



Rail Accident Investigation Branch

Rail Accident Report



**Passenger dragged a short distance by a train
at Holborn station
3 February 2014**

Report 22/2014
October 2014

This investigation was carried out in accordance with:

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

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Passenger dragged a short distance by a train at Holborn station, 3 February 2014

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Summary

At about 19:00 hrs on Monday 3 February 2014, at Holborn station in central London, a passenger was dragged about ten metres along the platform by a departing Piccadilly line train, after her scarf became caught between the closing doors of one of the carriages.

The train had stopped normally in the platform and passengers had alighted and boarded. A member of staff on the platform signalled to the train operator, by raising a baton, to begin the process of closing the train's doors. As the train operator started to close the doors, a passenger arrived on the platform and moved towards the train, stopping as she realised that the doors were closing. As she stopped, the end of the scarf that she was wearing round her neck continued to swing towards the train and became trapped in the closing doors.

The train operator was unaware that the scarf was trapped. He started to move the train, and the passenger was dragged along the platform. The member of staff on the platform tried to help the passenger by catching hold of her, and she fell to the ground. This resulted in the scarf being forcibly removed from the passenger's neck and carried into the tunnel by the train. The passenger suffered injuries to her neck and back, but the actions of the member of staff may have saved her from being more badly hurt.

The investigation found that the force required to remove the trapped scarf is likely to have been less than the maximum specified in the relevant London Underground standard, but it may have been difficult for a person taken by surprise and being dragged along the platform to exert such a force.

The RAIB has made one recommendation to London Underground, covering possible improvements to the means available to staff to stop trains from departing if an emergency occurs during the train despatch process.

Introduction

Preface

- 1 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.
- 2 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.
- 3 The RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of all other investigations, including those carried out by the safety authority, police or railway industry.

Key definitions

- 4 All dimensions in this report are given in metric units. Where appropriate the equivalent imperial value is also given.
- 5 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report). These are explained in appendices A and B.

The accident

Summary of the accident

- 6 At about 19:00 hrs on Monday 3 February 2014, a passenger, who had narrowly missed being able to board a westbound Piccadilly line train (train 237) at Holborn station in central London, was dragged about ten metres along the platform by the departing train after her scarf had become caught between the closing doors.
- 7 She fell to the ground and the scarf was pulled from her neck as the train moved away.

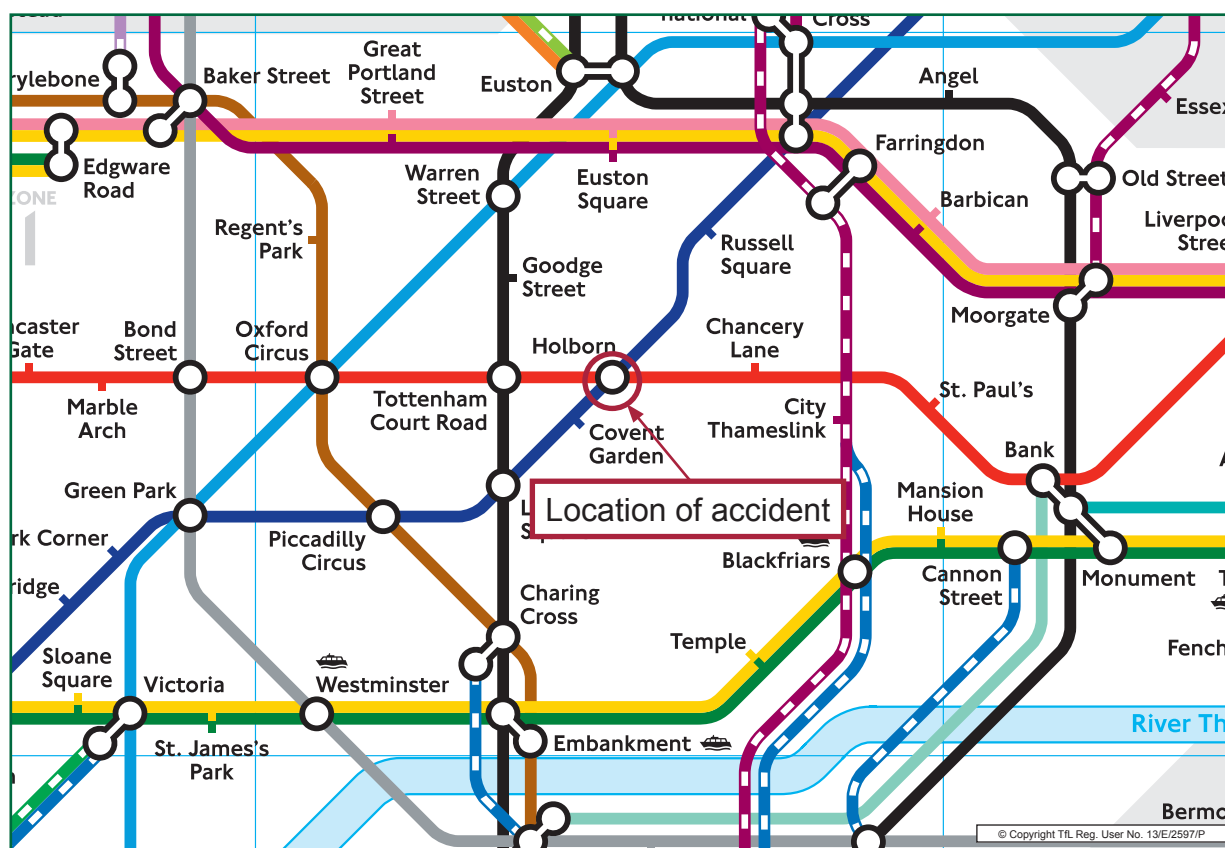


Figure 1: Location of accident

- 8 The passenger suffered injuries to her neck and back, and was taken to hospital for treatment. There was the potential for a more serious outcome if her scarf had not come free and she had been dragged to the end of the platform.

