Rail Accident Report

**Trap and drag accidents at Archway and Chalk Farm stations
18 February and 20 April 2023**

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.

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.

This page is intentionally left blank

Trap and drag accidents at Archway and Chalk Farm stations, 18 February and 20 April 2023

Contents

Summary

On Saturday 18 February 2023 at around 15:50 hrs, a passenger became trapped in the door of a Northern line train at Archway station. The passenger was exiting the train using a single leaf door at the rear of the fifth car when the door began to close on them, and their coat became trapped. The train departed and the passenger was dragged for approximately 2 metres along the platform before falling to the ground and the coat became free of the door. The passenger's companion, who was holding on to them at the time, also fell to the ground. The train travelled approximately 20 metres until it stopped after the train operator became aware of the passenger being dragged and applied the brakes. The passenger sustained serious injuries and their companion was uninjured.

The accident occurred because the passenger's coat had become trapped in the door as the passenger alighted, and because the train's door control system did not detect the presence of the coat trapped in the door. Although the train operator was aware of the passenger and their companion, they were not aware that the passenger's coat was trapped before they initiated the train's departure. The train operator was not aware that the pilot light, which indicates that the train's doors are closed, could still illuminate with something trapped in closed doors.

On Thursday 20 April 2023 at around 23:03 hrs, a passenger's coat became trapped in the doors of a Northern line service at Chalk Farm station. 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 train operator was unaware of the accident and continued the journey. The passenger sustained minor physical injuries to their left elbow and both knees and psychological distress.

This accident also 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. However, in this accident, the train operator was not aware of the passenger nor that their coat was trapped in the doors before initiating the train's departure. They were also unaware that the passenger was subsequently being dragged along by the train.

The investigation identified underlying factors associated with both accidents. It is possible that the train operators' actions may have been affected by the automatic train operation system in use on the Northern line. Also, the methods for managing the safety of the platform-train interface were not sufficiently effective at controlling the risks to passengers by getting their clothing trapped in closing doors.

RAIB has made four recommendations addressed to London Underground Limited and made three learning points. The recommendations concern the understanding of risk arising from trap and drag events, the risk mitigation options, the minimum station dwell times and how the design of the task and the cab environment can influence train operators' attention and awareness.

The first learning point concerns the importance of documenting action plans in accordance with company procedures and recording when safety briefings have been undertaken. The second learning point concerns the importance of promptly reporting notifiable accidents to RAIB. The third concerns the importance of trainers and managers ensuring the risks of relying on the pilot light when deciding whether it is safe to start the train from platforms are completely understood by train operators.

Summary

Introduction

Definitions

1   Metric units are used in this report, except when it is normal railway practice on London Underground 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   Both accidents were reported to RAIB some time after they occurred (paragraph 150). This delay led to a loss of data from some monitoring and recording systems. The timings used in this report relating to the movement and operation of the trains involved in the accidents are therefore based on RAIB's analysis of the remaining data sources. The timestamps used by those systems for which data is available have been synchronised with that used by one of the station CCTV recordings on the relevant platforms.

The accidents

Summary of the accidents

4   At around 15:50 hrs on Saturday 18 February 2023, a passenger became trapped in the door of a Northern line train at Archway station. The passenger was leaving the train using a single-leaf doorway at the rear of the fifth car, when the door began to close. The passenger's coat became caught in the closed door. The train then departed, and the passenger was dragged along the platform for approximately 2 metres before falling to the ground, at which point the coat became free of the door. The passenger was travelling with a companion who held onto the passenger as they both fell to the ground. The train travelled a total of approximately 20 metres until it was stopped by the train operator when they became aware that the passenger was being dragged.

5   The passenger, who was 101 years old, sustained serious injuries and has continued to suffer from the effects of the accident. The companion travelling with them was uninjured.

6   At around 23:03 hrs on Thursday 20 April 2023, a passenger became trapped in the doors of a Northern line service at Chalk Farm station. The passenger had approached the last set of doors on the rear car of the train from the stairs located at the rear of the platform, known as the tailwall end. The doors were closing as the passenger approached them and attempted to board the train. Although the passenger did not board, their coat became trapped in the closed doors. The train then departed dragging the passenger along the platform. The train travelled for approximately 20 metres until the coat became free, as the passenger fell to the ground. The train operator was unaware of the accident and the train continued its journey.

7   The passenger in this second accident sustained minor injuries but did not require further medical assistance at the time. They have subsequently experienced psychological distress due to the accident.

Context

Locations

8   Both accidents occurred on the Northern line of the London Underground. The Northern line runs between north and south London. It has two branches in the south, serving Battersea Power Station and Morden. It also has two routes through central London, via Charing Cross and via Bank and two main branches in the north, serving Edgware and High Barnet. A further branch off the High Barnet line serves Mill Hill East.

9   Archway station is a deep-level tube station located in the London Borough of Islington, approximately 4 miles (6.4 km) north of central London. The accident occurred on platform 1, the northbound platform, used by trains going to High Barnet or Mill Hill East. Platform 1 is relatively straight (figure 2).
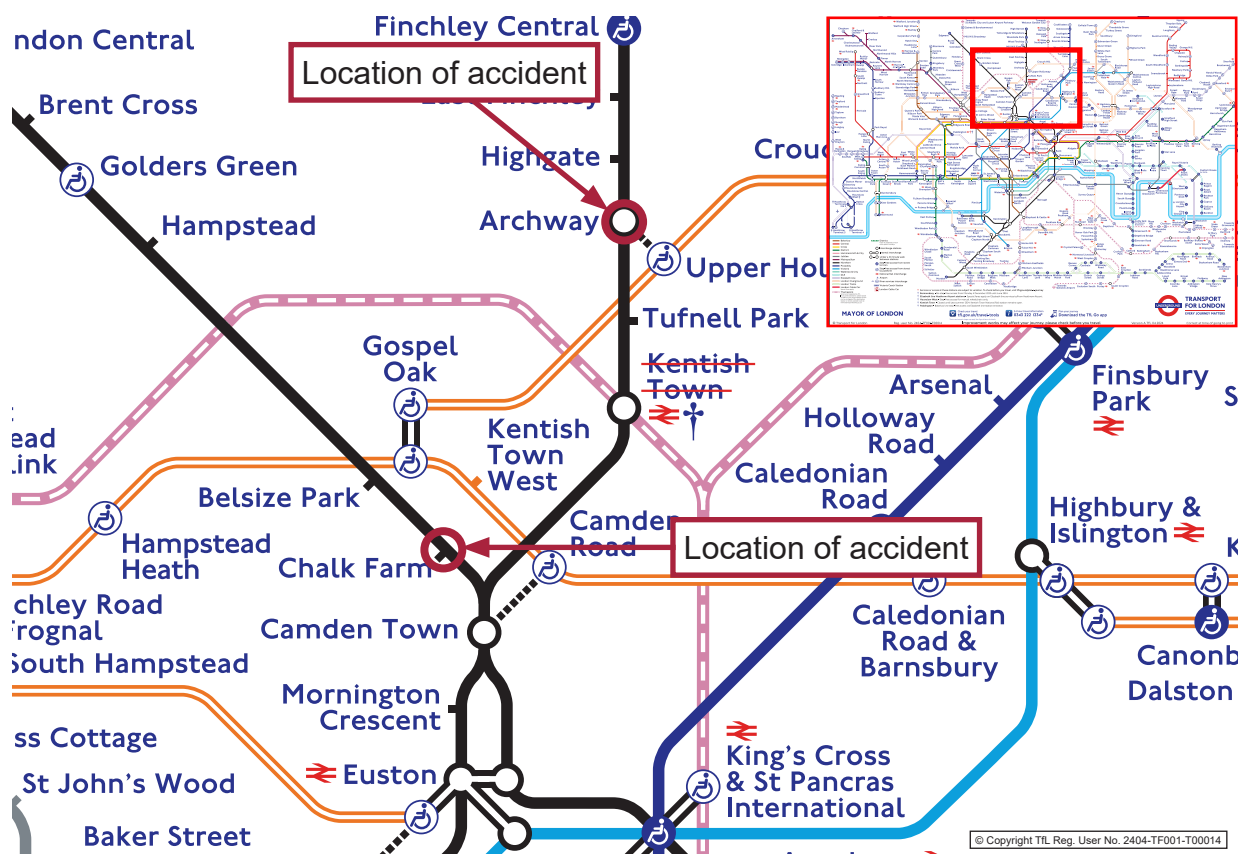
Figure 1: Extract from London Underground map showing location of both accidents (courtesy of Transport for London with RAIB annotations).

10   Chalk Farm station is also a deep-level tube station, on the Edgware branch of the Northern line. It is located near Camden Town in the London Borough of Camden, approximately 3 miles (4.8 km) from central London. The accident at Chalk Farm station occurred on platform 2, which is for southbound trains. Passengers enter and exit the platform via stairs at the tailwall end of the platform (figure 3).

11   Closed-circuit television (CCTV) cameras, located on the platforms at Archway and Chalk Farm, supply images to a monitor in the driving cabs of trains. These images start to be displayed to the train operator before a train stops in the platform and remain displayed until the last car has left the platform. These images are displayed live but recordings are only retained for around two weeks, so were not available to RAIB due to the late reporting of the accidents (paragraph 150).

Organisations involved

12   London Underground Limited (LUL), a wholly owned subsidiary of Transport for London, is the operator of Northern line trains and infrastructure. It also employs the train operators of the Northern line trains involved.

13   Alstom Transport UK Ltd (Alstom) built and maintains the trains involved. Alstom is also part of a consortium which leases the trains to LUL.

