaken jointly by MTR, Crossrail, Network Rail and RfL in May 2018. This is discussed further in paragraph 159.

33 In preparation for the opening of the Elizabeth line, and before the start of the MTREL concession, submissions were made to the Office of Rail and Road (ORR, the economic regulator and safety authority for railways in Great Britain) regarding the alterations to Elizabeth line platforms which were proposed by Network Rail on behalf of Crossrail. These submissions related to changes in access to station facilities. The changes were not subject to safety approval by ORR because they fell outside of the approvals regime of the Railways (Interoperability) Regulations 2011.[1]

34 In November 2021, additional works (figure 6) included a new canopy and new passenger waiting shelters. Consultation was undertaken with the operators of services using the station, with the changes agreed by TfL in June 2023 and by MTREL in August 2023. These installations were fully completed in October 2023.

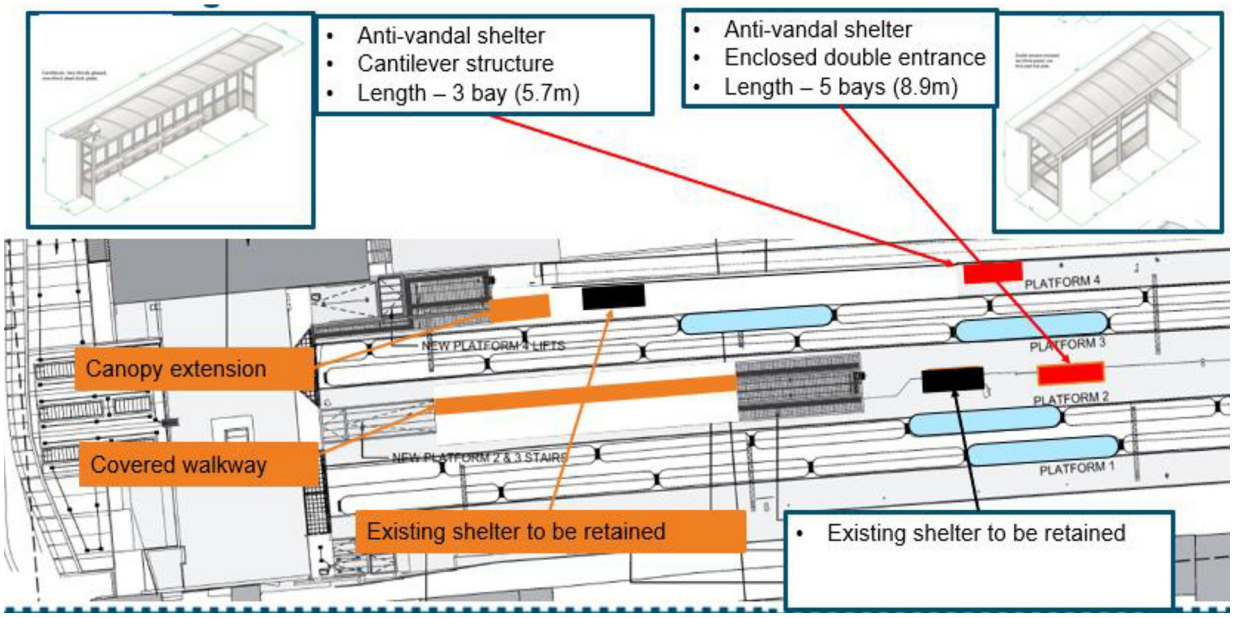

Figure 6: Network Rail drawing showing proposed station changes implemented in 2023 (courtesy of Network Rail).

35 A white metal fence separates platforms 2 and 3. This fence was installed some years before the Elizabeth line began operating at Ealing Broadway station. The width of platform 3 is mainly constant, with the widest gap from the fence to the platform edge being approximately 6.9 metres. However, the width of the platform significantly reduces along the length of the waiting room building, to approximately 3 metres and (at one point) to 2.6 metres (figure 10), due to the building not running completely parallel with the platform edge. This gap remains just above the minimum threshold of 2.5 metres required by Railway Group Standard GI/RT7020, 'Requirements for width of platforms', issue 2 dated 2022.

Train door system and operation

36 Each train car has three pairs of electrically operated, sliding plug doors per side (figure 7).

[1] As the safety authority ORR is responsible for authorising the placing into service of the structural and functional subsystems which fall within the remit of these regulations.

Figure 7: The class 345 electrically operated, sliding plug doors.

37 For trains stopping at Ealing Broadway station, the train doors are enabled by the driver pressing the two red ‘doors open’ buttons on their driving desk simultaneously (figure 9). Passenger operated pushbuttons on the doors illuminate green (open and opening), flashing red (when closing) and solid red (when locked).

38 Once the driver has stopped the train and enabled the doors, the internal and external pushbuttons on the passenger doors will illuminate green, and a chime will sound. Passengers can then press the door button to open the doors. Once open, the door chime sound repeats, and floor level lighting will illuminate.

39 To close the train doors, the driver presses the ‘doors close’ button. The internal door indicator lamps and door buttons illuminate red, the ‘hustle alarm’ will sound, and the doors will begin to close. The hustle alarm is intended to warn passengers that the train’s doors are about to close and that they should stand back from them.

40 The door system also provides low level infrared motion detection. After 15 seconds where no movement (boarding or alighting) is detected, the doors will automatically close. The doors can be reopened by the passenger operated pushbutton (illuminated green) unless the driver has made a doors close command, after which this system is deactivated.

41 When closing, the doors align with the train's bodyshell and lock. A 'door closed' switch detects the physical presence of the doors in the closed position. The door closed switch is linked to the traction interlocking circuit and the external orange bodyside indicator lamps. The driver cannot take traction power until the traction interlocking circuit has been made, preventing the train from departing from a station with any doors open (see paragraph 112).

42 The train doors are fitted with an obstacle detection system which permit the doors to detect an object caught in the doors and pause or stop the door closing sequence (see paragraph 102).

43 Once all the train doors are closed, locked and traction interlocking has been achieved, a blue 'close/interlock' button is illuminated in the driver's cab. The driver will then start a final train safety check (see paragraph 76).

DOO train dispatch process

44 The railway Rule Book GERT8000 Module SS1, 'Station duties and train dispatch', issue 9 dated December 2023, section 3.9, sets out the following procedure for train drivers when dispatching their train from an unstaffed platform under DOO conditions:

- *'You must 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.*
- *You must then close the doors.*
- *Before you start the 'train safety check', you must make sure that the passenger doors have closed, either by seeing that the external orange hazard lights have gone out, or, where appropriate, the traction interlock light is illuminated.*
- *You must not rely only on the external orange hazard lights or the traction interlock light as an indication that it is safe to start.*
- *You must carry out the 'train safety check', using the monitors by making sure that:*
  - *nobody is trapped in the doors, for example by clothing*
  - *nobody is in contact with the train.*
- *You must only start the train if it is safe to do so.*
- *You must do either of the following if you cannot make sure it is safe to close the doors or carry out the 'train safety check' from the cab because of defective on-train cameras or monitors, defective platform monitors or mirrors or poor visibility.*
  - *Use another means of doing so, as shown in your train operating company instructions.*
  - *Carry out any other instructions you are given.'*

The sequence of events

Events preceding the accident

45 The train driver booked on duty at Maidenhead station at 16:04 and was due to finish their shift at 00:48.

46 Train 9N68 departed Abbey Wood station at 23:28 and formed the driver's final service of their shift. By this time, the driver had been on duty for about 6 hours, including rest periods.

47 All westbound trains automatically transition from ATO (in the CBTC section) to manual mode (in the TPWS section) at Westbourne Park (figure 5). The train changed from TPWS manual mode to ETCS manual mode when it arrived at Ealing Broadway platform 3. It came to stand at 00:08:27, with approximately 1,200 passengers on board. The service had encountered minor delays at stations before Ealing Broadway station and was running approximately 1 minute late.

48 The CEA started their duty at 23:30 and was on duty, assigned to platform 3, as the train arrived. Another CEA was working on platform 4. No additional CEAs or station management staff were rostered on duty after 22:00.

Events during the accident

49 By the time the train had come to a stop in platform 3 at its correct position, the CEA had positioned themselves by the rear doors of car 3 (figure 8). The driver released the doors, which opened, and passengers began to alight from the length of the train, making their way towards the platform exit near the front of the train. Passengers from the middle and rear of the train had to walk through a narrowed section between the platform edge and the waiting room building to reach the exit (figure 10). This area was adjacent to cars 3 and 4.