Context

Location

- Holborn station is an interchange between the Piccadilly and Central lines of London Underground. The Piccadilly line platforms were opened in 1906 and have remained substantially unaltered, although the station was rebuilt in 1933 when the Central line platforms were added. The westbound platform is on the left-hand side of the line in the direction of travel. There are three entrances to the platform in normal use, and the accident occurred opposite the entrance closest to the rear of trains



Figure 2: Westbound Piccadilly line platform at Holborn, viewed from the front of the train.

Organisations involved

- London Underground Limited (LUL) owns, operates and maintains the infrastructure, stations and trains of the Piccadilly line, and employs the staff who were involved.
- LUL freely co-operated with the investigation.

Train involved

- The train involved was a 6-car electric train of LUL's 1973 *tube stock*, which was built in 1975. The accident occurred at the leading set of double doors of the fourth vehicle from the front of the train.

Staff involved

- The train operator (driver) had about six years' train driving experience, all of it on the Piccadilly line. He had been trained, certified as competent and managed by LUL in this role.

- 14 On duty on the platform at Holborn was a customer service assistant (CSA), acting in the role of station assistant (train services) (SATS)¹. He had worked for LUL for less than two years, and had been at Holborn station for four months at the time of the accident. He had been trained by LUL for the role which he was performing.

External circumstances

- 15 The accident took place underground. The weather conditions played no part in the sequence of events.

Events preceding the accident

- 16 The train had been in service all day on the Piccadilly line as train number 237. The train operator who was driving at the time of the accident took the train over from another train operator at Northfields at 16:57 hrs and drove it to Cockfosters, where it arrived at 18:22 hrs and departed at 18:26 hrs, running about 13 minutes late.
- 17 Another train operator, travelling on duty, joined the train at Arnos Grove and rode in the leading cab². The journey was uneventful, except for some difficulties with door *interlock* lights, which were not relevant to events at Holborn. Neither of the people in the cab noticed anything unusual during the train's call at Holborn.
- 18 The passenger and a relative had travelled into London from Essex, intending to go to Covent Garden station. They used the Central line from Liverpool Street, and changed at Holborn to complete their journey on the Piccadilly line.

Events during the accident

- 19 The train stopped at Holborn at 18:59:04 hrs (times from station CCTV), and the doors began to open one second later. After the doors had been open for 17 seconds, the SATS raised his baton to signal to the train operator that the train despatch procedure could begin (see paragraph 28).
- 20 The doors began to close at 18:59:31, and at the same moment the passenger arrived on the platform, emerging from the entrance opposite the leading set of double doors on the fourth car of the train. She reached the edge of the platform two seconds later, and stopped because the doors had almost closed. As she stopped, one end of the scarf that she was wearing became trapped between the door leaves. She turned towards the SATS, who was standing next to her on the platform, and said that her scarf was caught.
- 21 At 18:59:38, five seconds after the doors finished closing, the train began to move. The passenger started to move with it. Three seconds later the SATS, wanting to try and get the scarf free, leaped forward and made a grab for the passenger (figure 3), she fell to the ground, and the scarf unwound from her neck. The train continued into the tunnel, with the scarf still trapped in the doors.

¹ Customer service assistants perform several roles in London Underground stations, including helping passengers to buy tickets and advising them on their journeys, staffing ticket gate lines, and providing assistance and making announcements on platforms. One of these roles is that of SATS (paragraph 31).

² LUL staff in uniform are only permitted to travel in the cabs of trains if this is part of their duties (such as for training purposes), and not just for journeys around the system.



Figure 3: the SATS pursues the trapped passenger as the train moves off (image courtesy LUL)

Events following the accident

- 22 The train operator was unaware of the accident, and the train continued in service. Station staff at Holborn notified LUL's Piccadilly line controller of the accident, and the controller traced the train involved. By the time this had been done, the train had reached Gloucester Road, where it was taken out of service.
- 23 Staff at Holborn station attended the passenger, and called an ambulance. She was taken to hospital, and released after treatment for bruising and abrasions to her neck, arms and legs. At the time of publication of this report, she informed the RAIB that she was still experiencing some pain when turning her head.
- 24 LUL staff made inquiries at Covent Garden (the station after Holborn) and at South Kensington (the next station where the platform is to the left of the line), but the scarf could not be found, and it has not been recovered.
- 25 The train was taken to Northfields depot for examination. LUL staff carried out the routine tests on the doors of the vehicle involved in the accident that are laid down in the company's standards, and no faults were found. The train was released back into service the following day, following discussions between LUL and RAIB.