14   The organisations involved freely co-operated with the investigation.
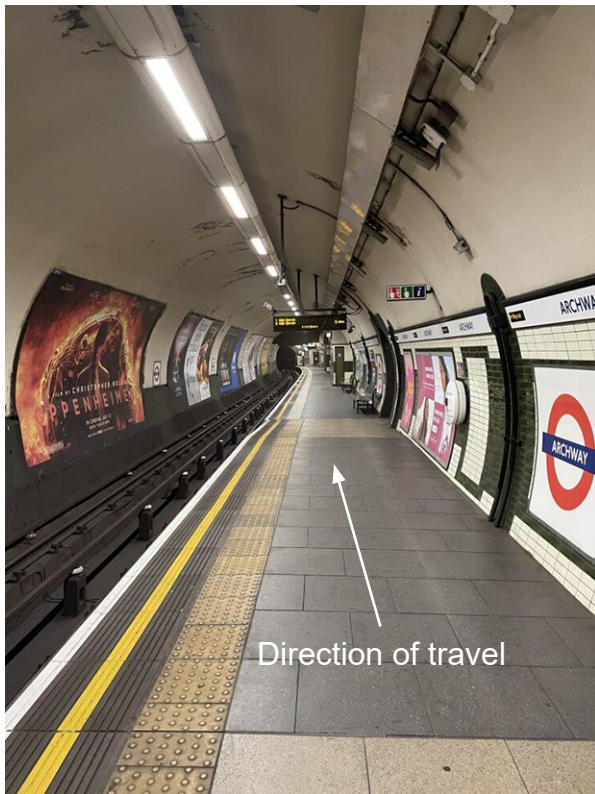
Figure 2: View northbound from the west (tailwall) end of platform 1 at Archway.
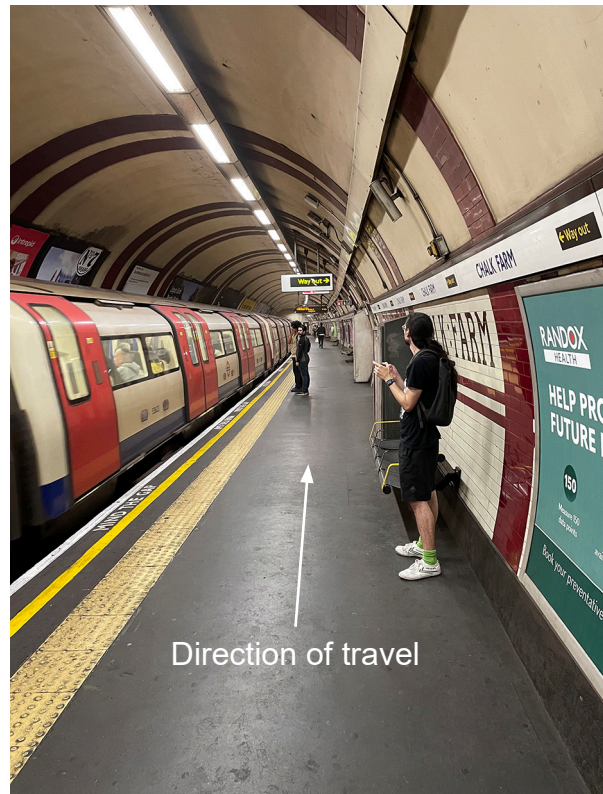
Figure 3: View southbound from the west (tailwall) end of platform 2 at Chalk Farm.

Trains involved

15   Both trains were formed of London Underground 1995 tube stock. This type of train operates all services on the Northern line. Each train consists of six cars, comprised of two three-car sets coupled together. On both sides of each car there are two sets of sliding double doors towards the centre, and two single doors, one at each end of the car. The single doors at the front and rear of each six-car train allow access to the driving cab are for the train operator's use only.

16   The Archway train, running number 072, formed the northbound Northern line service from Morden to High Barnet which was due to arrive at Archway station at around 15:49 hrs. It was running approximately 36 seconds behind the timetable.

17   The Chalk Farm train, running number 137, formed the southbound Edgware branch service due to arrive at Chalk Farm station at around 23:02 hrs. It was running approximately 75 seconds behind the timetable.

18   On the Northern line, trains are normally controlled by automatic train operation (ATO) (paragraph 50).

People involved

19   The Archway train operator joined LUL in 2014 working on stations and began driving part-time on the Night Tube in 2019. They then took up a full-time position as a train operator on the Northern line in 2020.

20 In accordance with LUL's competence management system, the train operator had undergone periodic assessments. These had been generally positive. They had been involved in a safety-related incident in 2021 when a passenger was momentarily caught in the doors while trying to board their train (see paragraph 74).

21 The Chalk Farm train operator had worked for LUL for 20 years and had been working on the Northern line for 13 years. Before this they worked on the Jubilee line as a train operator. Competence assessment feedback had been positive overall, but they had also experienced a previous platform-train interface (PTI) incident in 2019 (see paragraph 133).

External circumstances

22 External circumstances did not play a part in either of the accidents.

The sequence of events

Events preceding the accident at Archway station

23 The train operator began their duty from High Barnet at 08:28 hrs on the morning of the accident. They operated trains until their break, between 13:05 and 13:35 hrs. They then operated a train from High Barnet to Morden before returning towards High Barnet at 15:02 hrs.

24 The passenger was travelling with their companion. Both regularly travelled on London Underground and were familiar with the Northern line. They boarded the train at Moorgate at approximately 15:33 hrs.

25 As the train approached the station, the passenger, who was wearing a coat which was unzipped, and their companion moved to the door area to be ready to alight.

26 The on-train data recorder (OTDR) shows that the train stopped at Archway station at around 15:49:51 hrs. The train operator opened the passenger doors using push-buttons in the driving cab two seconds after the train had stopped.

27 Four seconds after the doors were completely open, the train operator initiated the doors close sequence using the doors close push-buttons in the driving cab. The door closing sequence takes about five seconds. For the first two seconds a door chime sounds at each passenger doorway to warn passengers the doors are about to close, after which the doors begin to move and reach their closed position approximately three seconds later. The doors had remained completely open for about six seconds before they began to close.

28 Comparison of CCTV and OTDR shows that, at the point that the doors close buttons were operated, the companion was visible in the doorway exiting the train. The passenger was still alighting from the train when the door closed on them. They managed to pull themselves free but the coat they were wearing became trapped in the door. The passenger and their companion both realised that the coat was trapped and tried to pull it free but were unable to do so. They both believed that the train operator would be able to see them and would open the doors to release the coat.

Events during the accident at Archway station

29 When the doors closed, the 'doors closed' visual indicator in the driving cab, commonly known as the pilot light, illuminated indicating that the doors were closed and the train was able to start. The train operator was aware that the passenger and their companion were close to the train but was not aware that the passenger's coat was trapped in the closed doors. Believing it was safe to do so, the train operator commanded the train to depart.

30 As the train departed, the passenger and companion were dragged along the platform. After about 2 metres of being dragged they both fell to the ground. The companion tried to offer some protection by holding the passenger as they both fell. The combined weight of the falling passenger and companion pulled the coat free of the doors.

31 The train operator, who was observing the in-cab CCTV monitor, stated that they saw the passenger falling as the train was departing the station. They then made an emergency brake application to stop the train. The train came to a stop at 15:50:19 hrs.

Events following the accident at Archway station

32 Passengers travelling on the train operated a passenger emergency alarm (PEA) to alert the train operator, although by the time this occurred, the train operator had already taken action to stop the train. After the train had stopped, passengers on the platform operated a passenger help point to alert London Underground staff to what had happened.

33 The train operator called the Northern line controller to report what had happened. The Northern line controller then alerted LUL's network incident response manager and London Ambulance Service. The train operator was not tested for the presence of drugs or alcohol following the accident although it was required by LUL's process.

34 Passengers were subsequently detrained, and the train taken out of service and departed the station to return to the depot at 16:11 hrs.

35 At around 16:25 hrs, the injured passenger was moved by stretcher from the platform to the ticket hall, and approximately eight minutes later London Ambulance Service arrived to take the passenger to hospital for further treatment.

36 The accident was not reported to RAIB. Following the accident, LUL and Alstom examined the train. This included testing the operation of the door involved in the accident and its control circuits which were found to be operating correctly.

Events preceding the accident at Chalk Farm station

37 The train operator began their duty at 18:11 hrs on the evening of the accident at Morden depot. It was their last duty of the last shift in a block of seven days at work.

38 The passenger entered the London Underground network at Chalk Farm station, intending to travel home towards east London.

39 The OTDR shows that the train entered the southbound platform at around 23:03:22 hrs. The train operator opened the passenger doors using push-buttons in the driving cab. The doors began to open about three seconds after the train had stopped.

40 Approximately six seconds later, the passenger is visible on CCTV footage entering the platform from the stairway at the rear of the train. The passenger arrived on the platform and attempted to board the train at the rear set of double doors of car six as the doors were closing and the door chimes would have been sounding.

41 When the passenger realised the doors were closing, they stepped backwards on the platform. At this point, they realised that part of their unzipped coat had become caught in the doors. The passenger tried to pull the coat free from the doors but was unable to do so.

Events during the accident at Chalk Farm station

42 When the doors had closed and the pilot light had illuminated (paragraph 29), the train operator commanded the train to depart. The train departed the platform with the passenger's coat still trapped in the doors, dragging the passenger along the platform.

43 After travelling approximately 18 metres, the zip separated from the passenger's coat. The coat was then pulled through the edges of the door as the passenger fell to the ground. The train operator was unaware that the passenger was being dragged by the train, and so continued out of the platform and on to the next station.

Events following the accident at Chalk Farm station

44 Passengers on the platform came to the aid of the injured passenger and requested assistance from the station staff using the passenger help points. The passenger had sustained injuries to their left elbow and both knees in the accident.

45 The station staff accompanied the passenger to the control room for further assistance. The passenger was keen to get home, having a flight to catch early the next morning, and so declined further medical attention.

46 The accident was not reported to RAIB. Following the accident the train was examined by LUL and Alstom. This included testing the operation of the doors involved in the accident and its control circuits for correct operation (see paragraph 79). The train operator did not become aware of the accident until booking on for duty five days later.

Background information

The train despatch process

47 The despatch process is documented in LUL's Rule Book 8 'Managing the platform train interface', issue 6, dated November 2021, which is used as the basis of train operators training. This gives instruction as to what the operator must do on arrival at the station and for despatching the train.

The train operator must make sure that they have authority to move and then:

- '*Check the entire platform train interface*
- *Close the doors and check the doors closed visual* [the pilot light]
- *Check the entire platform train interface again'.*

Then they must:

- *'Check that the station signal is still clear* [Train operator display (TOD) on the Northern line]
- *Make a final check of the platform train interface*
- *Start the train*
- *Check the in-cab monitors as the train leaves the platform'.*

48 A yellow line is painted along the platform 300 mm from the platform edge which provides passengers with an indication of the distance they should stay back from the platform edge unless boarding or alighting from trains. There is also a white line painted along the platform edge.