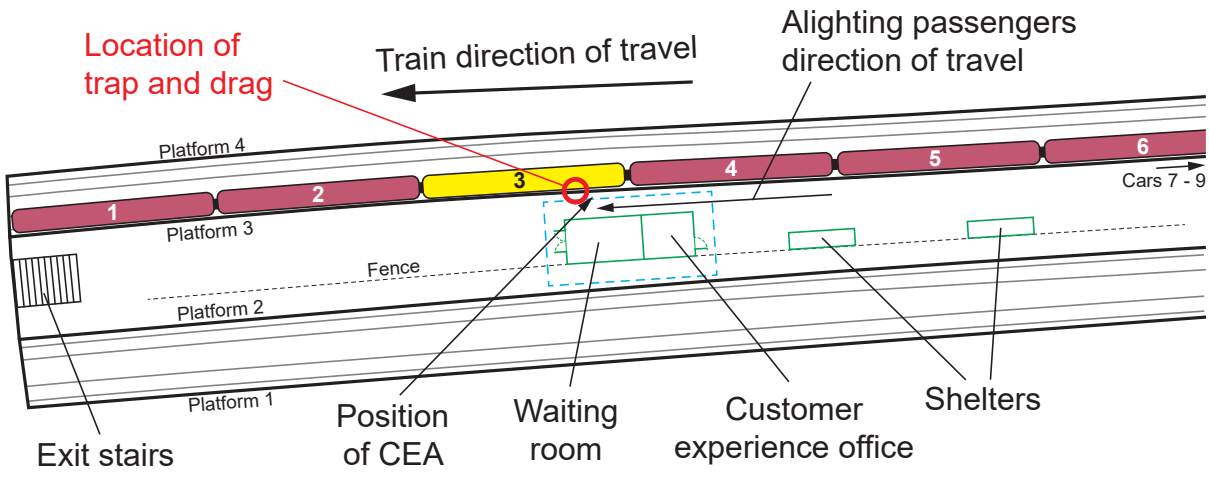

Figure 8: Diagram showing train 9N68 stationary on platform 3.

50 At 00:08:57, around 30 seconds after the train had come to a stand, the driver is recorded as pressing the doors close buttons. At 00:09:00, station CCTV shows that the train's doors started closing, while passengers were still alighting from the train, and while other passengers were waiting to board. CCTV also shows that the doors on car 1 and car 3 took longer to close than other doors, probably due to alighting passengers activating the obstacle detection system fitted to the doors.

51 At 00:09:02, station CCTV shows the area between car 3 and the adjacent waiting room was still heavily congested with passengers. The CEA observed the doors closing and told the passengers by the rear doors of car 3 to "stand clear", as the hustle alarm on the doors was sounding. The train doors closing cycle continued, and all the doors on the train closed apart from the rear doors of car 3. This was due to the companion of the passenger involved in the accident, pulling the closing doors open in order to board.

52 At 00:09:03, the passenger's companion boarded the train, and the doors on car 3 reopened and then started to close again (known as recycling, see paragraph 102). The passenger involved in the accident was on the platform and was now separated from their companion. The passenger was standing with three others, who were also waiting to board. As the doors were closing, at 00:09:07, the passenger placed their right hand into the gap between the closing doors, which then trapped their hand.

53 Despite the passenger's hand being trapped in the doors, the obstacle detection system did not detect the obstruction (see paragraph 96). The driver obtained traction interlock at 00:09:09 with the indicator illuminating in the driver's cab. The driver undertook their train safety checks and then applied traction power 3 seconds later at 00:09:12. The train began to depart with the passenger's hand still trapped in the doors.

54 Station CCTV shows the passenger being dragged by the train and in visible distress as they were pulled along while remaining on their feet. Other passengers on the platform became aware of the accident and one passenger ran towards the trapped passenger and took hold of their arm, attempting to pull them free from the moving train. The CEA, who had also seen what was happening, raised one arm and waved it towards the driver to gain their attention. The CEA realised that the driver had not been alerted and the train was not coming to a stand, so they also grabbed the passenger. Both the CEA and the second passenger were able to pull the trapped passenger free from the doors.

55 DOO CCTV and station CCTV evidence shows other passengers were trying to alert the driver by waving, shouting and striking the side of the train. The driver, who could see another waving passenger running alongside the train in their DOO CCTV monitor, realised something was wrong and braked at 00:09:20, bringing the train to a stop. The train had moved approximately 18 metres.

56 Passengers on the train were also alerted to the accident by the passenger's companion who was now urgently trying to open the doors from inside the train. Internal saloon CCTV from the train shows that passengers in car 3 were pressing door buttons and searching around the door frames, probably to find a passenger emergency alarm (PEA, which allows passengers to contact the driver in an emergency) to stop the train. It is likely this is when an emergency egress device handle (EED, a device used in emergency situations to open train doors) was first pulled in car 3.

Events following the incident

57 At 00:10, the driver contacted the signaller via GSM-R and reported that they had seen a passenger running along the platform hitting the side of the train to gain their attention. The driver informed the signaller that they would try to find out what had occurred.

58 At 00:11, the CEA on platform 3 phoned MTREL customer experience control (CEC) and informed them that a passenger's hand had become trapped in the train doors, and they had been dragged along the platform. CEC requested additional information, and the CEA informed control they would speak to the driver.

59 The CEA walked up the platform to the driver's cab to inform them what had happened, but on arrival they were unable to speak with the driver as the driver was already on the phone reporting the accident to the signaller. During this time, the train system alerted the driver to multiple EED activations in car 3 on the platform side. The CEA returned to the passenger who was now kneeling on the platform where they had been pulled free.

60 At 00:14, MTREL control sent a message via GSM-R to the driver to 'contact control'. MTREL control believed there was an accident involving a passenger who had been trapped in the train doors and pulled free, but that no drag (that is no movement of the train with the person still trapped) had occurred.

61 The driver contacted MTREL control and explained to the DCM that, after the train had departed, they observed on the in-cab monitors that a passenger on the platform was waving and striking the side of the train to attract attention. The driver at this stage was not aware that a trap and drag accident had occurred. While this conversation was taking place, a PEA was activated in car 3. It is probable that this alarm activation was the passenger's companion looking to leave the train. The driver then requested permission from the DCM to release the doors on the platform side to let a passenger off. The request was declined as the train was past its designated point on the station platform. MTREL operational policy also only allows forward train movements when a train is past this point.

62 At 00:18, the CEA, having spoken to the passenger involved, returned to the driver's cab and informed the driver that someone had been caught in the doors, that the CEA had freed them and they were now going back to check on the passenger's welfare. The CEA also reported that the passenger involved and their companion had become separated. The driver was not aware at this stage that the EED activations were connected to the initial PEA activation they had received.

63 Shortly afterwards, another EED activation occurred in car 3 and the driver made an announcement over the train's PA system requesting passengers be patient and not to attempt to open doors or leave the train, as it would cause further delays. A second CEA, who had been working on platform 4, arrived on platform 3 to assist the CEA. The second CEA walked along the platform up to the driver's cab to explain that they had instructed the passenger's companion, who was still on the train, to pull the EED to enable them to get off and be with their companion who was still in distress on the platform.

64 At 00:20, the driver received another EED activation, showing a set of doors opening on the non-platformed side of car 3. This side of the train faced the Up Relief line, which was open to traffic. The driver was unable to immediately close the doors on this side of the train and was concerned that a passenger might have self-evacuated from the train onto the track. The driver, therefore, made a railway emergency call (REC) on the GSM-R to the signaller (a REC call is broadcast to all trains within an area when there is a need for trains to be stopped immediately as there may be an obstruction on the line or a risk to life).

65 The driver informed the signaller of the situation. The line was blocked to prevent train movements and permission was given for the driver to check if any passengers had self-evacuated onto the up line track. The driver completed the check with no issues being identified and contacted the signaller to report all was correct. The signaller informed the driver that they would call back.

66 At 00:24, MTREL control centre attempted to contact the on-call duty manager and left a voicemail message reporting an incident. At this time, the control room entered details of the accident onto the company's accident reporting system. The accident was recorded as a trap and drag stating, 'customer hand trapped in train doors'.

67 At 00:27, the driver contacted MTREL control as they had not received a call back from the Network Rail signaller and could not get permission to depart the station. Following advice from control, the driver contacted the signaller again and was then given permission to depart Ealing Broadway at 00:31. Due to the position of the train, a degraded dispatch process was implemented and the driver obtained assistance from the CEA staff on the platform to depart safely.

68 At 00:33, the on-call duty manager contacted MTREL control and was informed that a possible trap and drag had occurred. The on-call manager requested that control contact the train driver and instruct the driver to meet them at Maidenhead station, the final destination of the train.

69 At 00:43 the CEC control room updated the accident entry onto the system reporting 'customer trapped, removed but not dragged'.

70 The passenger, now being supported by their companion who was let off the train, was offered medical assistance but declined.

71 In line with the standard rail industry processes following an incident, a drug and alcohol test was completed on the driver following the incident. This returned a negative result.

Analysis

Identification of the immediate cause

72 The train departed with the passenger's hand trapped in the doors.

73 Station CCTV shows that the passenger's hand became trapped in the closing doors of the stationary train (paragraph 52). The train then departed with the passenger trapped in the door, dragging them on foot for about 12 metres before they were pulled free (paragraph 54).