The investigation

Sources of evidence

26 The following sources of evidence were used:

- witness statements;
- data from the train's on-train data recorder (OTDR);
- closed circuit television (CCTV) recordings taken from Holborn station;
- RAIB site photographs and measurements;
- tests by RAIB and LUL on the doors of the train; and
- a review of previous RAIB investigations that had relevance to this accident.

Key facts and analysis

Background information

27 Trains on the Piccadilly line, in common with the rest of the London Underground network, are operated by one person. At each station, part of the train operator's responsibilities is to open and close the train doors, and check that it is safe to move the train from the platform. LUL Rule Book 8 'Managing the platform train interface' says, at section 3.5:

Despatching the train

Train operator's actions

You must:

- *check the station starting signal is clear [ie showing the train can proceed]*
- *check the entire platform train interface*
- *close the doors and check the doors closed visual³*
- *check the entire platform train interface again.*

You must then:

- *check that the station starting signal is still clear*
- *make a final check of the platform train interface*
- *start your train*
- *check the in-cab monitors (if fitted) as your train leaves the platform.*

28 LUL does not require station platforms on its network to be staffed. However, LUL has arrangements in place to provide staff on certain platforms at busy times to assist passengers and expedite the flow of people, and the movement of trains in and out of the station. Duties of staff working on platforms are also described in LUL Rule Book 8, section 3.1. The text is addressed to the platform staff:

Dwell times

Station dwell times must be kept to a safe minimum. Where platform staff are available they will make announcements to customers to inform them when the train is ready to depart.

When it is time for a train to depart and the station starting signal is showing a proceed aspect, you must tell customers:

- *that the train is ready to depart*
- *to stand clear of the doors, and*
- *to stand back behind the yellow line.*

You must then:

- *indicate to the train operator that you have done this, using a baton or raised hand, and*
- *continue to show this indication until the first car of the train has left the platform.*

³ This is an indicator light in the train operator's cab which is lit when all the train doors are detected as closed and locked.

- 29 The duties of platform staff in an emergency are described in section 3.5 of Rule Book 8:

If an emergency arises as the train is leaving the platform

You must try to stop the train by using any of the following methods (as appropriate):

- *emergency stop signal*⁴
- *emergency stop plunger*⁵
- *headwall tunnel telephone*⁶
- *section ahead plunger*⁷
- *traction current plunger*⁸

If you cannot stop the train, you must immediately tell the controller what has happened.

- 30 In this same section the following text is addressed to the train operator:

You must stop your train immediately if:

- *you see an emergency stop signal, or*
- *you become aware that traction current has been switched off before the train reaches the last car count-up marker*⁹.

- 31 London Underground customer service assistants perform a number of duties, including working at ticket gate lines, in control rooms and on station platforms. At certain times (which LUL defines for each station where this applies) they perform the SATS role on busy platforms. When a member of staff is on duty performing the SATS role, a white board with a black letter **S** is placed on or near the *headwall* of the platform, to indicate the SATS presence to train operators.

⁴ Given by waving both arms above the head: see paragraph 54.

⁵ A control which, when operated, removes the electronic code which is required for automatic train operation, thus stopping the train.

⁶ A telephone mounted on the wall at the leading end of the platform, communicating with the line controller, which when used cuts off the electric current supply to the track in the station area.

⁷ A control which, when operated, cuts off the electric current supply to the track in the section immediately beyond the station, which tells the train operator to stop a train which is leaving the station.

⁸ A control which, when operated, cuts off the electric current supply to the track in the station area.

⁹ Count-up markers are fitted to the side of the line on the exit from each station platform, and indicate to the train operator how many cars length the cab is beyond the platform. If a passenger emergency alarm is operated or if traction current is switched off while a train is leaving a station, the train operator must stop if any part of the train is in the platform. The last car count-up marker is the train's length from the platform end.

- 32 Training material produced by LUL ('Customer Service Assistant Handbook 11 SATS/Detrainments', version 1, October 2013) gives a further explanation of the duties of customer service assistants when they are carrying out SATS duties:

The CSA platform duties can be split into five activities:

1. *Preparing the platform before the train arrives; this includes positioning the "S" board on or near the headwall, then taking up a position themselves so that they will be seen by the Train Operator and have the best available view of the platform, also by making relevant announcements, including asking customers to stand behind the yellow line.*
2. *Monitoring the platform from the train's arrival until the doors open, again by making relevant announcements.*
3. *Checking the PTI¹⁰, during the time the train doors open until they close. In doing this be on the look out for late boarders and customers being trapped in the doors.*
4. *Manage platform dwell times and give customers advice via the public address system.*
5. *Raising the baton and watching the train as it leaves the platform.*

- 33 The same document defines the equipment used by SATS and its method of use:

Batons

White plastic batons with a white cross on a black background are raised by SATS on the platform to indicate to the Train Operator that it is time to commence the door close procedure.