49 There are no specific rules relating to not moving a train if anyone is over the yellow line, but training reinforces that train operators should not move a train unless it is safe to do so. Train operators checking the PTI can look for interruptions in the yellow or white lines as a reference to judge if anyone is close to the train.

Method of train operation

50 Trains on the Northern line use ATO as the default method of operation. This automatically accelerates and brakes the train for signals and station stops. In stations, the train operator is responsible for checking in-cab CCTV monitors for potential issues at the PTI, opening and closing the doors and initiating the despatch of the train. Between each station, the train operator is expected to monitor the ATO system and remain vigilant for any obstruction on the track. In certain circumstances, with permission from control, it is possible for train operators to take control and drive the trains manually, but operating in this mode is not compatible with the full timetabled service. For this reason, manual driving is normally only done at weekends and during initial training.

51 At both Archway and Chalk Farm stations, the CCTV cameras on the platforms display an image on the in-cab monitor on the train. The image is split into two. Images are displayed to the train operator before the train stops in the station and until the last car has left the station.

52   The train operator's cab display and control panels include the following features:

- A pair of 'doors open' and a single 'doors close' push-button for each side of the train, used by the train operator to command the doors to open and close respectively.

- A TOD screen (paragraph 47), which includes a countdown to departure display when applicable. This is set automatically depending on prevailing service conditions.

- A 'doors close' visual indicator, a blue light within the doors close push-button, commonly known as a 'pilot light' (paragraph 29), which illuminates when the door interlock circuit (see paragraph 53) has detected that all the doors are closed and that the train is capable of being moved.

- A pair of start buttons which must be simultaneously pressed and held for at least two seconds to command the train to start.
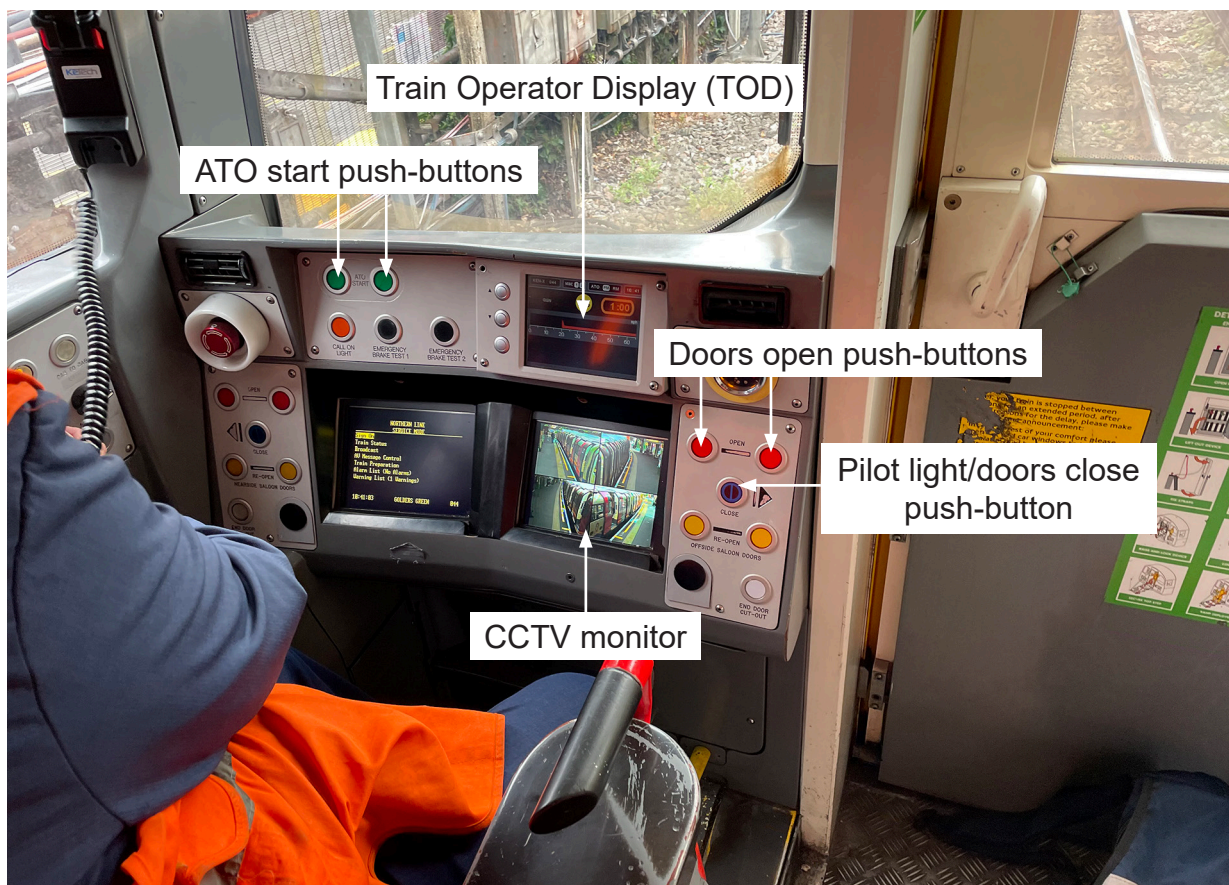
Figure 4: 1995 stock cab display and control panels. The panels to the left and right are for door operation on each side of the train. There is an LCD monitor to display platform CCTV images, and a primary display panel.

The door system

53   1995 stock is fitted with a door interlock system which prevents the train from taking power unless all the passenger doors are closed. Once the doors are detected as being fully closed, the interlock is made. This is indicated to the train operator by the pilot light illuminating. The system is designed to detect an object with a minimum thickness of 11 mm, meaning that power cannot be taken if an object of this size or greater is successfully detected.
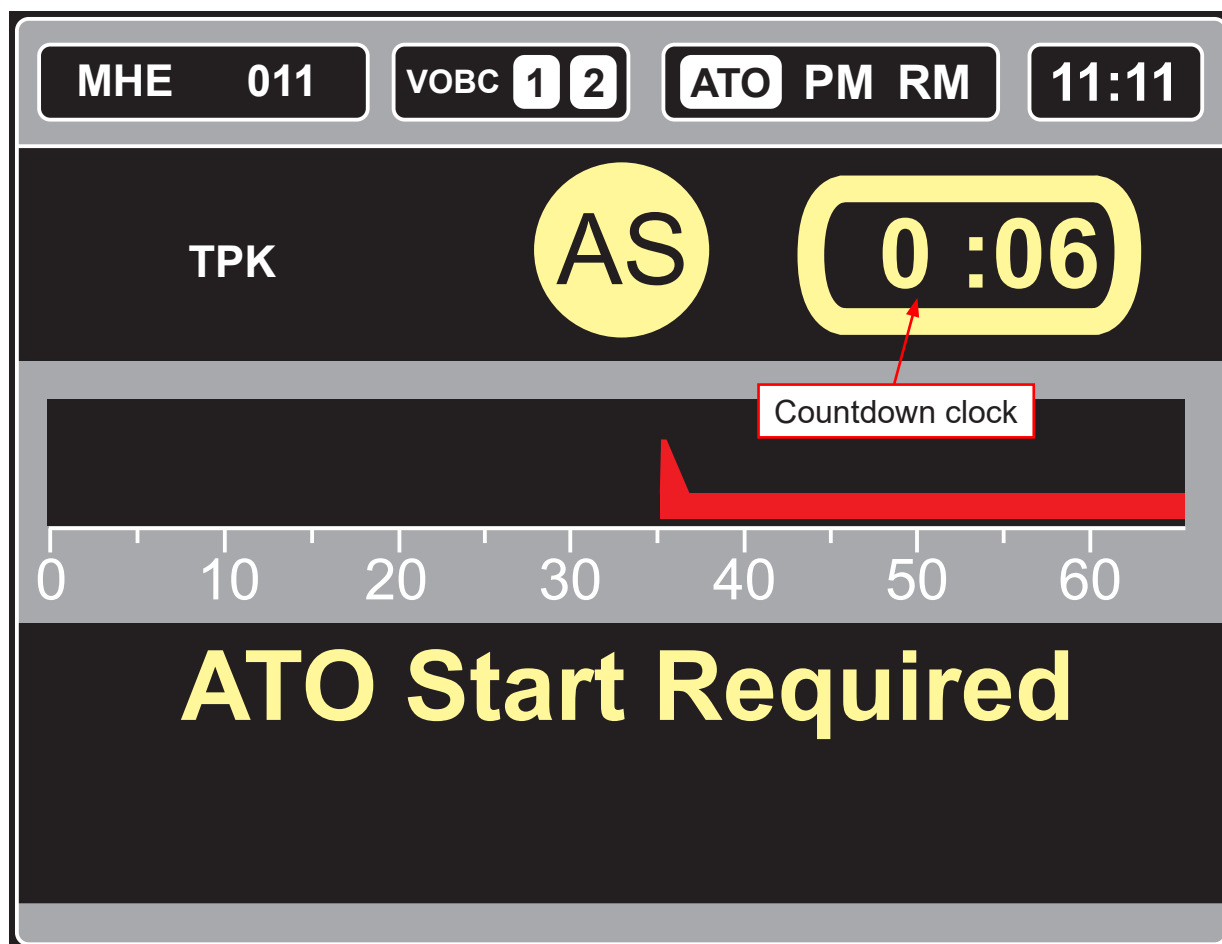
Figure 5: ATO countdown to departure (in seconds) TOD.

54   When detected closed, a correctly set-up 1995 stock door mechanism will be in over-centre lock, which will hold the door in place until it is commanded to open. Each pair of doors has one door which can be pushed back up to 115 mm against a spring to allow the release of trapped objects. Each single door is also fitted with a spring that allows the door to be opened by 115 mm if pushed back, for the same reason.