Identification of causal factors

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

a. The driver closed the doors while passengers were still attempting to leave and board the train (paragraph 75).

b. The passenger attempted to board the train while the doors were closing (paragraph 88).

c. The train's door detection system did not prevent the passenger's hand from becoming trapped in the closing doors (paragraph 96).

d. There was no intervention before the train departed (paragraph 110).

Each of these factors is now considered in turn.

The closing of the train's doors

75 The driver closed the doors while passengers were still attempting to leave and board the train.

76 Rule Book GERT8000-SS1 'Station duties and train dispatch' sets out the procedure for train drivers when dispatching their train (paragraph 44). MTREL's train dispatch procedure (MTR-SQE-PRC-COM-0099) requires drivers to complete the following steps:

- *'5 seconds before departure, check the in-cab monitors to ensure doorways are clear and unobstructed.*
- *Make PA announcements if they need to.*
- *When then safe to do so, begin the doors close sequence.*
- *Recheck all doorways are clear and unobstructed.*
- *Undertake their train safety checks – confirm they have a proceed signal, that the doors are properly closed (traction interlock is achieved), that nobody is trapped or in contact with the train, and it is safe to move the train.*
- *When safe to do so, start the train.'*

77 In the driver's cab, a maximum of eight camera images may be displayed to show the entire length of the train while it is in the platform. The monitors become active once the driver operates the doors open controls and remain enabled until the train has departed and moved 10 metres or exceeded a speed of 3 mph (5 km/h). The actual number of camera images provided to the driver is dependent on the DOO CCTV assessment for each platform.

78 At platform 3 at Ealing Broadway station, four images are provided to the driver on the monitors (figure 9), compared to the eight images provided to the driver on platform 4. The additional cameras on platform 4 were provided as a result of the CCTV assessment identifying an additional risk due the curvature of that platform.

Figure 9: Still taken from the DOO CCTV recordings, superimposed by RAIB onto a photograph of the monitors in the driver's cab (photo taken during daylight hours).

79 Footage from platform 3's DOO CCTV shows that, when the train doors were opened by the driver, passengers at the front of the train were able to freely move along the platform towards the exit. Station CCTV recordings also show passengers on the platform waiting by the rear doors of car 3, allowing passengers to alight from the train.

80 Passengers who had alighted from other cars also started to make their way along the platform, with a constant flow coming from the middle and rear portions of the train towards the exit. As they moved down the platform, the reduced width in the area around the waiting room created a 'pinch point', and the platform at the rear of car 3 became heavily congested with passengers (figure 10). As well as increasing congestion, the flow of passengers moving towards and through the narrower section (figure 16) made it difficult for passengers at the rear of car 3 to join the flow of passengers leaving the station, and for some passengers on the platform to board the train.

Figure 10: The route taken by passengers and the changes in platform width.

81 Witness evidence suggests that when the driver decided to the start the doors close sequence, they could not see anything of concern on the in-cab monitors. The driver was aware that the station platform was busy and that there was a flow of passengers heading along the platform towards the exit.

82 However, RAIB's review of on-train data recorder (OTDR) data and station CCTV indicates that, when the door close sequence started, passengers were still leaving cars 1 and 3 and were also waiting to board at the rear doors of both cars (figure 11). CCTV shows the platform adjacent to the rear of the train had cleared of passengers by this time. It took 12 seconds between the driver pressing doors close to obtaining traction interlock (paragraphs 50 and 53).

83 RAIB has not been able to clearly determine why the driver did not identify that passengers were still leaving the train and waiting to board when they decided to start the doors close sequence. Possible reasons include:

- The train transitioned from TPWS to ETCS mode when it arrived at platform 3, and Ealing Broadway was also the first station stop after the change from ATO into manual driving mode (paragraph 47). These operating changes introduce additional tasks for the driver compared to the previous scheduled station stop. It is possible that these additional tasks caused the driver to reduce their focus on the platform-train interface.
- The heavily congested section of the platform adjacent to the waiting area partially obscured the driver's view of the rear doors of car 3 and affected their ability to distinguish which passengers were moving to leave the station and which passengers were waiting to board this car.

Figure 11: Images from DOO CCTV showing passengers leaving car 1 (left image) and congestion around car 3 (right image) (courtesy of MTREL).

84 MTREL's internal investigation found that, throughout the journey from Abbey Wood, it took 5 to 6 seconds between the driver pressing the doors close button to obtaining traction interlock at the majority of stations, against a typically expected value of 3 seconds. MTREL's internal investigation found that this was probably due to passengers obstructing the doors, although it did not determine if the cause of this was unintentional (due to passengers being trapped in closing doors) or intentional (due to passengers attempting to prevent the doors from closing).

85 Witness and OTDR evidence also show that the driver experienced issues with doors closing at a previous station stop, with repeated door close attempts by the driver taking place at Bond Street station. MTREL determined that it took 22 seconds to obtain traction interlock at this station, which is equipped with platform edge doors (which, when closed, create a barrier between the platform and the train). Other door related incidents occurred after the accident, at Southall and Hayes and Harlington stations.

86 RAIB found that there was no additional evidence (such as CCTV) which would support a conclusion as to why these other door incidents occurred, or why there were extended times between the driver pressing the doors close button to obtaining traction interlock throughout the journey from Abbey Wood. Post incident testing undertaken by Alstom did not identify any faults with the train doors. GTS (the current operators of the Elizabeth line) stated that any delay in achieving traction interlock following the operation of the door close function is in all probability due to the train doors being physically obstructed (held) by customers either in error (to avoid being trapped or struck) or intentionally (to prevent the doors from closing).

87 Despite the previous issue that had occurred on the route, the train was only 1 minute late arriving at Ealing Broadway station, and witness evidence suggests the driver did not feel under any pressure to make up time during the station stop.

The passenger's attempt to board the train

88 The passenger attempted to board the train while the doors were closing.

89 Industry research has been undertaken to better understand how passengers interact with train doors when boarding and alighting from trains. The focus of the research has been on preventing door closure incidents, rather than mitigating their consequences.

90 Industry research on passenger perception of trap and drag risks (Bayliss, Waterson and Young, February 2025) found that many passengers are unaware of the risks and so their actions can be a causal factor. There was an expectation in 65% of responders in the study that train doors would work similarly to lift doors, which reopen if obstructed. The research showed passenger mental models of train doors are inconsistent, leading passengers to take risks that can result in trap and drag incidents.

91 Research by the Rail Safety and Standards Board[2] (RSSB) (T1102 'Optimising door closure arrangements to improve boarding and alighting', 2017) also showed that two-thirds of passengers interviewed did not understand the hustle alarm to mean they should stand back from the stationary train. This research also showed some passengers tend to disregard the alarm and continue to board, evidencing that the purpose of the hustle alarm may not be well understood.

92 The advice to the industry from the research included:

- increasing passenger awareness of door closure arrangements to enable passengers to make better boarding and alighting decisions and take evasive action when confronted with closing doors
- enhancing audible messages and timings of warning and alarm types for door closure arrangements to support passengers' decisions when boarding and alighting.

93 MTREL's control measures on the night to mitigate the risk of a passenger trap and drag event occurring included:

- 'sharks' teeth' stickers on the inside and outside of the train doors (figure 12)
- a hustle alarm sounding as the doors were closing
- door push buttons lights changing from green to red
- a platform staff member (the CEA) giving a verbal warning to mind the closing doors and to stand back.

94 CCTV showed passengers initially waiting to board as other passengers were alighting from car 3, with the delay probably due to the congestion inside the train and outside the train doors (paragraph 80). CCTV and witness evidence suggest the passenger and their companion were both still waiting to board when the doors started to close and that the CEA instructed them to stand clear of the closing doors. The passenger did not appear to react to this verbal warning, or to the hustle alarm. Station CCTV showed the passenger's companion attempting to board as the doors were closing and pulling them open to board the train. The doors can be seen to reopen and start to close again due to them having been obstructed.

[2] The Rail Safety and Standards Board (RSSB) is a not-for-profit company owned by major industry stakeholders. It is the independent safety, standards and research body for Great Britain's rail network.

95 This left the passenger still on the platform and now separated from their companion on the train. CCTV showed that the passenger subsequently placed their hand in the doors as they were closing for the second time. It is not known if the passenger was attempting to step onto the train using their hand to take hold of something inside or if they put their hand in the closing doors, believing the train door system would detect their hand and again reopen.

The train's door detection system

96 The train's door detection system did not prevent the passenger's hand from becoming trapped in the closing doors.

97 Class 345 trains on the Elizabeth line operate with an obstacle detection system intended to detect people and obstacles that become trapped in a door. The door design also includes passive anti-drag seals which aim to make it easier for thin materials such as clothing and bag straps, which have become trapped in doors, to be freed.

Standards

98 Standard BS EN 14752:2005 'Railway applications for bodyside entrance systems', published in 2005, specified the minimum requirement for construction and operation of railway passenger access doors. These included provisions to ensure the safe access and egress from passenger trains through bodyside doors and to minimise the risk of injury to persons as a result of door operation.

