RAIB

Rail Accident Investigation Branch

Rail Accident Report

Dangerous train door incident at Bank station on the Docklands Light Railway 6 February 2017

Report 12/2017
September 2017

This investigation was carried out in accordance with:

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

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Preface

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

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

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

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

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

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

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

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

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Dangerous train door incident at Bank station on the Docklands Light Railway, 6 February 2017

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Summary

At around 21:30 hrs on 6 February 2017, at Bank Station on the Docklands Light Railway, part of a coat worn by a passenger on the platform became trapped in the closing door of a train. The passenger was unable to release the coat from the closed door, but managed to partially take off the coat before it was dragged from her as the train departed. The passenger was not injured, but was distressed by the incident.

The incident occurred because the part of the coat which was trapped was too small to be detected by the obstacle detection system fitted to the train door. Additionally, the design of the door nosing rubbers meant that a relatively high pull force was required by the passenger to extract her coat. The member of Docklands Light Railway (DLR) staff on the train was unaware that the coat was trapped. His position when dispatching the train meant that he was dependent on a CCTV system to observe the doors during the dispatch, but defects in this CCTV system meant that the staff member was unable to observe the door of the train at which the incident occurred.

As a result of this investigation, the RAIB has made three recommendations. One recommendation is made to Keolis Amey Docklands, in conjunction with Docklands Light Railway Limited, to review the design of door nosing rubbers with a view to reducing the forces needed to remove trapped objects. The second recommendation, made to Docklands Light Railway Limited, seeks that their specification for new trains to be procured gives adequate consideration to the safety learning from this investigation in relation to pull-out forces. The third recommendation is also made to Keolis Amey Docklands; this is to improve its processes for the management of platform observation equipment.

The RAIB has also repeated a learning point for staff responsible for the dispatching of trains; that door obstacle detection systems are not always able to detect small objects and therefore it is vital that a final, visual, safety check is made to ensure that no object is trapped in a closed door prior to a train being allowed to depart from a station.

Introduction

Key definitions

1 Metric units are used in this report.

2 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. Sources of evidence used in the investigation are listed in appendix C.

The incident

Summary of the incident

3 At around 21:30 hrs on Monday 6 February 2017, a passenger approached a Docklands Light Railway (DLR) train service standing at platform 9 at Bank station (figure 1). As she neared the leading train door (identified as door leaves B1 and B2), the door closed. Part of the passenger's coat, the drawstring used to tighten the coat around her waist, became trapped between the leaves of the closed door. The passenger managed to partially take off her coat before the train moved away from the platform. The departing train dragged the coat from the passenger and into the tunnel beyond Bank station.

4 The passenger remained on the platform at Bank station. She was uninjured, but distressed by the incident. Her coat was subsequently recovered by railway staff from the tunnel, between Bank station and the next station at Shadwell.