55   When the train operator presses the doors close button, door closing warning chimes sound for between 1.5 and 2 seconds before the doors begin to close. The purpose of the door chimes is to warn passengers to keep clear of the moving doors to avoid being struck or trapped. Research has shown that this sound is often misinterpreted, with Rail Safety and Standards Board (RSSB) research[1] stating: '*Two-thirds of passengers interviewed did not understand the door close alarm as indicating that they should 'stand back'. Instead, passengers tend to disregard the alarm and continue to board, which shows that the meaning of hustle alarms* [known as door chimes on LUL] *is not well understood by passengers.*'

---

[1] RSSB, 'Optimising door closure arrangements to improve boarding and alighting (T1102)', 2017, https://www.rssb.co.uk/.

Analysis

Identification of the immediate cause for the accident at Archway station

56 The passenger was trapped while alighting the train and was dragged along the platform.

57 CCTV footage from a camera overlooking the platform at Archway station shows the passenger becoming trapped by their coat when alighting from the train. Along with their companion, they are seen being dragged along the platform by the departing train, before falling to the ground.

Identification of causal factors

58 The accident at Archway occurred due to a combination of the following causal factors:

a. The passenger's coat became trapped in the closing door and was not released before the train started to move (paragraph 59).

b. The train was able to depart with the passenger's coat trapped in the doors (paragraph 82).

c. The train operator was unaware the passenger was trapped in the door before starting the train (paragraph 88).

Each of these factors is now considered in turn.

The passenger's coat became trapped

59 The passenger's coat became trapped in the closing door and was not released before the train started to move.

60 CCTV shows the trapped coat, and that the passenger and their companion remained close to the train as the doors closed. Approximately four seconds after the doors close, the train moves, dragging the passenger and their companion, who was holding onto them, until they both fall to the ground.

61 This causal factor arose due to a combination of the following:

a. The passenger's coat became trapped in the closing door (paragraph 62).

b. The trapped coat was not released from the door before the train started to move (paragraph 76).

Each of these factors is now considered in turn.

Proximity to the doorway

62 The passenger's coat became trapped in the closing door.

63 The passenger was travelling with a companion who was also helping them to get on and off trains during their journey. Before reaching Archway station, the passenger and their companion had moved to the rear single leaf door on the car to prepare to alight onto the platform. Once the train had stopped and the doors were open, the companion exited the train first and stood on the platform facing the open door to assist the passenger as they stepped onto the platform. The companion took hold of the passenger's right arm to help them.

64   As the passenger stepped onto the platform the door closing chimes sounded. Around two seconds later the door began to close and momentarily trapped the passenger's left arm in the door as they attempted to alight from the train. Although the passenger was able to pull their arm free of the closing door, the bottom corner of their coat, which was unzipped at the time, became trapped between the door edge and the vehicle body.

Door opening period

65   The doors on the train were not open long enough to enable the passenger, with the aid of their companion, to step off the train and move clear of the closing door. The train operator stated that when operating the train, they are normally prompted to close the doors by the ATO system (see paragraph 67) and by the general pressure to keep the train service moving.

66   Station dwell times (the time between train stopping and restarting) are set by the system management centre (SMC). Stations have different dwell times for peak and off-peak times. A minimum, nominal and maximum dwell time are calculated for each station platform and the dwell time that is selected will depend on different factors. For example, if the train is running late then the minimum dwell time will be implemented. Public address announcements are used to provide passengers with service information and to assist in keeping to timetabled dwell times. The minimum dwell time for Archway station at that time of day was 19 seconds, with the actual dwell time on the day of the accident being 19.2 seconds.

67   Although train operators are not specifically aware of the platform dwell times calculated by the SMC, they receive target departure time information that is displayed in the driving cab during the station stop (figure 5). As soon as the wheels stop with the train in the platform, the ATO countdown starts. When the timer begins counting down the numbers are displayed in yellow on the TOD. When the countdown reaches 11 seconds, there is an audible tone and 'ATO start required' is displayed. When the countdown reaches zero, the numbers are displayed in orange and then start counting up.

68   LUL's Northern Line transmission-based train control (TBTC) Handbook, version 2, dated 3 November 2021, informs train operators that dwell times *'should be treated as an indication to keep the train running to time. It does not mean that you have to close the doors and depart when it is not safe to do so.'*

69   The train stopped at Archway station at 15:49:51 hrs. Approximately two seconds after arriving at the platform, the train operator pressed the buttons in the cab to open the doors. The OTDR from the train shows that the doors open buttons were pressed by the train operator at 15:49:53 hrs and the doors close button was pressed at 15:49:58 hrs, five seconds later. CCTV shows that the doors begin the closing sequence at 15:50:04 hrs and are fully closed at 15:50:06hrs. OTDR records and CCTV images show that the doors were only available for use by passengers for approximately eight seconds.

70   Due to the way that the timetable is planned, there would be little benefit to a train operator from shortening dwell times for purposes other than meeting the timetable (for example, to finish a journey earlier). This is because they would be likely to be subsequently held by control until the timetable could be balanced again, particularly as there is a general desire to minimise the need to stop trains in tunnels between stations.

71 Although the train operator involved in this accident stated that they were not experiencing unusual pressure to move, data from the train shows that the doors close button was pressed before 'ATO start required' was displayed. Witness evidence also suggests that train operators are conscious of the need to keep the service running on time, and they have stated that the countdown may add to a sense of urgency. This may mean that the countdown display is given priority over monitoring the platform in the driving task. The auditory and visual prompts that the train operators receive approximately 11 seconds before the countdown ends could also be sufficient to automatically cue the action of pressing the doors close button.

Closing the train doors

72 When deciding to close the doors, the train operator was unaware of the presence of the passenger in the doorway. At the point that the train operator pressed the doors close button, CCTV footage from a platform camera shows that the passenger's companion had just begun to alight from the train and was in the doorway but had not yet stepped off the train. Platform CCTV images are not necessarily representative of what the train operator could see on the in-cab monitor display, so it is possible that the passenger's companion was not visible in the doorway to the train operator when they viewed the in-cab monitor at this point (see figure 6).

Figure 6: The view of the train at the point the doors close button was pressed.

73 Although the train operator was unaware of the presence of the passenger when they decided to close the doors, they had seen the companion getting off the train. The train operator believed that the companion was clear of the doors and that it was therefore safe to close them. Although the companion was close to the train when this decision was taken, the train operator may have believed that by the time the closing sequence had completed, which takes around five seconds from the doors close buttons being pressed (paragraph 27), the companion would be completely clear of the doors. The train operator was unaware that the companion was waiting to assist the passenger off the train.

Previous door operation incidents

74 On 16 December 2021, the train operator had been involved in a previous PTI incident in which a passenger was caught in the doors while attempting to board a train at Bank station. The passenger made a complaint about the incident and this was passed to the manager of the train operator, who had the responsibility for putting an action plan into place to provide support and implement corrective action.

75 The type of action plan implemented is decided on a case-by-case basis and may provide an opportunity to reinforce the importance of not relying on the pilot light and the need for carrying out adequate checks of the platform-train interface before departure. LUL stated that although an action plan was put in place for the train operator following this incident, it was not documented in accordance with LUL's procedures and there is no record detailing what action was agreed or how it was implemented. It is therefore not possible to say whether the action plan was adequate or if it would have provided an opportunity to reinforce safe practice in this area.

Releasing the trapped coat

76 The trapped coat was not released from the door before the train started to move.

77 The passenger and their companion were surprised that the train operator did not see them and reopen the door. Although they tried to free the coat by pulling it, they did not have much time to attempt to do this before the train started moving and were unsuccessful in releasing it.

78 Objects trapped in closed doors which are thinner than 11 mm may not be detected (paragraph 53), as the doors on the 1995 stock are not fitted with systems that will detect them, such as sensitive edges (see paragraph 86). The coat that the passenger was wearing was quilted and it would have been compressed in the door when closed. The lack of detection of the passenger's coat suggests that it was compressed to a thickness of less than 11 mm.

79   Testing by Alstom showed that the door system was generally compliant with relevant standards, but it was noted that the door seals had become stiff, and a force of up to 140 N was required to pull a test-piece of canvas from between them. This was higher than the 90 N described in the testing process, but it should be noted that the actual force required to pull a coat out can be considerably different to the force required for the test piece. This did not result in the doors failing the test, as it is based on a combination of parameters rather than individual test pass/fail criteria. This may indicate, however, that it would have been more difficult for the passenger to pull their coat out of the doors than if had they attempted to do so if the seals had been newer and more flexible.

80   If the item of clothing had a fastening, such as a button or toggle, the force required could increase significantly. RAIB investigated an accident in 2015 where a passenger was trapped in train doors and was dragged at Clapham South station, suffering multiple injuries (RAIB report 04/2016, see paragraph 158). RAIB found that due to the design of the door seals on 1995 stock trains a force of over 350 N was required to pull a coat from a closed door in some situations.

81   Once doors are closed, it is possible to slide back the single leaf door, or one door of a pair, by around 115 mm to allow objects to be freed. This is known as the trapped item release or pushback facility. The pushback facility is not widely known about by passengers and was not known by the passenger or their companion.

Departing with objects trapped in the doors

82   The train was able to depart with the passenger's coat trapped in the door.

83   This causal factor arose due to a combination of the following:

   a.   The train's door control systems did not detect the trapped coat (paragraph 84).

   b.   No changes had been made to the door seals on 1995 stock trains in response to previous RAIB recommendations (paragraph 86).

   Each of these factors is now considered in turn.

The train's door control systems

84   The train's door control systems did not detect the trapped coat.

85   The door interlock system on the train is intended to prevent the train operator taking power if the train's control systems detect that any of the doors are not closed. Successful door interlocking is indicated to the train operator via the pilot light. The interlock system is designed to ensure that the train cannot start if an object of 11 mm width or greater is detected by the closing doors (paragraph 78). However, the train may still be able to start if thinner objects, such as clothing and bag straps, become trapped in the doors and are not detected.

Door seals

86 No changes had been made to the door system on 1995 stock trains in response to previous RAIB recommendations.

87 RAIB made a number of recommendations following its investigation into the Clapham South accident (see paragraph 158). These included reviewing ways of improving detection of objects trapped in train doors and improving the ability of passengers to pull out objects trapped in doors (including improving door seal arrangements). The review was undertaken but no changes were made (see paragraph 173).