99 The parameters described in BS EN 14752:2005 for obstacle detection were that:

> *'A rectangular bar of 30mm (width) x 60mm (height) will be detected and the door will open. A rectangular bar 10mm x 50mm will not be detected and the door leaves will close onto the obstacle … and the train should obtain interlock.'*

100 BS EN 14752:2005 was superseded in April 2015 by BS EN 14752:2015. This revision of the standard introduced new testing requirements for door systems, including specific test procedures for passenger interface devices, water tightness, and closing forces. The detection parameters for an obstruction remained the same as the 2005 standards, which was also the case following a further revision in 2019. The current standard, BS EN 14752:2021 'Railway applications. Bodyside entrance systems for rolling stock', published in 2021, also contains the same requirements.

101 The obstacle detection system on the class 345 train doors was compliant with the requirements of the 2005 standard at the time of its design and with the 2015 standard when it was introduced into service.

102 The doors on class 345 trains remain compliant with the requirements of BS EN 14752:2005 to detect obstructions greater than 30 mm in thickness and 60 mm in height. When an obstruction of this size is detected while the doors are closing, the doors will open, pause and then try to close up to another three times (recycling). After this, if the doors remain obstructed and traction interlock cannot be achieved, then the doors will 'fault' and remain open. The driver will receive a notification on a display in the cab (figure 13) with the relevant door illuminated, showing that there is an obstruction. Although traction power can only be applied once the traction interlock circuit is complete (that is, when all doors are closed and locked) smaller diameter items may not be detected by the system if they become trapped in doors. Traction power will still be available in these circumstances.

Figure 12: An undetected obstruction in the train doors.

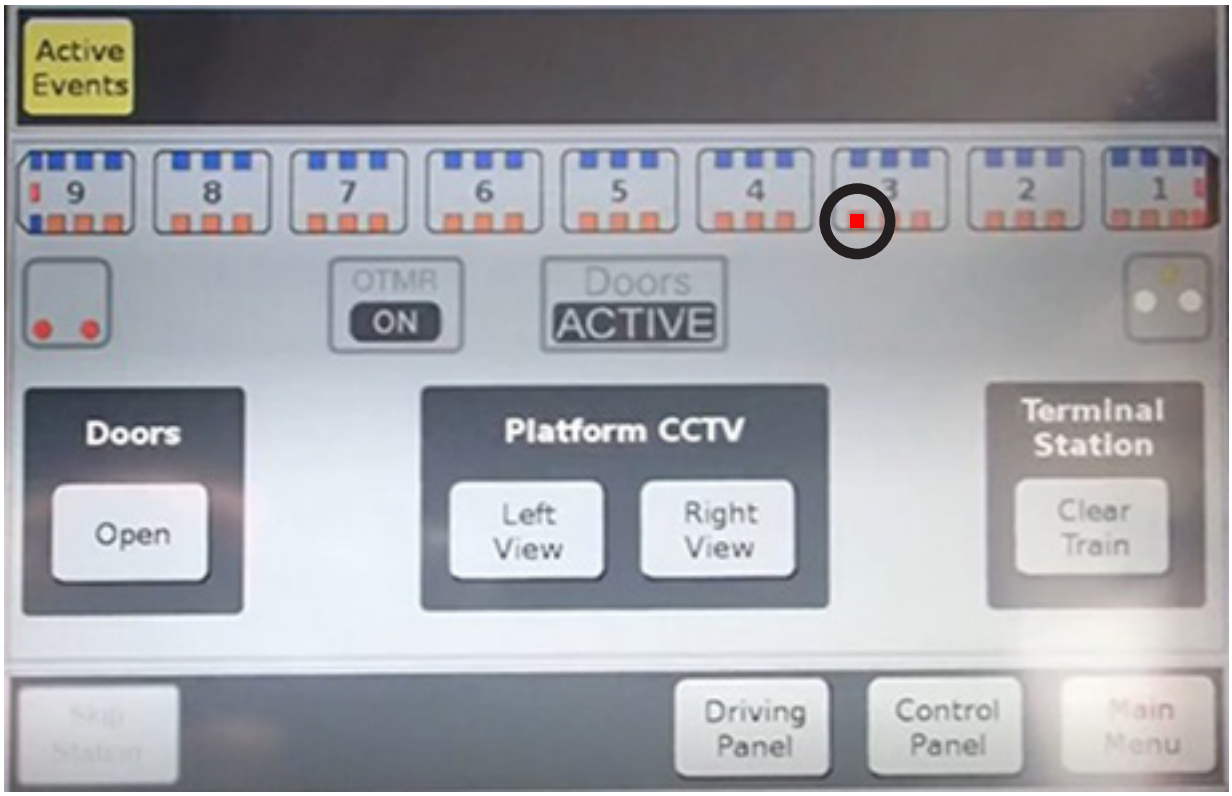

Figure 13: An example of a driver's panel displaying an item detected in the train's door.

103 The average dimension of a small adult hand[3] is 75 mm in height, with a finger thickness of 18 mm. These dimensions are not within the detection parameters of the obstacle detection system on class 345 trains. It is, therefore, likely that the dimension of the passenger's hand involved in the trap and drag accident was too small to be detected, resulting in doors not recycling and the interlock circuit being made.

Additional door technology

104 Additional technological door systems are used by other train operators in the UK, including those operating other classes of 'Aventra' trains. These include active anti-drag and sensitive edge technology (SET).

105 TfL's contract for the provision of Elizabeth line class 345 trains was awarded to Bombardier Transportation in February 2014. BS EN 14752:2015 which covered SET, was published after Bombardier had begun production. Although the Crossrail train specification for the class 345 included passive anti-drag measures (see paragraph 106), an active anti-drag functionality was not requested or added to the train specification later.

Specification of class 345 obstacle detection

106 The Crossrail technical specification was based principally on compliance with the industry design standards for door obstacle detection at the time of design. TfL reported that Crossrail had elected to include the passive anti-drag requirement in the Crossrail technical specification as a practicable addition to the other, mandated, obstacle detection requirements in BS EN 14752:2005. With the passive anti-drag measure, the door leading edge seal design allows for items of clothing trapped in closed doors to be extracted without the need for excessive force. This requirement was taken by TfL from their train door standards used on the London Underground.

107 Sensitive edge technology is fitted to TfL's London Underground S-Stock trains (which run on sub-surface lines) and on the 09 Tube Stock (Victoria line). This technology detects thin objects that have been trapped by the closing doors. Although it does not prevent the doors closing fully, it is intended to stop the train from starting in such circumstances.

108 TfL informed RAIB that, by 2010, it was aware of the revisions regarding passive anti-drag functionality being proposed to BS EN 14752:2005 as optional additional functionality. However, when setting the specification for the class 345 train, Crossrail decided not to include active anti-drag functionality due to concerns that the technology at that time had not been sufficiently developed, and this could have affected fleet reliability, availability and operational performance. In the absence of such a system, Crossrail considered the provision of platform-mounted CCTV cameras across the Elizabeth line and platform edge doors in the central section as adequate control measures to mitigate against passenger trap and drag risk.

109 TfL was unable to locate any design risk assessment documents from the Crossrail technical specification development stage specifically relating to door detection technology options. Therefore, no evidence was available to show how TfL had assessed its control measures intended to mitigate against passenger trap and drag risk.

[3] https://www.researchgate.net/figure/Dimenssions-of-a-human-finger-3_fig1_328581058.

The train departing while the passenger was trapped

110 There was no intervention before the train departed.

The train driver's safety checks

111 The MTREL dispatch procedure for DOO requires drivers to undertake train safety checks before moving off from a platform. This will include confirmation that the doors are closed, that traction interlock has been achieved, that nobody is trapped or in contact with the train, and that it is therefore safe to move (paragraph 76).

112 Class 345 trains are fitted with bodyside door indicator lights. These small lights mounted high on the side of each car are illuminated if any door on that car has not closed and activated the door closed switch for that car, which is linked to the traction interlock circuit (paragraph 41). After a driver had made a doors close command, they will be able to check on their DOO cab monitors to see if a bodyside indicator light has turned off.

113 Recordings from the station CCTV of the train in the platform and the DOO CCTV system show the bodyside indicator lights on the train extinguishing once the doors were closed. OTDR and witness evidence show the train driver gained traction interlock and took power 3 seconds later. At this point, the driver did not realise that the passenger was trapped during their final safety checks and before they took power. Witness evidence suggests that the driver was aware that traction interlock could still be achieved with items trapped in the doors.

114 The area along the platform, particularly by the rear of car 3, remained congested during the train safety check (figure 14). This may explain why the driver did not identify that a passenger's hand had become trapped in the doors.

Figure 14: The view of the platform from the DOO CCTV as the train started to depart at 00:09 (courtesy of MTREL).

115 Witness evidence shows that, after the train moved off, the driver became aware of a passenger running alongside the train. Station CCTV evidence also shows other passengers trying to alert the driver by waving, shouting, and striking the side of the train (paragraph 55). Around 8 seconds after departure, the driver braked and brought the train to a stop.