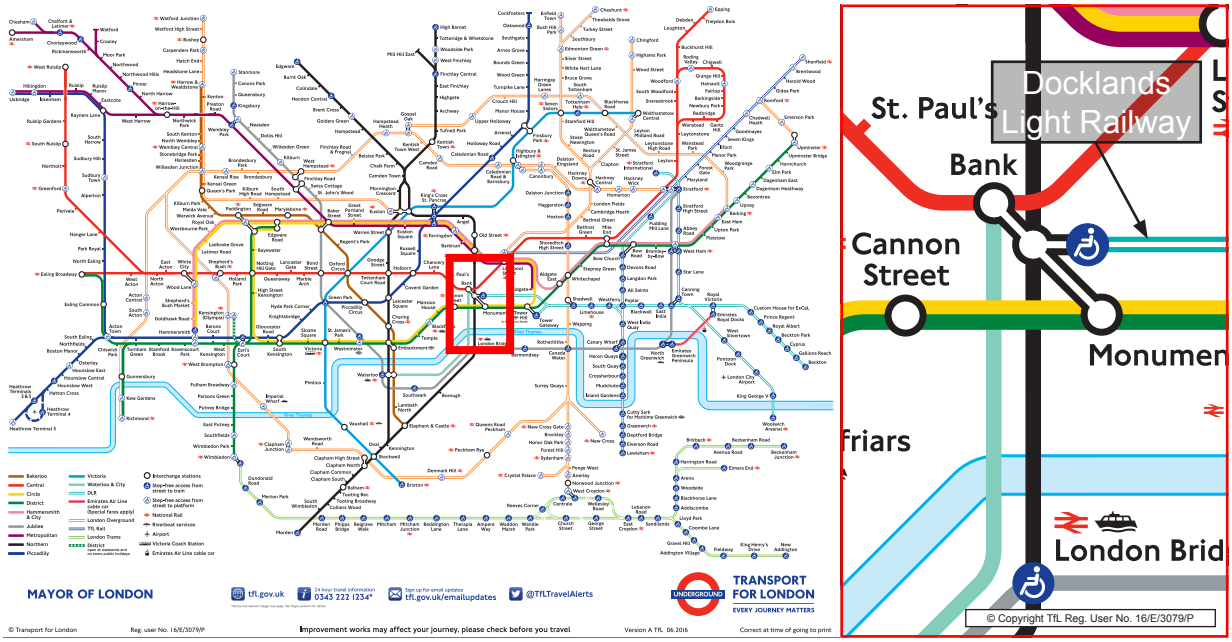

Figure 1: TfL network map and extract showing location of the incident

Context

Location

5 Bank station is located in the City of London. The station is a large underground complex serving three London Underground lines in addition to the DLR (figure 1). Bank station is linked by underground passages to Monument station, which serves two further London Underground lines. Platforms 9 and 10 are used exclusively by DLR trains.

6 Bank station is the westernmost extremity of the DLR network. All DLR trains arriving at Bank terminate at platform 10. Passengers alight from an arriving train and the empty train then moves into a *headshunt* beyond the station. The train then reverses direction and is routed into platform 9 where passengers embark prior to the train departing towards the east.

Organisations involved

7 Keolis Amey Docklands (KAD) is responsible for the operation of the DLR. KAD employed the Passenger Service Agent (PSA) on the train involved. KAD is also responsible for most of the system maintenance, including all maintenance of the trains.

8 KAD operates the system under a franchise agreement with Docklands Light Railway Limited (DLRL). This franchise agreement commenced in December 2014. DLRL is a wholly-owned subsidiary of Transport for London (TfL).

9 The station infrastructure used by KAD at Bank is owned by London Underground Limited (LUL) and is leased to DLRL. KAD is responsible for the maintenance of the DLR infrastructure at Bank, with certain exceptions. One such exception is the maintenance of the CCTV system on platforms 9 and 10, which remains the responsibility of LUL.

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

Train involved

11 The train involved was scheduled to depart from Bank station at 21:30 hrs and travel to Lewisham. This service was part of a planned series of journeys known as Run 215 and it was operated by a train formed from three cars, numbers 109, 138 and 128. Car 109 was leading at the time of the incident.

12 Train services on DLR are operated using two different types of cars. The older cars, introduced in stages between 1991 and 2001, are designated B90, B92 or B2K. The newer cars, of the type involved in the incident, are designated as B2007 and were introduced from 2008 (figure 2). All of the current DLR rolling stock was constructed by Bombardier Transportation. Each car comprises two individual vehicles, which are *articulated*.

Figure 2: A B2007 car similar to the one involved in the incident

13 DLR services are operated using two-car or three-car trains. The majority of services from Bank station are operated using three-car trains.

14 The RAIB found no evidence that the maintenance of the cars operating on Run 215 contributed to the incident.

Staff involved

15 Each DLR train carries a PSA. The PSA is responsible for closing the doors on the train prior to departure from each station. The PSA also has other responsibilities, including revenue protection and customer care. At the time of the incident, the PSA was the only member of KAD staff on board Run 215.

16 The PSA had been in his post for more than ten years. He was fully certified in all areas of competency required for his role.

17 The RAIB found no evidence that the PSA was fatigued at the time, or that he was otherwise unfit to perform his role correctly.

18 KAD provides staff at Bank DLR station. At the time of the incident, they were not required to be in any specific part of the station area. They were not on platform 9, and their location and actions had no bearing on the incident.

External circumstances

19 The DLR platforms at Bank station are underground. They are dry and well-lit. The condition and lighting of platform 9 had no bearing on the incident.

The sequence of events

Events preceding the incident

20 On the day of the incident, the passenger arrived at Bank station from elsewhere in London having travelled on LUL's Northern Line. She was intending to travel to Greenwich and therefore made her way to platform 9. Her intention was to catch a DLR train towards Lewisham, which would call at DLR's Greenwich station.

21 The route from the Northern Line platforms at Bank station to the DLR is by means of the 'Northern Line Steps'. This is a series of passageways and staircases which route passengers to a cross-passage at the east end of the DLR station area (figure 3). This cross-passage leads directly onto platform 9 (figure 4). Run 215 arrived at platform 9 from the headshunt (paragraph 6) at 21:27:45 hrs.