Use of Batons

When the station starter clears, give a PA announcement "Stand clear of the doors, this train is ready to depart". Raise the baton. Again give a PA announcement. "This train is now ready to depart. Please stand clear of the closing doors". The baton should remain raised until the first car of the train has passed the headwall or end of the platform barrier. On platforms with Platform Edge Doors¹¹ (PED's), it is only necessary to maintain the baton in the raised position until the train moves off.

- 34 On the westbound Piccadilly line platform at Holborn, one SATS is scheduled to be in position on weekdays between 16:15 hrs and 19:00 hrs.

¹⁰ Platform-train interface, ie the side of the train and the edge of the platform along the whole length of a train.

¹¹ Platform edge doors operate automatically, and are part of a barrier which separates passengers from moving trains. They are fitted on the Jubilee line between Westminster and North Greenwich.

Identification of the immediate cause¹²

35 The passenger's scarf became trapped in the doors of the train.

36 The station CCTV shows the passenger approaching the train and stopping in the face of the closing doors. She was wearing a lightweight scarf wound once around her neck, with both ends hanging down to just above her knee level. One end of the scarf was blown upwards (possibly in a current of air coming from the platform entrance through which she had just come) as the passenger stopped, and it was caught by the final movement of the doors.

Identification of causal factors¹³

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

- the passenger was near to the train doors when they closed;
- the passenger did not pull the scarf out from the doors before the train began to move (paragraph 38);
- the SATS did not alert the train operator to the situation (paragraph 52);
- the train operator did not see the scarf trapped in the doors (paragraph 58);
- the train operator was able to start the train despite the scarf being trapped in the doors (paragraph 63); and
- the train operator was unable to see what was happening on the platform after the train had begun to move (paragraph 66).

Each of these factors is now considered in turn.

The trapping of the scarf

38 The passenger was near to the train doors when they closed.

39 While the train was stationary at the platform, the SATS made announcements advising passengers that it was ready to depart, and to stand clear of the doors (paragraph 28). CCTV evidence indicates that he finished making these announcements about two seconds before the passenger arrived on the platform, at the moment that the doors began to close. She stopped close to the platform edge and did not attempt to board the train or obstruct the doors, but her scarf became trapped, as described in paragraph 36.

40 The passenger did not pull the scarf out from the doors before the train began to move.

41 There was a short period (about five seconds) between the scarf becoming trapped by the closing doors and the train starting to move. It seems likely, from the witness evidence, that during this time the passenger believed, firstly, that the doors would re-open because the scarf was trapped, and secondly, that the member of staff (the SATS) who was standing close by was in a position to do something about the situation.

¹² The condition, event or behaviour that directly resulted in the occurrence.

¹³ Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

42 It is probable that it was for these reasons that she did not immediately try to pull the scarf out of the doors, having tugged it and confirmed that it was trapped. The force required to pull out the scarf was probably about 70 N (7 kgf, 15 lbf) while the train was stationary (see paragraph 49) and it is likely that a sharp pull at this stage would have freed it.

43 The passenger was not able to pull the scarf out from the doors once the train had begun to move.

44 The doors of 1973 stock trains are operated by compressed air motors, controlled by buttons in the driving cab. The performance of the doors and their control system is defined by LUL (Tube Lines) standard 2-055, issue A1, of August 2008 'Rolling stock bodyside sliding doors & door control system'.

45 This standard defines the requirement for the door edge seal:

The seal will allow a piece of double thickness canvas, to drawing 76340, to be pulled through the door edge seals at right angles to the door leaf and at a height of 1.2 m ± 0.25 m with the doors closed with a force no more than 90N [9 kgf or 20 lbf] thus preventing injury to trapped limbs and also allowing trapped objects to be easily removed. (This requirement represents a pull through of passenger clothing)

46 Each pair of double doors has one leaf which is locked in position when the doors are closed, and one which can be pushed back against a spring to allow the release of trapped objects. The force required to push back this leaf is specified as 80-110N (8 to 11 kgf, or 18 to 24 lbf) for the first 5 mm, rising to 140-170N (14 to 17 kgf or 31 to 38 lbf) at 110-115 mm of opening. When the doors involved in the accident were tested by LUL on 4 February 2014, pushback force values of 96N (10 kgf, 22 lbf) and 153N (15 kgf, 34 lbf) respectively were recorded for the 0-5 mm and 110-115 mm openings.

47 The door seal is made by rubber door edgings, which are shaped with convex (the fixed door) and concave (the pushback door) profiles. These interlock to make a weatherproof seal. Drawings of the seal profile are at figure 4. The door seals on the train involved in the accident were smooth and in good condition, with no irregularities or significant wear. In common with most¹⁴ other types of train doors on LUL, the doors will not re-open automatically if an obstruction is detected.

48 The scarf worn by the passenger was not recovered after the accident (paragraph 24), but it is known to have been knitted, and made from wool (it is likely that it had plain ends, without knots or tassels). RAIB carried out tests on the doors involved, using a loose-weave mohair scarf which was probably reasonably representative of the actual scarf involved in the accident (figure 5).

¹⁴ The exceptions to this are the 09 stock trains used on the Victoria line and the S stock trains used on the Metropolitan, Circle, Hammersmith & City and District lines, which have sensitive door edges.