The CEA was unable to alert the driver to stop the train

116 MTREL's platform management duties for the role of a CEA include the following:

- Stopping a train in an emergency - CEAs are trained how to undertake an emergency stop by raising both hands above their head to alert a train driver.
- Making safety and passenger announcements over the PA system or by communicating directly to passengers.
- Crowd control - CEAs are trained to advise passengers to move away from moving trains and the platform-train interface area when at risk. They also try to keep passengers moving along the platform and away from the yellow line.
- Fault and accident/incident reporting to the CEC.

117 Rule Book Module SS1 states that '*you must take any action necessary to stop the train in an emergency*'.

118 CCTV shows the CEA speaking to passengers near car 3 while the train is at the platform and before passengers had started to board, including the injured passenger and their companion. Witness evidence suggests this was probably when the CEA told passengers to stay back and CCTV shows the CEA gesticulating and advising passengers to move behind the yellow line and back from the train.

119 Station CCTV recordings show the CEA, on observing the passenger being trapped and dragged, initially attempted to stop the train by waving to the driver with one hand raised (rather than raising two hands, which is the mainline railway's hand signal for 'emergency stop'). However, upon realising no action was being taken by the driver, they decided to assist the trapped passenger. Supported by another passenger, the CEA was able to pull the trapped passenger from the door and away from the moving train (paragraph 54).

120 The driver stated they did not see the CEA waving towards them in their DOO monitor. Even had the CEA raised both hands to give the correct emergency stop signal, RAIB believes on this basis that it is unlikely to have made any difference to the driver being able to see them as the train departed.

Identification of underlying factors

MTREL's control of risk

121 The measures used by MTREL to control the risks of a passenger being trapped in closing doors and dragged were not sufficiently effective.

122 Rail Industry Standard RIS-3703-TOM 'Passenger Train Dispatch and Platform Safety Measures', issue 5, dated 2022, was current at the time of the accident. It identifies factors to consider in managing the safe behaviour of passengers at the platform-train interface such as:

- a yellow line on the platform to delineate the platform edge area where passengers are not to walk or wait
- if there is sufficient space on the platform for all waiting and movement along the platform to take place behind the yellow line

- whether the space on the platform affects passenger movement and the view of the dispatch corridor.

123 Rail Industry Standard RIS-7016-INS, 'Interface between Station Platforms, Track, Trains and Buffer Stops', issue 2 dated 2022, sets out requirements for the design and maintenance of station platforms for their safe interface with trains. Appendix D of the standard provides guidance in relation to determining the position of the yellow line on platforms, obstructions that can force passengers to walk or wait close to the platform edge, and times when platforms can become congested.

124 Under the requirements of the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS), the Health and Safety at Work Act (1974) and RIS-3703-TOM, MTREL was required to undertake risk assessments of its operations at Ealing Broadway, and other stations it manages. Train dispatch risk assessments were undertaken by MTREL for each Ealing Broadway platform where Elizabeth line trains were permitted to operate from (platforms 1 to 4). The train dispatch risk assessment for platform 3 was undertaken by MTREL in May 2023.

Dispatch risk assessment

125 The MTREL dispatch risk assessment identified a '*trapping in doors*' risk at Ealing Broadway platform 3 due to '*poor or obstructed visibility*' for a driver. Adequate lighting and no identified obstructions were assessed as suitable control measures to manage the risk. For a trapping risk due to overcrowding on the platform, having station staff present to undertake platform management duties was identified as the suitable control measure (see paragraph 133). The risk assessment also mitigated the risk of trapping a customer attempting to access the train while the doors were closing, by requiring drivers to ensure there were no obstructions before departing.

126 For the risk of a customer being dragged along the platform at Ealing Broadway station due to a driver not following the dispatch process correctly, the risk assessment reduced this risk rating from high to medium by ensuring drivers completed their training, as part of the MTREL's competence management system.

127 MTREL's policy for the management of a train driver through their competence management system includes a mixture of practical assessments, where the driver is accompanied by a competent assessor, unobtrusive assessments in which the driver is either discreetly observed carrying out their duties, or a review of a sample of the driver's OTDR downloads.

128 The driver was on a three-year experienced driver competence management cycle which started on 19 January 2023. MTREL's competence management system recorded the driver had been involved in the following incidents:

- 15 February 2021 - saloon doors were closed before closed doors (CD) indication was given to the driver
- 24 September 2021 - driver failed to call at a station
- 29 January 2022 - signal passed at danger (SPAD)
- 26 July 2022 - doors released when train was off the platform.

129 Witness and documentary evidence shows the train driver had attended all required driver training. The driver had a general understanding of the risks from platform-train interface incidents, although not fully aware of the specific risk of passengers' hands becoming trapped and the train door system being able to obtain interlock (paragraph 113).

130 The MTREL driver training programme showed that the risks of trap and drag incidents were included within the training modules. Training sessions were also supported by a training module which reviewed historical incidents and learning from RAIB investigation reports relating to the platform-train interface.

131 The risk assessment did not identify the positioning of the yellow line, other markings or safety signage to encourage passengers not to walk or wait in the narrowed area by the waiting room. Platform markings had been applied on the platform at some point by the previous station facility owner, probably to deter passengers from waiting in the narrowed area, but this had worn away and was not clearly visible (figure 15). In addition, the risk assessment did not identify a need to effectively manage, monitor or report issues with the DOO cameras to ensure that images being provided to drivers were optimal.

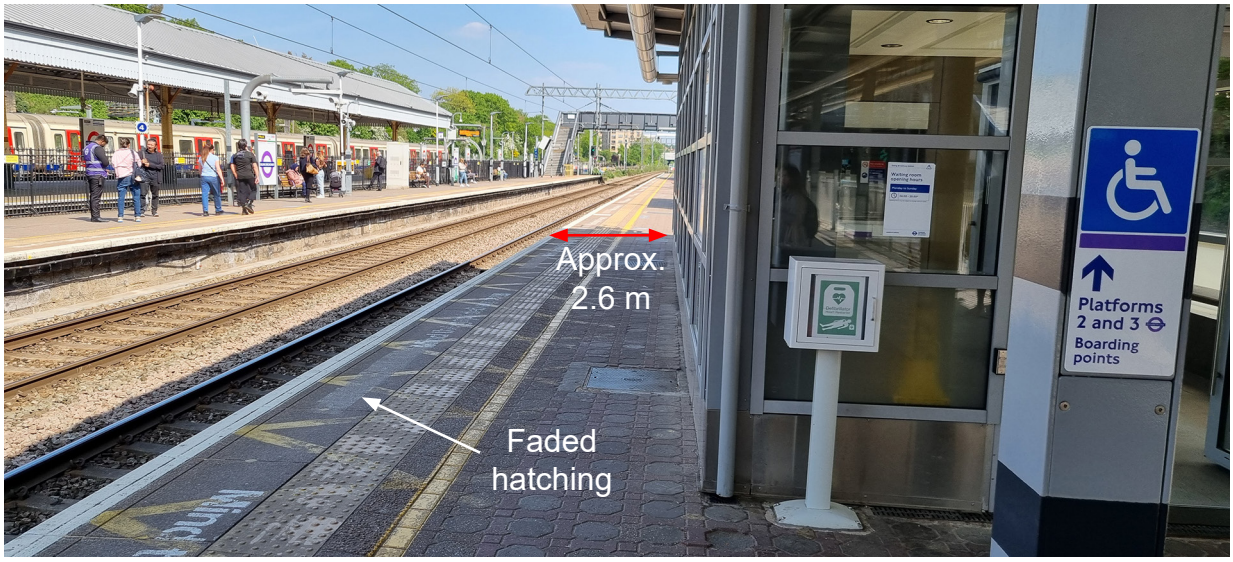

Figure 15: The waiting room and narrowest point close to where the trap occurred.

132 MTREL categorised Ealing Broadway station as '*high risk*' due to expected passenger numbers of around 21,000 per day. It considered rush hour/peak times at Ealing Broadway station to be between 07:00 and 10:00 on platform 4 (trains to London) and between 16:30 and 19:00 on platform 3 (trains from London), from Monday to Friday. MTREL informed RAIB following the accident that it did not originally consider late night trains on weekends to be '*peak time*' services, but it was aware that data had showed since then that year-on-year passenger numbers were increasing above expectation, including on late night services.

133 MTREL subsequently rostered additional CEAs to manage the platforms at Ealing Broadway station during peak times. However, this control measure was not applied outside the defined peak periods, and additional staff were not present on DOO trains. At weekends, MTREL considered one CEA was an effective control measure to manage duties on platform 3 during late night periods (23:30 to 06:30). MTREL did not appear to have considered that higher numbers of passengers may be present during this period or other issues which can make the management of platform duties during weekend late night services more problematic. Witness evidence indicates that CEAs frequently encountered passengers who were under the influence of alcohol and that those passengers were less receptive and responsive to safety advice.