Awareness of the trapped passenger

88 The train operator was unaware the passenger was trapped in the door before starting the train.

89 LUL's Rule Book 8 states that the train operator should complete a final check of the platform before departing. LUL Rule Book 8 also states that the train operator must check the in-cab monitors as the train leaves the platform (paragraph 47).

90 The train operator was monitoring the platform-train interface through the in-cab CCTV monitor once the doors had closed. The train operator was by now aware of the presence of both the companion and the passenger and was also aware that the passenger had initially been caught in the closing door as they alighted (paragraph 28). However, the train operator believed that the passenger had pulled themselves free and stated that they had allowed additional time for them to do this. The train operator was not aware that the passenger's coat had been trapped in the door. OTDR data shows that there were approximately 11 seconds between the doors closed button being pressed and the train starting to move.

91 The train operator started the train, although CCTV images show the passenger and the companion remained close to it. At this time, the passenger and companion were facing forward towards the train operator as they believed that they would be seen, and the doors would be reopened (figure 7). This may have appeared 'normal' passenger behaviour to the train operator and further supported their belief that no one was at risk. The train operator did not see that the passenger's coat was trapped in the door, and this may not have been easily seen in the image provided in the in-cab monitor.

92 The train operator did not make any announcements requesting passengers to stand clear of the train.

93 Approximately four seconds after the train started to move the train operator applied the emergency brake. The train operator stated that in carrying out a check of the platform as the train departed the station, they realised that there had been an accident and stopped the train.

Figure 7: The passenger, with coat trapped in door, on the platform at Archway station facing the front of the train.

The pilot light

94   The train operator was relying on several different cues to indicate that it was safe to start the train, particularly the pilot light which indicates that the doors are closed (paragraph 29). The illumination of this light reinforced the train operator's belief that it was safe to depart because they stated that they believed it would not illuminate if something was trapped in the doors. Although the limitations of the interlock system and issues surrounding reliance on the pilot light are explained to train operators during their training, this may not have been periodically reinforced (see paragraph 140). Previous RAIB investigations and safety digests suggest that many train drivers believe that a doors closed indication from an interlock system means that there is nothing trapped in the door. However, many systems cannot detect relatively thin objects.

95   LUL provides specific training in train despatch and scanning techniques which provide a method of systematically checking the available images for train operators. Although this explains techniques for effective scanning, it does not mention over-reliance on the pilot light. There is also some uncertainty as to whether the train operator had received this training as records were not kept as to who had received it.

96   The competence management system for train operators spans a two-year cycle, which includes three in-service assessments and one depot assessment in this period. In-service assessments cover the despatch process but the assessor's criteria when observing platform duties states '*close the doors, observing door closed visuals (pilot light) and OPO equipment*.' This does not draw the attention of assessors to the limitations of the door interlock system.

Other factors that may have influenced the train operator's decisions

97   Train operators on the London Underground often have to make the decision to start a train while people are standing on or beyond the yellow line, and, on some occasions, standing close to the train. This is particularly the case at busy platforms. In addition, it is not uncommon for passengers to get momentarily caught in closing doors as trains prepare to start. This most often results in the passenger pulling themselves free of the doors. Such events seldom lead to an incident or accident, and it is possible that this may result in train operators having a reduced perception of the risk of such events.

98   The repetitive and monotonous nature of automatic train operation can result in attentional capacity being diminished.[2] In periods of low workload, attention will begin to degrade and capacity to deal with new information is reduced. This may lead to a state of underload which can reduce alertness and memory function and increase the likelihood of distraction (see paragraph 134).

99   The train operator had only recently begun a phased return to driving after being involved in a traumatic accident at work in May 2022 that was not deemed to be their fault. At the time of the accident at Archway, they had been back driving for three weeks. They also had some personal issues at the time that may have been playing on their mind. While these things may lead to distraction, the train operator did not feel that either of these factors had affected their performance.

Identification of the immediate cause for the accident at Chalk Farm station

100 The passenger was trapped while attempting to board the train and was dragged along the platform.

101   CCTV footage from a camera overlooking the platform at Chalk Farm station shows that the passenger descended the stairs at the tailwall end of the platform and moved towards the rear doors of the train. The passenger stated that they intended to board the train, but the doors had already begun to close so they stepped back. As the train began to move the passenger can be seen being dragged along with their coat caught in the doors. The train continues to move, and the passenger becomes free of the doors and falls to the ground.

---

[2] Identifying and evaluating techniques to mitigate cognitive underload for train drivers, RSSB, 2019.

Identification of causal factors

102 The accident at Chalk Farm occurred due to a combination of the following causal factors:

    a. The passenger's coat became trapped in the closing doors and was not released before the train started to move (paragraph 103).

    b. The train was able to depart with the passenger's coat trapped in the doors (paragraph 111).

    c. The train operator was unaware of the trapped passenger (paragraph 114).

Each of these factors is now considered in turn.

How the passenger became trapped

103 The passenger's coat became trapped in the doors and was not released before the train started to move.

104 CCTV images show the passenger attempting to board the train at Chalk Farm station. The train doors close as the passenger is near to them and it is at this point that their unzipped coat becomes caught and trapped in the closing doors. The passenger is visible on CCTV near to the doors for approximately two seconds before the train begins to move, dragging the passenger along the platform.

105 This causal factor arose due to a combination of the following:

    a. The passenger's coat got trapped in the closing doors (paragraph 106).

    b. The trapped coat was not released from the doors before the train started to move (paragraph 109).

Each of these factors is now considered in turn.

Proximity to the doorway

106 The passenger's coat became trapped in the closing doors.

107 The passenger entered the platform from the staircase at the rear of the platform. While descending the stairs they became aware of the train in the platform and hurried towards it. As they reached the train and went to board through the rear doors, they realised that they would be unable to board as the doors had begun to close. They therefore attempted to step away from the train. This sequence of events placed the passenger near to the closing doors.

108 The coat that the passenger was wearing was unzipped and, as they stepped back from the train, the corner of their coat, which included the end of the zip, became trapped in the doors.

The trapped coat was not released

109 The trapped coat was not released from the doors before the train started to move.

110 The train involved in the Chalk Farm accident was 1995 stock, the same type of train that was involved in the Archway accident. The factors relating to obstacle detection and pulling trapped items free of closed doors are therefore mostly the same as found in the other accident (paragraph 82), with the following differences:

- The passenger at Chalk Farm tried repeatedly to release the coat, but they were unable to do so. Post-accident testing found part of the zip of the coat in the door runner. The weight of the falling passenger caused the zip to break, releasing the passenger's coat from the doors. Part of the metal slider was recovered in the post-accident testing of the doors and the passenger's coat was ripped in the process of it being released.

- The passenger believed that the door would reopen automatically to release their coat. Research undertaken by RSSB has shown this to be a widespread belief by rail passengers and noted that 58% of people asked believed that train doors would reopen automatically if an obstruction is detected (paragraph 55).

- As the passenger was trapped in a set of double doors, the pushback facility would have allowed one of the doors to be physically opened slightly to release the coat. In this case, the door that could move was the leading door, so pulling of the coat as the train started would have resulted in it pulling against the fixed door.

Train departed with the coat still trapped

111 The train was able to depart with the passenger's coat trapped in the doors.

112 As the same type of train was involved in the accidents at Archway and Chalk Farm, the reasons why the train was able to depart with the passenger's coat trapped in the closed doors are the same as discussed from paragraphs 82 to 87.

113 Post-accident testing of the doors of the train involved in the Chalk Farm accident by LUL showed that the door interlock system operated as designed. However, as with Archway, it was again noted that the force required to pull a test-piece of canvas through the closed door edges was greater than that described in the testing process at some angles and heights (paragraph 79). Again, this did not result in the doors failing the test due to the combination of the test parameters.

Awareness of the passenger

114 The train operator was unaware of the trapped passenger.

115 LUL's Rule Book 8 requires the train operator to complete a final check of the platform before departing and to check the in-cab monitors as the train leaves the platform (paragraph 47).

116 The passenger was not present on the platform when the train operator would have undertaken a platform check to decide it was safe to close the doors. The train operator did not see the passenger when viewing the in-cab monitor and deciding it was safe to start, nor as the train was moving out of the platform. They only became aware of the accident on being informed about it when next reporting for duty.

117 This causal factor arose due to a combination of the following:

a. The train operator did not detect the passenger was close to the doors before starting the train (paragraph 118).

b. The train operator did not see the passenger during departure from the platform (paragraph 130).

Each of these factors is now considered in turn.

The train operator did not see the passenger

118 The train operator did not detect the passenger was close to the doors before starting the train.

Passenger conspicuity

119 The train operator could not recall anything out of the ordinary during the stop at Chalk Farm and stated that they followed their normal despatch procedure. The reason the train operator did not detect the passenger is almost certainly a combination of the possibilities outlined below.

120 It is possible that the passenger was visible on the in-cab monitor but that the train operator's check of the monitors after the doors had closed was not effective. OTDR data shows that there is approximately one second between the pilot light illuminating and the ATO start button being pressed. The internal report into the accident by LUL states that it would not be possible to complete the final check effectively in this time. The speed of this check may indicate that the train operator was carrying out this action automatically due to the nature of the driving task (see paragraph 134). LUL stated that it is possible that a train operators' monitoring of the in-cab CCTV may start while they were pressing the doors closed buttons, leading them to think that their check was longer than it was.

121 It is also possible that the check was not effective as the passenger was difficult to detect in the monitors. RAIB observed that the passenger was not conspicuous against the platform background at the very rear of the platform and that they were wearing dark clothing, which did not stand out from the surrounding environment (figure 8).

122 The size and contrast of an object will also affect whether it is detected or not. A reconstruction carried out by RAIB, placing a person in a similar position to the passenger (without other passengers obscuring them) and viewing from the in-cab monitor, demonstrated that it was difficult to identify a person in that position. In the monitor, the passenger appeared small and there was low contrast in the overall image (figure 9). The passenger's position close to the train also meant that there was not a break in the yellow line on the platform (paragraph 48). This may also have further reassured the train operator that no one was close to the train.

Figure 8: The passenger close to the train mainly obscured by other passengers and not visible or conspicuous.

Figure 9: RAIB reconstruction showing person in same position as passenger on Chalk Farm platform.