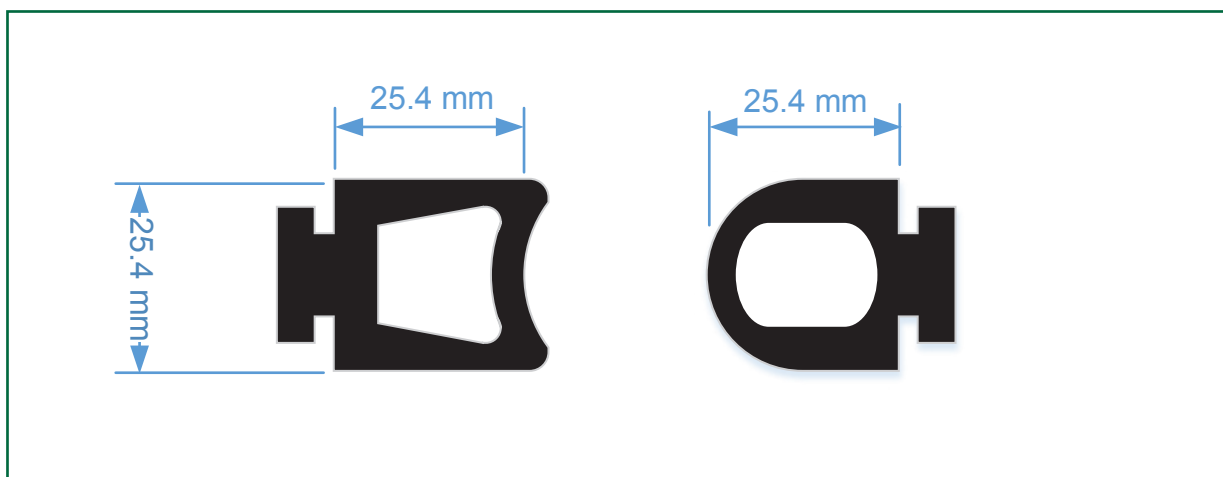


Figure 4: Profile of door edges



Figure 5: scarf during tests at Northfields depot

- 49 In these tests, the force required to pull out the scarf at right angles to the door leaf was approximately 70N. This is equivalent to 7 kgf (15 lbf), and could have been achieved by a sharp tug at right angles to the door (LUL's standard requires a maximum of 90N (9 kgf or 20 lbf) (paragraph 45)). However, in the accident, once the train started to move, the scarf was being pulled at an angle to the side of the train, and in the direction of travel, it was pulling against the fixed leaf of the closed doors. Replicating these conditions in tests, the RAIB found that the force required to pull out the scarf varied between 80 and 110N (8 to 11 kgf, or 18 to 24 lbf).
- 50 Exerting such forces is unlikely to present any difficulty to a person who is prepared for the action, and standing still on a good surface. However, if a person is taken by surprise by an unexpected event, and is then faced with having to pull something free while being pulled alongside a moving train, they may find it much more difficult to exert the necessary force. In this case, the passenger had less than five seconds to react to the situation between her scarf becoming caught and the train starting to move (paragraphs 41 and 42). She was able to get one hand to the scarf briefly, but when the train moved the scarf was pulled out of her hand, and she appears from the CCTV images to have been caught off-balance and dragged along the platform as the scarf was pulled tight around her neck. When she fell, the scarf was pulled off her neck and over her head, and its end remained trapped in the doors.
- 51 The tests carried out by the RAIB showed that the force required to pull the scarf out at right angles was likely¹⁵ to have been within the specification set by LUL, which requires a lower force than the standards used on the main line network¹⁶. The force needed to pull the scarf out at an angle was in some cases higher than the LUL specification, although still within the main line standard, and in all cases the results are less than the level of force which most adults are likely to be able to exert without difficulty¹⁷, in favourable circumstances (ie when both passenger and train are stationary).

The actions of the SATS

52 The SATS did not alert the train operator to the situation.

- 53 The LUL Rule Book lists the ways (paragraph 29) in which trains can be stopped in an emergency. For the SATS on the platform at Holborn, the only option available was to make the emergency stop signal: the others involved equipment which was either not fitted on that platform, or not close at hand.

¹⁵ Although the actual scarf was not recovered, the scarf used in the tests was almost certainly made of a thicker and rougher fabric, which would have required more force to pull out.

¹⁶ Railway Group Standard GM/RT2473, which uses a thin solid object rather than a piece of fabric, and requires a maximum extraction force of 150 N (15 kgf or 34 lbf). This standard has recently been reviewed and is due to be issued as a Euronorm (EN) standard in the near future. In its investigations into accidents at Huntingdon in 2006 and King's Cross in 2011 (paragraph 83), the RAIB found that the pull-out force required for objects trapped in the doors of class 365 trains on the main line network was significantly higher than specified in GM/RT2473 (the requirements in the standard were introduced after the class 365 trains were placed into service, and did not apply to trains which were already built), and there was no practicable way of modifying the door design to reduce it because these trains have sliding plug doors which lock into place.

¹⁷ Guidance on the Manual Handling Regulations 1992, published by the Health & Safety Executive, indicates that for pulling and pushing, between knuckle and shoulder height, a guideline figure of 20 kgf (200 N or 45 lbf) for men and 15 kgf (150 N or 34 lbf) for women is appropriate (<http://www.hse.gov.uk/pubns/priced/l23.pdf>).