134 The new waiting room building was relocated and built before MTREL undertook its dispatch risk assessment. However, the narrowed area was not identified as posing any additional risks, even though the width of the platform was very close to the minimum requirements (paragraph 35) and congestion in the area was not uncommon at peak times (paragraph 132).

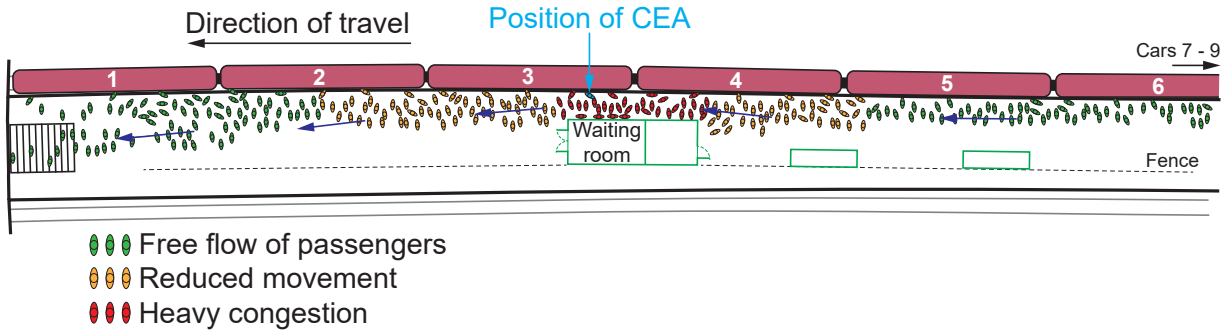

Figure 16: Passenger flow from the train and movement of passengers towards the station exit.

135 Although a testing programme was undertaken by the MTREL DOO CCTV commissioning team to ensure the DOO CCTV was compliant with the Crossrail standard before entering into service, RAIB could not find any additional assessments undertaken on the DOO CCTV system following the works undertaken to relocate the waiting room building in 2020 or the further infrastructure changes to platform 3 completed in 2023 (paragraph 34).

136 MTREL advised RAIB that the DOO CCTV system is under remote monitoring for predictive and preventative maintenance including three-monthly camera alignment checks using a 'shot book' of required images for comparison with the actual images presented.

Relocation of the waiting room building on platform 3

137 Network Rail was unable to provide evidence of a thorough risk assessment on the operational impact of relocating the waiting room building. This is a possible underlying factor.

138 The new passenger waiting area was constructed in 2020. All relevant train operators at Ealing Broadway station, including MTREL, were consulted on the planned changes in March 2019 in accordance with their station access agreement. No issues were raised by MTREL (or any other operators) relating to the proposed waiting room building change when it was proposed.

139 Network Rail initially advised RAIB that it believed the footprint of the building was unchanged from the original building design (paragraph 33). However, analysis of images taken as part of the 2018 CCTV detailed design report, compared to images taken from 2020, clearly show the earlier design is brick-built construction and is a greater distance from the platform edge. Whereas the new building appears to be longer, wider, constructed from different material and located closer to the platform edge (figure 17).

140 Network Rail was unable to confirm the dimension differences between the old and new buildings or provide a suitable risk assessment for the impact of the change. However, analysis of the images and measurements taken by RAIB shows the location of the new waiting room building is at least 0.7 metres closer to the platform edge than the old one.

141 There is no documentary evidence to show that Network Rail had undertaken any operational risk assessment in relocating the new waiting room building, or if any consideration had been given to potential changes in passenger flows and subsequent risk to platform-train interface. It is, therefore, not possible to determine how the risks associated with a narrowed platform adjacent to the revised waiting room were understood (paragraph 80).

Figure 17: Old waiting area building (taken in 2018) and the new building (taken in 2020) (courtesy of Network Rail).

Factors affecting the severity of consequences

142 The consequences of the trap and drag would probably have been worse without the actions of the CEA and other passengers.

143 It is probable that, had it not been for the timely action of a passenger on the platform and the CEA, who both acted to pull the trapped passenger from the door, the outcome of the accident would have been more serious (paragraph 54).

144 CCTV recordings of the accident and witness evidence show that there were also actions taken by other passengers on the platform to gain the driver's attention (paragraph 55).

Observations

Safety-critical communication

145 Safety-critical communications between the MTREL staff involved, the signaller and control did not lead to a common understanding of the accident that had occurred.

146 Rule Book GERT8000, Module G1 'General safety responsibilities and personal track safety for non-trackworkers' (issue 9.1, dated 2022, was in force at the time of the accident). It sets out the hierarchy for who should take the lead and provides guidance for ensuring a clear understanding is reached before any communication is ended. The module emphasises the importance of repeating back information to confirm a mutual understanding.

147 Rail Industry Standard RIS-8046-TOM 'Spoken Safety Critical Communications', issue 2 dated 2019, also emphasises the requirement to know when to be assertive and the importance of having the confidence to challenge any misinformation or decisions.

148 Voice recordings of calls and witness evidence show that various opportunities to confirm and clarify information between the CEA, train driver, signaller and DCM were missed. In the conversations with the train driver, neither the signaller nor the DCM led the conversation to ensure information was understood by both parties. In addition, messages were not repeated back when details on what had happened were still unclear (paragraphs 57 to 63). As a result, no clear understanding of what had happened was established and this affected how the accident was managed.

Passenger Announcements

149 The effectiveness of public address as a control measure to reduce the risk of incidents at the platform edge was reduced.

150 PA announcements by the CEA are intended to be a platform management duty (paragraph 116). PA announcements were recorded in the MTREL risk assessment as a control measure to prevent trap and drag incidents.

151 However, witness evidence shows that staff working on platform 3 were unable to make PA announcements along the length of the platform due to poor signal/connection issues with the handheld equipment. Choosing to use the desk-based PA system from within the CEA office would result in staff not being present on the platform to assist passengers.

152 Reception 'black spots' with the handheld PA equipment on platform 3 were also observed by RAIB during post-accident visits. Witness evidence suggests staff were also reluctant to use the system late in the evening and at night due to expected noise complaints from residents who lived close to the station.

153 RAIB has not been provided with any evidence of any PA related issues being raised by staff to MTREL or of any faults identified by MTREL with the PA system before the accident occurred.

Investigation management

154 MTREL did not ensure that the recommendations from its internal investigation into the accident were managed effectively.

155 MTREL's investigation into the accident resulted in four internal recommendations.

156 During the RAIB investigation, MTREL was asked to provide information relating to the progress and tracking of its recommendations. MTREL reported that its assurance processes to ensure recommendations had been correctly assigned, that achievable timeframes were allocated, and that recommendations were tracked through to completion with appropriate progress indicators had not been applied effectively.

157 MTREL subsequently took action to resolve the issues identified (see paragraphs 183 to 186).

DOO CCTV standards

158 Crossrail and rail industry standards do not mandate that the testing and commissioning of DOO CCTV replicate a realistic platform environment.

159 The DOO CCTV at Ealing Broadway station was assessed during its commissioning against internal Crossrail standard CCTV C160-MMD-R1-RGN-CR001-50043 rev 2.0, issued in 2013. As required by the standard, a non-intrusive survey was first undertaken in early 2017 with digital models produced for proposed camera locations and perceived camera coverage (figure 18). The full detailed design assessment was then signed off in April 2017.