123 Additionally, station CCTV images show that some passengers on the platform would have obscured the train operator's view when the doors were closing, however RAIB notes that the passenger was no longer obscured by the other passengers from a point two seconds after the doors had closed. Although this is not the same view transmitted by other cameras to the in-cab CCTV monitors (see figure 8), RAIB considers that the train operator's images would not have been significantly different in this respect.

124 It is also possible that the train operator experienced 'inattentional blindness', a phenomenon where people may fail to notice a seemingly obvious target, despite looking directly at it.

125 The train operator stated that they had not received the new training that covered scanning techniques to be used when reviewing in-cab CCTV images (see paragraph 140). Although this is now also included in the initial training, it is possible that some train operators may have missed it, for example, if they joined before it was included in the initial training. Whether a train operator had received this training is uncertain as records were not made, and therefore opportunities to reinforce this learning to all relevant staff may have been missed.

Quality of the CCTV

126 The CCTV cameras on the platform used for train despatch are known as 'one person operation' or 'OPO' cameras and are positioned to provide an image of the whole PTI to allow train operators to have a clear view of the PTI corridor, including the critical area of the PTI for train despatch.

127 The monitor in the train cab is approximately 100 mm x 150 mm and displays images from cameras located on the platform (figure 4). The image is displayed on the monitor from just before entering a station until the last car has left the station (paragraph 11). OPO CCTV document No: S1150 issue A2 states: '*All presented images shall be either a 2-way full vertical split, 3-way vertical split or 4-way vertical split (no full captured image used).*' The split at Chalk Farm was into two images, rather than four smaller images. Although four smaller images may have given a closer view of the passenger, they might have taken more time to scan than two images.

128 A benchmark image is available for every station on the Northern line and a daily check is made to make sure that the image displayed in the cab is the same as the benchmark image to ensure there is nothing wrong with the camera angle or the display of the image presented to the train operator in the driving cab. This allows any faults to be identified and rectified. LUL's post-accident testing of the platform CCTV cameras and monitors at Chalk Farm did not reveal any discrepancies against the appropriate benchmark images.

129 A number of elements can influence the perceived quality of CCTV images. Some of these are subject to standardised tests used in the set-up of CCTV systems. One such test called the 'Rotakin' test uses CCTV test targets to assess the detection of a person on the platform. Lighting surveys are also used to identify areas of low lighting. These are considered on initial installation of CCTV but are not checked during routine maintenance. There are no checks undertaken to assess image quality holistically, such as reviewing what train operators report they can subjectively see on the in-cab monitor images, unless there is an issue reported by train operators. No reports had been received from train operators concerning the image displayed on the in-cab monitor at Chalk Farm station.

Departing the platform

130 The train operator did not see the passenger during departure from the platform.

131 The train operator did not recall seeing the passenger as the train departed from the platform or anything else to indicate that something was wrong.

132 It is possible that the train operator did not check the in-cab monitors as the train left the platform to observe the PTI and check for irregularities. It is also possible that the train operator looked at the monitors immediately after departing but that the passenger was difficult to detect (paragraph 122).

Previous safety incident

133 The Chalk Farm train operator had been involved in a previous PTI incident. In 2019 they were involved in an incident at Morden and put on an action plan. LUL have stated that there are no details available of the action plan as these were lost in a recent switch to a new competence management system. It is therefore not possible to say whether the action plan was adequate or if it would have provided an opportunity to reinforce safe practice in this area.

Identification of underlying factors for both accidents

Automatic train operation

134 It is possible that the train operators' actions may have been affected by the use of automatic train operation on the Northern line.

135 ATO is a method of operating trains where the train and lineside systems control the train except in stations, which remain the responsibility of the train operator (paragraph 50). Between stations, the train operator's task is mainly monitoring the in-cab displays and looking for any obstructions on the line ahead of the train. At this point, the train operator will experience relatively low workload and undertake repetitive tasks which can result in an automatic mode of responding. During this time, attentional resources may be withdrawn, due to the routine nature of the task. When there is low task-related activity, alertness is also reduced which can result in cognitive underload.

136 Stations, in contrast, require a high level of attention and vigilance, and difficulties can arise in making the switch between levels of activity. When people experience cognitive underload, it can lead to faster reaction times but reduced attention and more errors.[3,4] Withdrawing attention when it is not required is not a 'human failing'; humans have limited attentional capacity and withdrawing attention is an adaptive adjustment to the task. For both the train operators involved in the accidents covered by this report, the time spent in stations was short overall, suggesting this may have been a result of their actions becoming automatic. The countdown in the cab which gave a cue to depart may have also contributed to the task being carried out quickly, as train operators are conscious of the need to keep the service running on time (paragraphs 66 to 68).

137 A recommendation was made in the investigation report into the accident and Notting Hill Gate ([RAIB report 14/2018](#)) which highlighted issues surrounding ATO and underload (see paragraphs 159 and 174). The recommendation stated that LUL should consider ways to support train operators of ATO trains in maintaining attention and awareness. It suggested strategies such as manual driving where feasible, additional task-focused vigilance activities or providing alerts if ATO start is attempted before the system is ready. LUL's plan to address this recommendation included new training for scanning the PTI and a toolbox of possible mitigations to manage underload for train operators. This toolbox is not prescriptive and suggests ideas that train operators may wish to try to help with underload, for example, standing up or changing posture. Regular periods of manual driving were not, however, introduced as LUL stated this could significantly disrupt the timetable. The strategies that were eventually adopted rely on attempting to improve individual performance rather than focusing on changes that can be made to the overall system which have a greater chance of success.

Controlling risk

138 LUL's methods for managing the safety of the PTI were not sufficiently effective at controlling the risks to passengers getting trapped by their clothing in closing doors.

139 Trap and drag events leading to fatal consequences are rare on the LUL network (paragraph 147). LUL aims to reduce the risk of people being trapped and subsequently dragged by a departing train on the Northern line using a range of control measures. The control measures include:

- rules for train despatch (paragraph 47)
- the obstacle detection system fitted to the doors (paragraphs 78, 86 and 111)
- the door interlock system (paragraph 53)
- the pushback facility door at each single passenger door and one door of each pair of doors (paragraph 81)
- real-time CCTV images provided to train operators via in-cab monitors (paragraphs 11, 51 and 126).

---

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

[4] Identifying and evaluating techniques to mitigate cognitive underload for train drivers, RSSB, 2019.

140 The existing control measures also included train operator despatch training and briefings. Initial training for train operators focuses on how to depart the platform safely including the need not to rely on the pilot light as evidence that it is safe to depart. After a recent review undertaken by LUL's training department, further material was added covering PTI management and effective in-cab scanning techniques (paragraphs 95 and 125). However, this additional training does not reinforce the explanation given in initial training that there is a risk of objects being trapped even when the pilot light is illuminated; therefore it should not be used as the sole indicator that it is safe to depart.

141 Initial train operator training includes awareness of the effects of underload (where workload and task demands are low), why it occurs and various strategies that may be useful to help counteract it. However, this is a difficult area to train and underload is one of many factors that may influence the vigilance of the train operator.

142 While not identified by LUL as a risk, train doors also need to be open for long enough to allow passengers to safely alight and board. This is particularly difficult at busy times when train operators must often make a judgement on when to close the doors. This decision will be influenced by the need to keep to the timetable, or to not further delay an already late running service. In the Archway accident the sequence from the doors starting to open until they were fully closed took around ten seconds. In the Chalk Farm accident, this sequence took around nine seconds. Although this is not directly relevant to the accident at Chalk Farm (as the passenger was boarding the train), at Archway and in other situations this may not have given sufficient time for passengers to alight safely. However, initial training for train operators emphasises being aware of the diverse needs of passengers travelling on the network and acknowledges that some passengers may need more time to board or alight from trains.

Observations

Risk assessment data

143 The data used in the London Underground Quantified Risk Assessment did not fully reflect the risk of a trap and drag accident.

144 LUL quantifies some elements of operational risk using the London Underground Quantified Risk Assessment (LUQRA). The risk to passengers was calculated by a mathematical model of the network within the LUQRA comprising two parts. The first determines the likelihood of an undesirable event (figure 10), and the second considers the consequences (figure 11). These LUQRA models are updated approximately every three years and were last updated in 2021. Data sources include previous incidents, human error analysis and professional judgement. The use of lagging, incomplete and/or misclassified data can therefore affect LUL's understanding of risk, which may in turn impact decisions made about safety improvements.
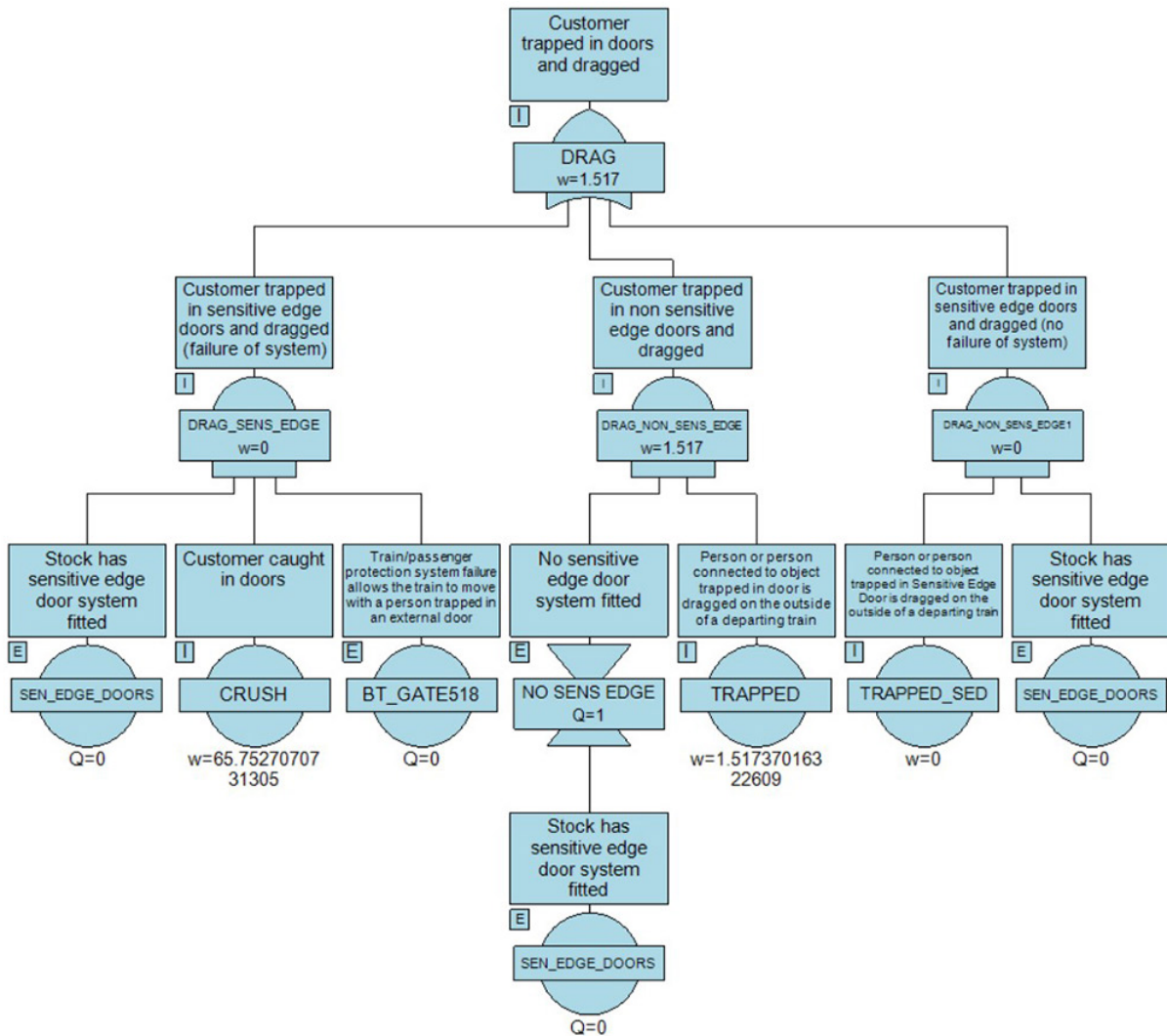
Figure 10: LUQRA fault tree for passenger trap and drag on the Northern line.