- 54 The emergency stop signal is defined in LUL Rule Book 21 'Personal safety on the track'. It is given by waving both arms above the head, or by waving a red handsignal (or anything else) across the body. The SATS had been trained in the meaning of this signal, but he had never had to make use of it.
- 55 The SATS saw the scarf become trapped in the doors. He stated that he assumed that the doors would re-open because the interlock between the doors and the traction control would prevent the train from moving (as described in paragraph 64), and the train operator would re-open the doors to resolve the problem. When this did not happen, he was unsure what to do next.
- 56 By the time that the SATS realised that the train doors were not going to open to release the scarf, the train was on the point of moving off. He moved forward to attend to the passenger.

The actions of the train operator

- 57 The train operator did not notice the trapped scarf, and he was able to start the train although the scarf was trapped in the doors. These factors are now considered in turn.

58 The train operator did not notice the trapped scarf.

- 59 The train operator noticed nothing unusual about the stop at Holborn, and was unaware that the accident had taken place until he was informed about it when the train reached Gloucester Road.
- 60 The train operator's view of the platform/train interface at Holborn is via two CCTV monitors, and a mirror which is mounted above the monitors. The monitor and mirrors are located on the platform immediately ahead of the cab when the train is stopped in the correct position in the platform (figure 6). The mirror shows the whole length of the train; the upper monitor shows the train from the centre of the second car rearwards; and the lower monitor shows the train from the centre of the fourth car rearwards.
- 61 Because their role in assisting customers can cause them to move along the platforms, SATS are not required to stand at specific points on the platform to signal to train operators. Before the accident, the SATS stood in a position opposite the centre of the fourth car. In this position his head and raised bat would have appeared prominently in the lower monitor. The accident occurred immediately forward of this point, out of the view in the lower monitor, and towards the background of the view in the upper monitor and the mirror (figure 6). This CCTV is only shown on the train despatch monitors, and is not recorded, so it was necessary to reconstruct what would have appeared on the monitors by using the footage from the station CCTV, which is recorded by different cameras.
- 62 In the view on the upper CCTV monitor, the passenger would have been shown standing immediately in front of the SATS, and it would have been difficult to distinguish between the two people. The scarf appeared on the CCTV as a thin diagonal line between the two people and the train, and it is unlikely that it would have been at all obvious to the train operator, because the passenger and the SATS did not move in a way that would have been likely to attract the train operator's attention until after the train began to move.



Figure 6: Train despatch mirror and CCTV monitors on Holborn westbound Piccadilly line platform, showing position of SATS as he would have appeared on both monitors

- 63 The train operator was able to start the train although the scarf was trapped in the doors.**
- 64 The train doors are fitted with equipment which is designed to detect an object 11 mm in diameter trapped in the bottom 450 mm of the doors. If such an object is detected, the train operator will not receive the doors closed visual light in the cab, or be able to take power to start the train. LUL standards do not require that all trapped objects should be detected, but in common with the main line railways, rely on a principle that it should be possible to pull out smaller objects (paragraph 51).
- 65 The scarf was made of a lightweight material that was gripped by the rubber door edges without causing any significant obstruction to the doors, and so it was not detected.

The accident was not visible to the train operator

66 The train operator was unable to see what was happening on the platform after the train had begun to move.

67 The Piccadilly line has external monitors and mirrors which the train operator must use to monitor the platform/train interface. As soon as the train begins to move, these displays (paragraph 60) pass out of the train operator's field of vision, and the view of the platform/train interface is lost.

68 It was therefore impossible for the train operator to see the events on the platform, and so the train continued without stopping.

69 More modern trains, on other Underground lines, have in-cab monitors which receive pictures by wireless link from platform-mounted cameras. These continue to show the views of the platform while the train pulls out of the station, and enable the train operator to keep checking the platform/train interface until the train has fully left the station.

70 The 1973 stock on the Piccadilly line is due for replacement by 2025. Modernisation of the line will include changes to train despatch methods.

Identification of underlying factors¹⁸

The role of the SATS

71 The SATS role is involved with the safe despatch of trains, but the equipment and procedures associated with the role do not enable the SATS to intervene effectively in an emergency.

72 LUL's procedures provide for SATS to be on duty on busy stations at peak times to improve the flow of trains and people through the station, so that risks arising from overcrowding are minimised. SATS do this by encouraging passengers to:

- use the full length of the platforms;
- stand back behind the yellow line;
- allow passengers off the train before boarding;
- pass right down inside the cars; and
- stand clear of the doors before and during the time the doors are closing.

73 They also use the baton to encourage train operators to start the despatch process promptly, thus reducing the station dwell time of trains. In between dealing with trains they provide advice and assistance to passengers. LUL's procedures do not give the SATS a formal safety role in the despatch process. LUL's CSA Handbook (paragraph 31) says:

Train Operators maintain overall responsibility for the closure of the doors and the departure from the platform. They must communicate with customers via the PA system in the event of service disruption or delay.