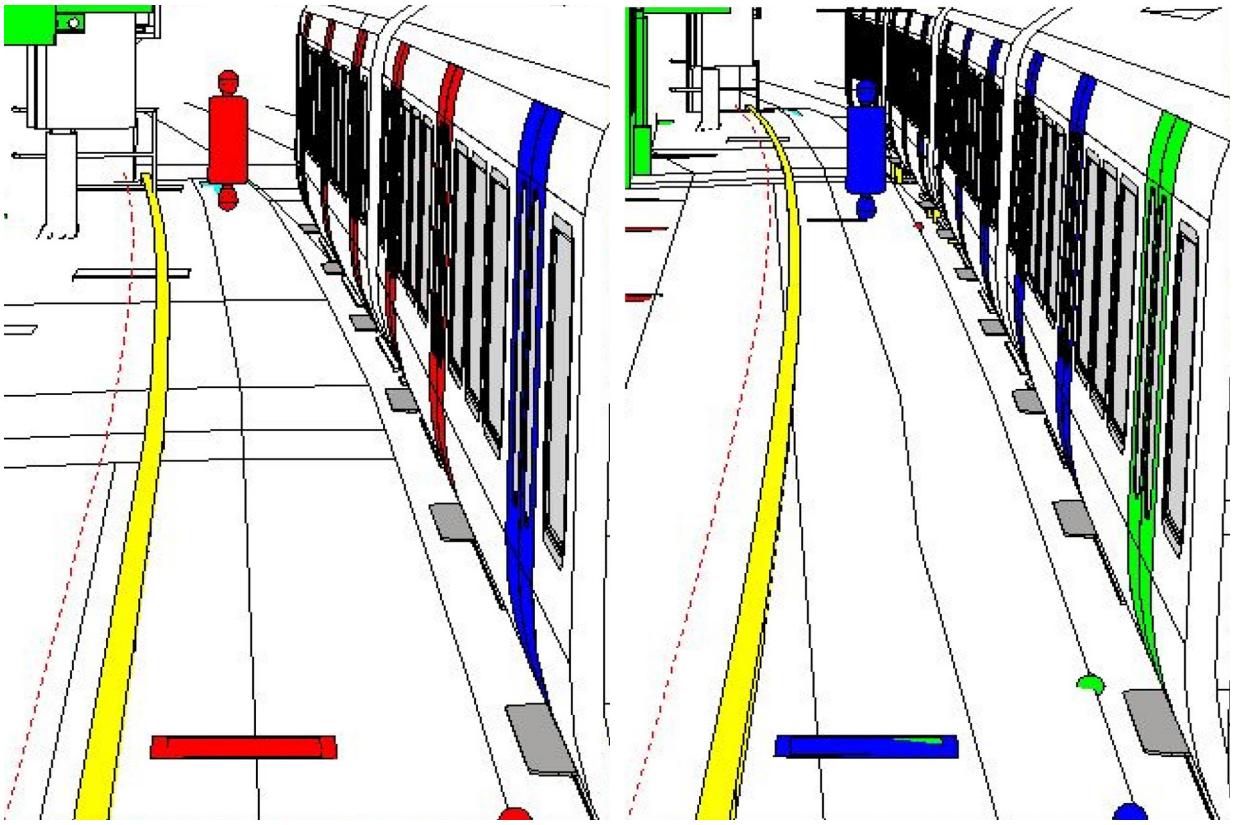

Figure 18: The digital representation of the DOO CCTV from the detailed design undertaken by Network Rail (courtesy of Network Rail).

160 The Crossrail requirements for the DOO CCTV assessment included the use of a Rotakin test target (a life-size cut-out resembling an average person with a height of 1.6 metres) to assess the performance of the CCTV system. The Rotakin test target comes from British Standard BS EN 50132-7:1996 'CCTV surveillance systems for use in security applications - Application guidelines', issued in 1996. The Home Office developed the standard to assess security CCTV camera performance, particularly in the context of identifying moving objects or individuals in various scenarios. Although it was not designed specifically for the rail industry, its methods, particularly the use of the Rotakin test target, were adopted and have been used by the rail industry for the past 20 years.

161 The Rotakin test target was used during the full site surveys on platform 3 to determine that the target image height (%Rotakin) was achieved throughout the coverage area for each camera. Image quality and other required performance criteria were applied. The process included placing the test target along the platform at various points to confirm that a complete image of the test target was visible in at least one DOO monitor at the nearest and furthest point of the platform. These assessments during the design stages were undertaken in a railway possession (with no trains running or passengers at the station) and with no train berthed in the platform.

162 A report on the DOO CCTV testing by MTREL prior to operational proving was produced in April 2018 and the system was assessed as compliant. This testing included the use of a test train in the platform and a small child sized target to replicate an unaccompanied child and did not rely solely on the Rotakin test.

163 Rail Industry Standard RIS-2703-RST, 'Driver Controlled Operation (DCO) On-Train Camera/Monitors (OTCM)', issue 1 dated 2014, and RIS-8060-CCS, 'Engineering Requirements for Dispatch of Trains from Platforms', issue 1 dated 2017, both applicable standards at the time of the DOO CCTV testing and commissioning, set out requirements for the function, design and testing of DOO camera and monitor systems used for the dispatch of trains from station platforms. They provide information on creating likely platform-train interface incident scenarios to determine the effectiveness and quality of the CCTV view for a driver in certain environments and guidelines on the Rotakin test respectively. They do not require the testing and commissioning stage to introduce a realistic platform environment.

164 While the use of the Rotakin test target can provide some assurance on visibility and image quality, it does not in itself consider the practical and realistic passenger/train environment (such as congested platforms) and the effect that this may have on a train driver's view to support the final safety check. The view provided to the driver on their in-cab monitors of platform 3 just before the accident occurred (figure 19), shows the impact a busy platform can have.

Figure 19: DOO camera positioning on platform 3 and actual view available to driver at 00:09 (images courtesy of MTREL).

Previous occurrences of a similar character

165 On 17 July 2024, a passenger's hand became trapped in the doors of a train at Enfield Town station in north London (RAIB safety digest 09/2024). The passenger had hurried towards the train as the doors were closing and placed their hand between the doors while attempting to board. The train subsequently departed from the platform with the passenger's hand still trapped in the doors. The passenger was forced to run alongside the train, until eventually losing their footing while being dragged along the platform by the accelerating train.

166 Passengers on the train alerted the driver by operating emergency door release handles. The driver then stopped the train and released the doors, allowing the passenger to free their hand. During the accident, the train travelled approximately 60 metres and reached a speed of 11 mph (18 km/h). The passenger was taken to hospital, having sustained minor injuries and also suffered psychological distress. The train involved was not fitted with sensitive edge door technology or an anti-drag system.

167 RAIB's safety digest stated that the evidence from this accident, and other incidents involving class 710 Aventra trains, suggested that the door seals on this class of train may make it difficult for passengers to pull themselves free once their hand becomes trapped.

168 On 14 May 2023, at Green Park station on LUL's Jubilee line, a passenger's clothing became trapped in the closing door of a train as they attempted to board it. CCTV footage showed that the passenger did not attempt to pull the clothing from the door. The passenger was subsequently dragged along the platform for approximately 12 metres before the clothing became released and they fell to the ground, sustaining injuries. They were taken by ambulance to hospital. The passenger had attempted to board the train as the doors were closing, but the train operator did not see the passenger and the train departed from the station. An investigation undertaken by LUL found that the injured passenger was obscured by other passengers on the platform, their image was small on the in-cab monitor, and the platform on the day was very busy.

169 On 20 April 2023, a passenger's coat became trapped in the doors of a London Underground train at Chalk Farm station (RAIB report 06/2024). The passenger had attempted to board the train but stopped as the doors began to close. The doors closed while the passenger was still close to the train, trapping their coat. The train then departed, dragging them along the platform. The train travelled for approximately 20 metres until the coat became free, and the passenger fell to the ground. The passenger sustained minor physical injuries to their left elbow and both knees and psychological distress.

170 This accident occurred because the passenger's coat became trapped in the train doors as they boarded the train and because the train's door control system did not detect the presence of the trapped coat. RAIB's investigation identified an underlying factor that London Underground's management of the safety of the platform-train interface was not sufficiently effective at controlling the risks to passengers being trapped and dragged.

Summary of conclusions

Immediate cause

171 The train departed with the passenger's hand trapped in the doors.

Causal factors

172 The causal factors were:

a. The driver closed the doors while passengers were still attempting to leave and board the train (paragraph 75) **Recommendations 1, 2 and 4**, **Learning point 2**.

b. The passenger attempted to board the train while the doors were closing (paragraph 88), **Recommendations 1 and 3**.

c. The train's door detection system did not prevent the passenger's hand from becoming trapped in the closing doors (paragraph 96), **Recommendation 3**.

d. There was no intervention before the train departed (paragraph 110), **Recommendation 1, 3 and 4**.

Underlying factors

173 The underlying factors were:

a. The measures used by MTREL to control the risks of a passenger being trapped in closing doors and dragged were not sufficiently effective (paragraph 121), **Recommendation 1**.

b. Network Rail was unable to provide evidence of a thorough risk assessment on the operational impact of relocating the waiting room building. This is a possible underlying factor (paragraph 137), **Recommendation 5**.

Factors affecting the severity of consequences

174 The consequences of the trap and drag would probably have been worse without the actions of the CEA and other passengers (paragraph 142).

Additional observations

175 Although not directly linked to the cause of the accident, the RAIB observed:

a. Communication

- Safety-critical communications between the MTREL staff involved, the signaller and control did not lead to a common understanding of the accident that had occurred (paragraph 145), **Learning point 1**.

- The effectiveness of public address as a control measure to reduce the risk of incidents at the platform edge was reduced (paragraph 149), **Recommendation 1**.

b. Investigation management

- MTREL did not ensure that the recommendations from its internal investigation into the accident were managed effectively (paragraph 154), **no recommendation**.

c. CCTV standards

- The Crossrail and rail industry standard used to commission the DOO CCTV did not mandate that testing and commissioning replicate a realistic platform environment (paragraph 158), **Recommendation 4**.

Previous RAIB recommendations relevant to this investigation

176 The following recommendations, which were made by RAIB as a result of its previous investigations, have direct relevance to this investigation. They were made to London Underground, which is part of TfL, as is the Elizabeth line, and relate to trap and drag events.