145 The LUQRA includes fault and event trees for 'passenger trap and drag' on the Northern line. The fault tree for this event (figure 10) shows that its estimated frequency is approximately 1.5 events/year. Overall, LUL estimates that there are 67.5 events per year where a passenger is trapped in the train doors on the Northern line. Therefore around 1 in 45 events involving a passenger being trapped in a door leads to them remaining being trapped as the train moves off, and therefore being dragged.

146 The event tree for trap and drag events on the Northern line is shown in figure 11. The event tree models a range of possible outcomes once a train has started moving with a passenger trapped in a door. In effect, each branch of the tree represents a different scenario, the nature of which varies according to the success or otherwise of the defined mitigation measure (that is to say, such as whether a person frees themselves or whether the train operator sees that someone is being dragged). Each scenario has a frequency and a consequence in terms of harm that is assigned to it. The extent of the harm is expressed in terms of fatalities and weighted injuries (FWI). This is a method that weights fatalities, major injuries and minor injuries in accordance with their severity.

Figure 11: LUQRA event tree for passenger trap and drag on the Northern line.

147 A scenario where none of the factors are deemed successful has an estimated frequency of 0.14/year in the LUQRA, approximately one event in seven years. The probability of that sequence resulting in a fatality is estimated at 0.125 which is one fatality in eight events, equivalent to an average of one fatality from a trap and drag event on the Northern line every 56 years. This scenario is the only one deemed by LUL to carry with it the possibility of a fatality.

148 The data LUL uses to estimate the outcome from a trap and drag event was not accurate for a number of reasons. For example:

- LUL classified the outcome of the accident at Archway as 'minor'. However, the passenger in this case suffered a broken shoulder which would normally be defined as a 'serious injury' for the purposes of The Railways (Accident Investigation and Reporting) Regulations 2005 (as amended) (the 2005 Regulations).[5] Both passengers at Chalk Farm and Archway have also suffered long-term effects arising from their accidents. If injuries are more widely classified as minor, when they are in fact serious, then any estimates using data from previous incidents will be inaccurate and will underestimate risk.

---

[5] https://www.legislation.gov.uk/uksi/2005/1992/regulation/2.

- LUL does not know for certain how many passengers free themselves from being trapped in closed doors before or after a train moves because many events of this nature are not formally reported by passengers, who may be unharmed and wish to continue their journey. In the case of the accident at Chalk Farm, the passenger stated that she felt that she had not been encouraged by station staff to report the accident. An incomplete data set will also affect the accuracy of any risk assessment using it as part of its base data.

- The review of the LUQRA takes place every two to three years and therefore reflects lagging data. The accidents at Archway and Chalk Farm at the beginning of 2023, for example, will not be reflected in the LUQRA's assessment of trap and drag events until the next review cycle is completed between 2024 and 2025. Some delay is inevitable and so will not generally affect accuracy unless there is a rapidly changing trend, in which case it will.

149 Although LUL uses other local customer, station and train operation risk assessments in safety decision-making, it is important that safety decisions made across the network include use of the LUQRA and that it is used for evaluating options when responding to previous RAIB recommendations (see paragraph 173).

Accident reporting

150 LUL did not report the accidents at Archway and Chalk Farm to RAIB.

151 Although LUL notified the Office of Rail and Road (ORR) about the accidents, RAIB was not aware of them until 17 May 2023, three months after the accident at Archway and a month after the accident at Chalk Farm. LUL stated that it was not clear that the accidents were notifiable. The accident at Archway resulted in a serious injury and should have been immediately reported to RAIB.

152 While the accident at Chalk Farm did not result in a serious physical injury, the 2005 Regulations (paragraph 148) require that incidents, that in slightly difference circumstances could have led to serious injury or worse, should be immediately notified to RAIB. RAIB would therefore expect the type of accident seen at Chalk Farm to have been notified to it immediately. RAIB's guide about notifying accidents[6] states that if there is any doubt about reporting an accident, duty holders should notify them anyway.

Train operator records

153 Records relating to train operator action plans and training updates were not available to RAIB's investigation.

154 No details of the action plans implemented for the train operators involved in these accidents were available to RAIB's investigation (paragraphs 75 and 133). It is difficult in this case to therefore evaluate whether these were appropriate and covered the necessary learning from previous incidents. In addition, a briefing on PTI scanning techniques had been given to some train operators, but no records kept of who had received this training.

---

[6] https://www.gov.uk/government/publications/a-quick-guide-to-notifying-accidents-and-incidents-on-uk-railways.

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

156 Neither train operator was tested after the accidents for the presence of drugs or alcohol. There was nothing to indicate that either of the train operators were under the influence of drugs or alcohol, however it is a requirement of LUL process R2692 'Alcohol and drugs at work information for managers and employees', issue A3, dated May 2021, to test employees following any incident which caused, or had the potential to cause death or major injury, or substantial damage to property. LUL stated the tests were not undertaken following these accidents due to an oversight.

Previous occurrences of a similar character

157 RAIB has previously investigated two similar accidents on the London Underground network. One of these accidents occurred on the Northern line, while the other took place on the Central line. Both accidents involved tube stock operating in ATO and the investigations into them identified factors which are similar to those present in the accidents at Archway and Chalk Farm.

158 RAIB's report into a passenger trapped in train doors and dragged at Clapham South station 12 March 2015 (RAIB report 04/2016) found that:

- The passenger was unable to remove their coat from the door after it became trapped. The door control system did not detect that the clothing was trapped.

- CCTV did not allow the train operator to see that the passenger was trapped.

159 RAIB's report into a passenger trapped and dragged at Notting Hill Gate station, 31 January 2018 (RAIB report 14/2018) found that:

- The passenger was unable to remove their bag from the door after it became trapped.

- The train door did not detect that the bag strap was trapped.

- CCTV did not adequately assist the train operator in detecting a passenger was trapped.

160 Recommendations made by RAIB identified areas where some risk mitigations for trap and drag accidents could be improved (paragraph 137 and see paragraph 170).

Subsequent occurrences of a similar character

161 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 continued with the journey. An investigation undertaken by LUL found that:

- The passenger was obscured by other passengers on the platform.

- Their image was small on the in-cab monitor.

- The platform on the day was very busy due to an event nearby.

162 On 21 February 2024, an accident occurred at Bank station on the Central line when a passenger's coat became trapped in the closing door of a train. The passenger had approached the train with the intention to board but stepped back once the doors started to close. The passenger tried to pull their coat free but was unable to do so. The train then started to move and the passenger was dragged along the platform for approximately 25 metres.

163 The train operator saw that the passenger was moving with the train as it departed and used the emergency brake stop the train. The passenger did not sustain serious injuries. The train operator in this case had seen the passenger approach the door and step back but did not believe they were trapped when they decided that it was safe to depart.

Summary of conclusions

Immediate causes

164 At Archway, the passenger was trapped while alighting the train and was dragged along the platform (paragraph 56).

165 At Chalk Farm, the passenger was trapped while attempting to board the train and was dragged along the platform (paragraph 101).

Causal factors

166 For both accidents, the causal factors were:

    a. The passenger's coat became trapped in the closing doors and was not released before the train started to move (paragraphs 59 and 100). This causal factor arose due to a combination of the following:

        i. The passenger's coat got trapped in the closing door (paragraphs 62 and 106, **Recommendations 1, 2 and 3**).

        ii. The trapped coat was not released from the door before the train started to move (paragraphs 76 and 109, **Recommendations 1 and 2**).

    b. The train was able to depart with the passenger's coat trapped in the doors (paragraphs 82 and 111). This causal factor arose due to a combination of the following:

        i. The train's door control systems did not detect the trapped coat (paragraph 84, **Recommendation 2**, **Learning point 3**).

        ii. No changes had been made to the door seals on 1995 stock trains in response to previous RAIB recommendations (paragraph 86, **Recommendations 1 and 2**).

    c. At Archway, the train operator was unaware the passenger was trapped in the doors before starting the train (paragraph 88, **Recommendations 2 and 4**).

    d. At Chalk Farm, the train operator did not detect the passenger was close to the doors before starting the train (paragraph 118, **Recommendations 2 and 4**)

    e. Additionally, the train operator at Chalk Farm did not see the passenger during departure from the platform (paragraph 130, **Recommendation 2 and 3**)

Underlying factors

167 The underlying factors for both accidents were:

    a. It is possible that the train operators' actions may have been affected by automatic train operation system in use on the Northern line (paragraph 134, **Recommendation 4**)

    b. LUL's methods for managing the safety of the platform-train interface were not sufficiently effective at controlling the risk to passengers getting trapped by their clothing in closing doors (paragraph 138, **Recommendation 1**).