¹⁸ Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

- 74 In normal operations on LUL, the train operator is entirely responsible for viewing the platform/train interface to confirm that it is safe for the train to move. A SATS on the platform has no role in this part of the process, and signals to the train operator only to indicate that they have completed the duties listed in paragraph 72, and that it is time to commence the door closing process. However, the CSA Handbook refers to the need to check for people who attempt to board trains late in the despatch process, and people who may become trapped (although it does not give guidance on what should be done if a SATS encounters these situations (see paragraph 79)). This implies that the SATS has a safety role.
- 75 Under degraded conditions, ie if there has been a failure of the CCTV monitors and/or mirrors, platform staff may assist the train operator on certain platforms (which are defined as Category A in LUL's procedures) because the train operator cannot see the whole of the platform from the cab window. In these circumstances the member of platform staff views the portion of the platform that is out of sight of the train operator, and gives a hand signal to the train operator when it is safe for the train to depart. This method of despatch is also used, in normal working, at some stations on the main line network.
- 76 In this case the passenger may have assumed that the SATS was in a position to take immediate action to prevent the train from starting. This demonstrates that there may be potential for confusion, on the part of members of the public, about the role of a member of staff who is present on the platform, and signalling to the train driver with a baton.
- 77 Witness evidence indicates that the training given to CSAs who act as SATS tends to focus on expediting the flow of trains. However, as this accident shows, if something goes wrong during the despatch process, a CSA is potentially in a position to take action if they are on the platform carrying out SATS duties, or for any other purpose. The LUL rule book (see paragraph 29) requires platform staff to try to stop a train from leaving the platform by various means. Of those listed, only giving an emergency stop signal (waving both arms above the head) is likely to be practicable in the timescale available to a SATS who becomes aware of something trapped in train doors.
- 78 The time available for action in this case was very limited, particularly because the Piccadilly line uses external monitors/mirrors, so that the train operator loses visibility of the platform/train interface almost immediately the train has started to move (there was about seven seconds between the scarf becoming trapped and the train moving beyond the point where the monitors passed out of the train operator's view). This means that it is important for a CSA (acting as SATS) to react instantly to any emergency situation, to have any chance of being able to alert the train operator. In this case, the SATS, by force of habit, kept the baton raised while he assimilated what was happening and also when he leapt forward to grab the passenger as she was being dragged along.
- 79 It is not clear what purpose is served by keeping the baton raised until the first car of the train has passed clear of the end of the platform and into the tunnel (paragraph 33). The initial act of raising the baton indicates to the train operator that it is time to begin the process of closing the doors. LUL has confirmed to the RAIB that the train operator is not expected to stop the despatch process if they lose sight of the SATS baton, even if it is deliberately lowered.

- 80 A preoccupation with keeping the baton raised may have affected the way the SATS reacted to the trapping of the passenger's scarf. However, it is possible that the SATS would have been able to attract the attention of the train operator, if he had given an emergency stop signal as soon as he became aware of the problem with the scarf, but in the situation of a crowded platform and in the very limited time available, this possibility may be quite small.

Factors affecting the severity of consequences

The actions of the SATS

- 81 The SATS was standing close to the passenger when she arrived at the train doors. He moved quickly to try and grab the passenger as she was dragged away by the train. The passenger is not sure whether or not the SATS caught hold of her arm before she fell to the ground, which probably helped to unwind the scarf from her neck. The RAIB believes that, if the SATS had not been close by, and in a position to assist, it is still possible (given the relatively low 'pull-out' forces measured by RAIB) that the scarf might have been pulled free from the doors or unwound from her neck, but she might have been pulled a longer distance, come into contact with the side of the train and/or the equipment and headwall at the end of the platform, and been more seriously injured.

Previous occurrences of a similar character

- 82 At the same location, the westbound Piccadilly line platform at Holborn, on 21 October 1997, the last fatal accident of this type on the LUL system occurred in similar circumstances, and involved the same type of train. It is described in the HMRI annual report on railway safety for 1997-98:

A nine-year-old boy was accompanied by his guardian, but slightly ahead of him. The boy boarded a train and, probably realising that his guardian would miss the train, alighted as the doors were closing. A drawstring and toggle from his anorak became trapped in the closing door. The train driver was unaware of the problem and departed from the station. The boy was dragged along the platform and under the train. The cross-section of the drawstring was such that detection by the door safety system was not possible, if the doors were to operate reliably. The toggle prevented the drawstring from being pulled free of the closed door, and tragically the boy was killed.

There do not appear to be any factors associated with the location that could create any link between the 1997 and 2014 accidents.