Trap and drag accidents at Archway and Chalk Farm stations,18 February and 20 April 2023, RAIB report 06/2024, Recommendation 2

177 Recommendation 2 reads as follows:

> *The intent of this recommendation is to further reduce the risk of a person becoming trapped in train doors and subsequently dragged by a departing train.*
>
> *London Underground Limited should identify and evaluate options which may further reduce the risk of a passenger becoming trapped and subsequently dragged by a departing train. This should include consideration of options including:*
>
> - *technology that will detect when thin objects, such as fingers, straps or clothing, become trapped in train doors*
> - *modifying door seals to make it easier for small, trapped objects, such as clothing and straps to be pulled free from closed doors*
> - *using technology to detect when something is being dragged along by the departing train and to generate an appropriate response when this has occurred*
> - *improving the images presented to train operators on in-cab monitors to enable them to identify whether a passenger is potentially trapped in the closed doors by clothing or other small objects.*

178 In June 2025, ORR reported to RAIB that this recommendation was ‘closed’.

179 ORR reported that London Underground had identified and evaluated options for reducing the risk of trap and drag incidents, including modifying door seals. London Underground had also initiated a project to improve the train operator’s (driver’s) view of the platform-train interface, by improving the quality of the image provided by their monitors. London Underground had considered retrofitting sensitive edge door technology to train fleets not currently equipped with it but concluded the cost would be grossly disproportionate to the safety benefit.

Passenger trap and drag Holborn, February 2014, RAIB report 22/2014, Recommendation 1

180 Recommendation 1 reads as follows:

> *The intention of this recommendation is that staff performing the SATS role should be properly equipped to reduce risks at the platform/train interface by being able to take effective action to stop trains in an emergency. Consideration of how this can best be achieved should take into account the possibility that the waving of two hands in the ‘emergency stop’ signal is not sufficiently conspicuous on a crowded platform.*

London Underground Ltd should provide staff acting as Station Assistant (Train Services) (SATS) with an effective means of alerting the train operator to a dangerous situation that arises after the SATS has given the signal to start the door closing sequence, and before the train has begun to move.

London Underground Ltd should also review how the role of the SATS is described in Rule Book 8 and other company documents, so that the duty of the SATS to rapidly respond to dangerous events that occur during the despatch process is given appropriate emphasis.

181 In June 2015 ORR reported to RAIB that this recommendation was 'part-implemented'.

182 ORR reported that London Underground had held a workshop in which additional effective methods by which station assistants could alert train operators to dragging incidents had been considered. London Underground's view was that none of the options identified could be justified as offering a 'reasonably practicable' alternative.

183 London Underground also reported that it had reviewed how station assistant duties are described in the Rule Book and other company documents to emphasise that a train should be immediately and rapidly stopped in an emergency using the methods presently available to do so.

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

Actions reported that address factors which otherwise would have resulted in an RAIB recommendation

184 MTREL undertook post-accident safety briefings with the driver, CEA, signaller and DCM which included the requirements and importance of safety-critical communications.

185 MTREL assigned a development action plan with the driver involved in the accident in line with their competence management system.

186 All investigation recommendations are allocated a unique reference number on the GTS accident report recommendations tracking database. The safety team administers the database, and each recommendation is allocated to a responsible owner with a close-out date. Overdue actions are reviewed and managed at the GTS Safety Executive meetings. GTS has produced a new reportable accident procedure and reviewed and updated its investigation management standard and procedures.

Other reported actions

187 GTS has reported that additional announcements are now being made during peak times at Ealing Broadway station. There is now a requirement for a CEA to be located adjacent to the waiting room at peak times. However, this requirement has not been applied during late-night services.

188 GTS installed signage that warns customers to stay behind the yellow line (June 2025). Yellow paint has been reapplied along the narrowed section of the platform outside the waiting area with new ‘move along platform’ markings applied to the platform surface (October 2025).

Recommendations and learning points

Recommendations

189 The following recommendations are made:[4]

1 *The intent of this recommendation is to improve how the risk associated with trap and drag events is understood and controlled on the Elizabeth line*.

Based on the findings of this report, GTS Rail Operations should undertake a risk-based assessment of its measures for controlling risk at the platform-train interface on the Elizabeth line stations for which it is the station facility owner. The review should include, but not be limited to:

- understanding how passenger flow on platforms can be affected by factors such as platform structures and width, passenger numbers (including outside of peak hours) and the presence of staff
- evaluating whether there are sufficient resources and effective methods of communication between staff and passengers during peak and off-peak times
- ensuring that staff can effectively communicate with train drivers in the event of an emergency
- reviewing the functionality of station and handheld PA equipment to identify any local factors which may impact their effectiveness as a measure to manage platform safety.

GTS Rail Operations should develop a timebound programme to make any changes identified as appropriate by this review.

This recommendation may be applicable to Elizabeth line stations managed by other station facility owners (paragraphs 172a, 172b, 172d, 173a and 175a).

[4] 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.

2 *The intent of this recommendation is to enhance the views captured on DOO CCTV and presented on in-cab monitors to minimise the possibility of a train driver being unaware of problems at the platform-train interface on the Elizabeth line*.

Transport for London, working in conjunction with GTS Rail Operations and other relevant station facility owners, should:

- Assess if the images of the platform-train interface provided to train drivers remain sufficient to effectively monitor the safety of the platform-train interface given the presence of platform structures and crowds. This should consider if improved/additional images of specific locations may provide drivers with a greater opportunity to identify whether a passenger is potentially trapped in the closed doors and then dragged.
- Establish a system for ensuring that images of the platform-train interface provided to train drivers remain sufficient to effectively monitor the safety of the platform-train interface following changes to platform structures, or to other infrastructure, that could affect camera views or the flow and/or distribution of passengers on the platform.

Transport for London should develop a timebound programme to make any changes identified as appropriate by this review (paragraph 172a).

3 *The intent of this recommendation is to further reduce the risk of a person becoming trapped in train doors and subsequently dragged by a departing train on the Elizabeth line*.

Transport for London should identify and evaluate options which may further reduce the risk of a passenger becoming trapped and subsequently dragged by a departing train on the Elizabeth line. This should consider:

- current and future technologies that will detect when thin objects, such as fingers and hands, become trapped in train doors
- technology that will detect when something is being dragged along by a departing train and to generate an appropriate response when this occurs
- consider any additional passenger education initiatives that could improve awareness of trap and drag risks.

Transport for London should consider whether developments being undertaken by London Underground in response to recommendation 3 of RAIB report 06/2024 ‘Trap and drag accidents at Archway and Chalk Farm stations’ could also be applied to trains on the Elizabeth line.

Transport for London should develop a timebound programme to make any changes identified as appropriate (paragraphs 172b, 172c, and 172d).

4 *The intent of this recommendation is to ensure the rail industry standard for driver only operation CCTV incorporates the latest practice*.

The Rail Safety and Standards Board, in conjunction with relevant industry transport undertakings or station franchise operators, should review rail industry standards RIS-2703-RST issue 2 'Driver Controlled Operation (DCO) On-Train Camera/Monitor (OTCM) systems' against relevant CCTV standards and good practice, both within the UK and internationally. This is to understand if the use of a test target on empty platforms remains an appropriate method for assessing the image quality of CCTV systems and if there are potentially more effective assessment techniques available that could be adopted.

The Rail Safety and Standard Board should update Rail Industry Standard RIS-2703-RST with any appropriate changes identified by this review (paragraphs 172a, 172d and 175c).

5 *The intent of this recommendation is to ensure changes made to platforms on stations owned by Network Rail do not impact the safety of railway operations and passenger safety*.

Based on the findings of this investigation, Network Rail should review whether relevant standards, procedures and guidance are being effectively applied to changes made to the infrastructure on platforms at stations owned by Network Rail. This review should specifically consider processes relating to risk assessment, change management controls, and approvals.

Network Rail should develop a timebound programme to make any changes identified as appropriate by this review (paragraph 173b).

Learning points

190 RAIB has identified the following important learning points:[5]

1 This accident demonstrates the importance of effective safety-critical communications in ensuring both parties have correctly understood the information and any decisions that have been made (paragraph 175a).

2 This accident is a reminder of the importance of the final safety check for drivers, ensuring sufficient time is allocated to checking the platform-train interface is safe both before door closing and after the door interlock is made and before taking power (paragraph 172a).

[5] 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where 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

Abbreviation / acronym	Term in full
CBTC	Communications-based train control
CEA	Customer experience assistant
CEC	Customer experience control
DCM	Duty control manager
DCO	Driver controlled operation
DOO	Driver only operation
EMU	Electric multiple unit
ETCS	European train control system
GSM-R	Global System for Mobile Communications for Railway
GTS	GTS Rail Operations
MTREL	MTR Elizabeth line
ORR	Office of Rail and Road
PA	Public address
PTI	Platform-train interface
PEA	Passenger emergency alarm
RfL	Rail for London
TfL	Transport for London

Appendix B - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- voice communication recordings
- information taken from the train's OTDR
- station and DOO CCTV recordings
- site photographs, videos, and measurements
- weather reports and observations at the site
- standards, procedures, and O&M manuals
- train specifications and manuals
- internal investigation reports
- a review of previous reported incidents on the Elizabeth line
- a review of previous RAIB investigations that had relevance to this accident.

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