Additional observations

168 Although not linked to the cause of the accidents on 18 February and 20 April 2023, RAIB observes that:

a. The data used in The London Underground Quantified Risk Assessment did not fully reflect the risk of a trap and drag accident (paragraph 143, **Recommendation 1**).

b. LUL did not report the accidents at Archway and Chalk Farm to RAIB (paragraph 150, **Learning point 2**).

c. Records relating to train operator action plans and training updates were not available to RAIB's investigation (paragraph 153, **Learning point 1**).

d. While there is no evidence that either train operator was impaired by drugs or alcohol, LUL did not follow its own processes for testing staff involved in a serious accident (paragraph 155, no recommendation – see paragraph 180).

Previous RAIB recommendations relevant to this investigation

169 The following recommendations, which were made by RAIB as a result of its previous investigations, have relevance to this investigation.

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

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

170 RAIB considers that more effective implementation of work arising from the first three bullet points of recommendation 1 in RAIB report 04/2016 could have addressed the causal factors in these accidents associated with train operator awareness of passengers before initiating train departure.

171 Recommendation 1 reads as follows:

> *The intent of this recommendation is to ensure that London Underground continues to improve management of PTI risks by building on work already started by a group established after the Clapham South accident. The time-bound, funded programme provides a means for London Underground to demonstrate its long-term commitment to reducing these risks where reasonably practical.*
>
> *London Underground should review the feasibility and effectiveness of measures to reduce risks associated with passengers being trapped in train doors and then dragged at the platform-train interface (PTI). The review should include measures already considered for all or part of the London Underground network, techniques already used by other railway operators, measures already considered by RSSB and measures made possible by the latest technology available when the review is undertaken. The review should include, but not be restricted to, consideration of:*
>
> - *improving detection of objects trapped in train doors;*
>
> - *improving the ability of passengers to pull out objects trapped in doors (including by improving door seal arrangements);*
>
> - *improving train operator views of the PTI at despatch (eg increasing the number of CCTV cameras, repositioning cameras and providing larger monitors);*
>
> - *enhancing the methods available to staff performing SATS duties when they need to alert train operators, or stop trains, in an emergency;*
>
> - *using gap fillers or alternative means to reduce the gap between platforms and both moving and stationary trains;*
>
> - *adapting platform markings to reduce passenger crowding close to trains/doors; and raising passenger awareness of the safety risks associated with objects, fingers and hands becoming trapped in doors.*

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

172 The safety authority for railways in Great Britain, ORR, reported to RAIB on 8 March 2017 that LUL had implemented this recommendation. The actions taken by LUL in response included the publication of a PTI risk management strategy and the initiation of an extensive project to improve train operators' views from platform CCTV cameras.

173 LUL also reported that it had reviewed solutions for improving the detection of objects trapped in train doors. The review concluded that a double pushback system was neither safer nor practical, as this would cause the doors to detect fewer items and therefore place a higher reliance on staff identifying trapped objects. This would increase the risk of trapped objects not being detected which may lead to more dragging incidents. LUL considered that fitting a double pushback system to a single leaf door would require considerable structural work and was therefore not practical, and that the single pushback feature was already as low as reasonably practicable (ALARP). LUL also concluded that the best option would be to fit sensitive edge technology to any new train fleets and that the costs of retrofitting such technology to existing fleets was impracticable.

[Passenger trapped and dragged at Notting Hill Gate station, 31 January 2018, RAIB report, RAIB report 14/2018, Recommendation 2](#)

174 RAIB considers that more effective implementation of recommendations 2, 3 and 4 in report 14/2018 could have addressed one of the underlying factors that led to these accidents.

Recommendation 2 reads as follows:

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

London Underground should support train operators of ATO trains in maintaining attention and awareness by considering and, as appropriate, implementing task-related strategies that are based on established human factors knowledge and a review of current good practice (with specific reference to RSSB's ongoing project T113323). Such strategies may include (but not be limited to) interspersing more regular periods of manual driving where feasible, introducing additional task-focused vigilance activities, or providing alerts if ATO start is attempted before the system is ready.

175 ORR reported that LUL had completed actions in response to the recommendation on 27 April 2020. The action at that time was to establish a timebound plan for addressing the recommendations. LUL reported to RAIB that a review was undertaken in April 2023 and these actions have now been completed, and underload training and guidance has been introduced. Although several actions and workstreams were implemented in response to the recommendation, most of the workstreams focused on strategies and training relating to individual performance. The additional task-focused activities or manual driving were not considered to be feasible (paragraph 137).

176 Recommendation 3 reads as follows:

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

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

177 The recommendation was reported as implemented by ORR on 13 August 2019. The GAPS project is ongoing and has identified high-risk platforms, but neither platform involved in this investigation was identified as high risk, so were not included in the project.

178 Recommendation 4 reads as follows:

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

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

179 This recommendation was reported as implemented by ORR on 13 August 2019. The review resulted in specific training on scanning platforms for train operators being introduced (paragraphs 95 and 125).

Actions reported as in progress relevant to this report

180 LUL has carried out an internal investigation into the accidents at Archway, Chalk Farm and Green Park. The investigation report identified twenty recommendations. Actions in progress include:

- rebriefing relevant operational staff in the process for requesting post-accident drug and alcohol screening for all serious PTI incidents

- reviewing the position of the OPO CCTV camera at Chalk Farm southbound platform to improve the view of the tailwall

- reviewing the train operator competence assurance process for undertaking PTI duties

- improving train operator awareness and retention of the correct procedure for departing the platform safely, highlighting the importance of the final PTI check and also the need to continue to check the monitors for the entire time the train departs the platform

- reviewing the minimum viable door open dwell times to enable safer boarding and alighting of trains

- reviewing the maintenance arrangements for monitoring pull through forces to ensure they are managed within appropriate limits and tested after train door irregularity events

- confirming that incident response is consistent, that perishable evidence is secured, and that information which may be later required is preserved.

181 LUL met with RAIB to discuss notification criteria and has taken steps to ensure that trap and drag events will be correctly notified in the future.

Recommendations and learning points

Recommendations

182 The following recommendations are made:[7]

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

London Underground Limited should review its processes for managing the risk arising from trap and drag events on the Northern line. The review should include, but not be limited to:

- improving the speed at which accident and incident data, including that from trap and drag events is recorded, reviewed and incorporated in risk management systems (such as LUQRA) and other safety decision making processes

- accurately recording the severity of harm arising from trap and drag accidents

- assessing the validity of the mitigation assigned to existing control measures, such as door obstacle detection systems and train operators identifying passengers trapped in train doors.

Following this review, London Underground Limited should develop a timebound programme to review and update the relevant risk assessments and to identify any additional risk controls which are found to be appropriate.

This recommendation may also apply to other London Underground lines (paragraphs 166a.i, 166a.ii, 166b.ii, 167b and 168a).

---

[7] 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 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 (paragraphs 166a.i, 166a.ii, 166b.i, 166b.ii, 166c, 166d and 166e).

3   *The intent of this recommendation is to provide sufficient time for people to be able to alight safely from trains at stations where automatic train operation is in use.*

Considering the sequences of events detailed in this investigation along with relevant industry guidance and good practice, including from other railway operators, London Underground Limited should review the current minimum automatic train operation station dwell times to determine if passengers have sufficient time to safely alight or board trains.

Based on this review, London Underground should determine the minimum time needed for train doors to be open and available for use, and the effect which this will have on the associated minimum automatic train operation station dwell times.

London Underground Limited should produce a timebound plan and make any appropriate changes to automatic train operation station dwell times on any of its lines using this mode of operation (paragraphs 166a.i and 166e).

4   *The intent of this recommendation is to reduce the risk of train operators losing attention and awareness while operating automatic train operation trains.*

London Underground should review the environmental, organisational and job factors related to operating trains in automatic train operation mode to understand how underload may affect train operators. This review should specifically consider the effect that underload may have on undertaking safety-critical tasks, such as train despatch, and what improvements may be made to assist train operators in maintaining attention. These improvements should include consideration of how the driving task is designed and the cab environment as well as measures such as individual awareness and training (paragraphs 166c, 166d and 167a).

Learning points

183 RAIB has identified the following important learning points:[8]

1   Managers of train operators:

- should document action plans in accordance with company procedures and ensure that action plans are recorded and retained so that they remain accessible when later required (paragraph 168c)

- should record when safety briefings have been undertaken, including the names of the people briefed and date of the briefing (paragraph 168c).

2   Duty holders are reminded to promptly report serious, and potentially serious accidents to RAIB in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005 (paragraph 150). Not doing so can result in evidence loss and reduced safety learning (paragraph 168b).

3   The importance of trainers and managers ensuring the risks of relying on the pilot light when deciding whether it is safe to start the train from platforms, and the limitations of the system being able to detect small or thin objects, are completely understood by train operators (paragraph 166b.i).

---

[8] '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

ATO	Automatic train operation
CCTV	Closed-circuit television
LUL	London Underground Limited
LUQRA	London Underground Quantified Risk Assessment
OPO	One person operation
ORR	Office of Rail and Road
OTDR	On-train data recorder
PEA	Passenger emergency alarm
PTI	Platform-train interface
RAIB	Rail Accident Investigation Branch
SMC	System management centre
TOD	Train operator display

Appendix B - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses

- information taken from the OTDR of the trains involved

- CCTV recordings provided by LUL from Archway and Chalk Farm stations

- RAIB site visits, reconstructions, site photographs, observations and measurements

- a review of previous reported incidents and accidents

- LUL risk assessments, processes and procedures

- LUL investigation reports

- a review of previous RAIB investigations that had relevance to this accident.

This page is intentionally left blank