83 Since it began operations in 2005, RAIB has investigated six accidents/incidents in which passengers have been dragged along platforms by departing trains or trams:

- At Huntingdon on 15 February 2006, a member of the public was standing on the edge of a platform seeing a passenger off, when he became trapped by the edge of his coat in the doors of a train. The train moved off, and the person ran, and then was pulled along the platform before falling down the gap between the train and the platform edge. He was seriously injured. The investigation found that the design of the door mechanism and door seals on the type of train involved provided sufficient closing force to trap the coat and prevent it from being easily removed (report 11/2007).
- At Wellesley Road, on the Croydon tramway, on 15 June 2007, a person who was attempting to board a tram may have got his hand or clothing trapped in the doors. The tram moved off and the person ran alongside it for a short distance before freeing himself (report 40/2007).
- At Tooting Broadway, on the Northern line of LUL, on 1 November 2007, the hem of a passenger's coat was trapped in the closing doors of a southbound Northern line train as she got off the train. The train moved off and the passenger was dragged for a short distance before she managed to remove the coat, falling onto the platform in the process. There were no members of staff on the platform. The investigation found that the train operator did not observe that all passengers were clear of the train doors before moving off, and that he did not monitor the in-cab CCTV screens as the train left the platform (report 17/2008).
- At King's Cross, on 10 October 2011, a passenger's hand became trapped in train doors when she attempted to board the train while the doors were closing. She was dragged about 20 metres along the platform before she was able to release her hand. The investigation found that a member of staff on the platform did not fully check the platform/train interface before signalling to the driver that the train could depart. The train was of the same type as in the Huntingdon accident (see above), and in the period between the two events the train operator had reviewed options to reduce the force required to withdraw objects trapped in the doors (in response to a recommendation made by the RAIB), and had been unable to find any practicable method of doing so (report 09/2012). ORR reported to RAIB in June 2014 that the operator has since reported that it has decided to modify the design of the doors by fitting a sensitive edge, and that a contract has been placed for the modification to be made as the trains undergo refurbishment.
- At Jarrow, on the Tyne and Wear Metro, on 12 April 2012, a passenger attempting to board a train placed her arm in the path of the closing doors, and became trapped. The train moved off, and the passenger was forced to run alongside it. A timely activation of the emergency door release by a passenger inside the train enable the trapped person to free herself, and she fell onto the platform. The investigation found that there was a fault on the set of doors involved in the incident, which disabled the obstruction detection system, and that the driver did not notice the trapped passenger (report 26/2012).

- At Newcastle Central, on 5 June 2013, a passenger was unable to remove her hand when it became trapped between a pair of leaves of an external door of a train that was about to depart from platform 10. The train started to move and she was forced to move beside it to avoid being pulled off her feet. The train reached a maximum speed of around 5 mph (8 km/h) and travelled around 20 metres before coming to a stop. The passenger was able to stay on her feet but suffered soft tissue damage to her wrist and was very shaken. The investigation found that the conductor of the train had not carried out a final safety check before signalling to the driver that it was safe to depart, and that, in certain circumstances, the design of the doors permitted an object such as an adult's wrist to be trapped and not detected (report 19/2014).

RAIB made recommendations for improvements to safety in all of these investigation reports (except for the Wellesley Road incident). However, none of the recommendations are directly relevant to the circumstances of the accident at Holborn, because they did not relate to the process for stopping trains in an emergency.

Summary of conclusions

Immediate cause

84 The passenger's scarf became trapped in the doors of the train (**paragraph 35**).

Causal factors

85 The causal factors were:

- a. The passenger was near to the train doors when they closed.
- b. The passenger did not pull the scarf out from the doors before the train began to move (**paragraph 38**).
- c. The passenger was not able to pull the scarf out from the doors once the train had begun to move (**paragraph 43**).
- d. The SATS did not alert the train operator to the situation (**paragraph 52, Recommendation 1**).
- e. The train operator did not notice the trapped scarf (**paragraph 58**).
- f. The train operator was able to start the train although the scarf was trapped in the doors (**paragraph 63**).
- g. The train operator was unable to see what was happening on the platform after the train had begun to move (**paragraph 66**).

Underlying factor

86 An underlying factor was that the SATS role is involved with the safe despatch of trains, but the equipment and procedures associated with the role do not enable the SATS to intervene effectively in an emergency (**paragraph 72, Recommendation 1**).

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

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

- 87 LUL reports that its Network Operational Learning team have modified the training courses for any staff who may operate at the platform edge. This is to raise awareness of the ways in which staff can take rapid and effective action to signal a train operator not to start the train should any emergency or out-of-course event occur.

Recommendation

88 The following recommendation is made¹⁹:

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

London Underground Ltd should provide staff acting as Station Assistant (Train Services) (SATS) with an effective means of alerting the train operator to a dangerous situation that arises after the SATS has given the signal to start the door closing sequence, and before the train has begun to move (paragraphs 85d and 86).

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

¹⁹ Those identified in the recommendation, 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, this recommendation is addressed to the Office of Rail Regulation 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.raib.gov.uk.

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed circuit television
CSA	Customer service assistant
LUL	London Underground Ltd
ORR	Office of Rail Regulation
OTDR	On-train data recorder
PA	Public address
PTI	Platform-train interface
SATS	Station assistant (train services)

Appendix B - Glossary of terms

Dwell time	The time that trains spend stationary in a platform.
Headwall	The wall at the end of the platform of a London Underground station, where trains enter the tunnel leading away from the station.
Interlock	An electronic or electro-mechanical system which prevents a train from being moved under power if the doors are not closed and locked.
Starting signal	On London Underground, the signal at the end of a platform which controls admission of trains into the section of line towards the next station.
Tube stock	London Underground trains designed to run in the deep-level tunnels of the Central, Piccadilly, Bakerloo, Northern, Victoria, Jubilee and Waterloo and City lines. They are of restricted size compared to main line and sub-surface trains.

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