Events during the incident

22 At 21:29:48 hrs, the PSA attempted to close the train doors. Another passenger, not directly involved in this incident, joined the train after the leading door had started to close. That action obstructed the door and caused it to partially re-open (paragraph 36).

23 The passenger, who was directly involved in this incident, entered platform 9 from the Northern Line Steps at 21:29:50 hrs. She recognised that the train standing in the platform was the one she needed to catch for her destination, and moved towards it with the intention of boarding the train through the leading door.

24 As the passenger approached the train, the door re-closed automatically after the earlier interruption to the closing sequence (paragraph 22). The passenger stopped close to the closing door.

25 The coat worn by the passenger was not fastened closed. It had a loose external drawstring around the waist. The drawstring was caught and trapped between the closing leaves of the door at 21:29:53 hrs.

26 The passenger attempted to pull the coat free but was unable to do so. She quickly recognised that she was in a hazardous situation, and managed to extract her left arm from the coat.

27 At 21:29:57 hrs, the train departed from platform 9. The coat drawstring was still trapped in the door. As the train departed, it pulled the coat from the passenger's back and off her right arm.

Events following the incident

28 The passenger reported the incident to the PSA on the next DLR train to arrive at platform 9.

29 The coat was subsequently recovered from the tunnel between Bank and Shadwell, and was returned to the passenger.

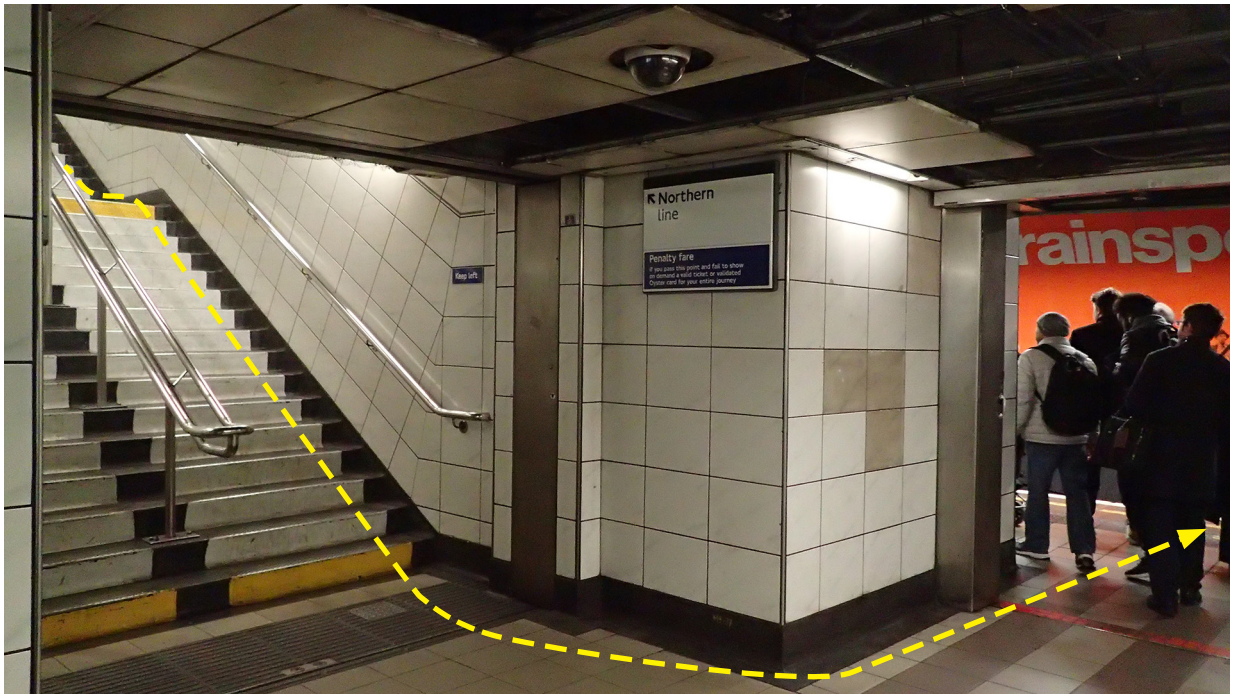

Figure 3: The Northern Line Steps and the access to platform 9 at Bank station where the incident took place. Arrow indicates path of the passenger

Figure 4: The area of platform 9 at Bank station where the incident took place – view looking east. Arrow indicates path of the passenger.

Key facts and analysis

Background information

Operation of the DLR

30 Operation of the DLR is normally largely automatic. The movement of trains is controlled by a central computer system. There is no requirement for human intervention during normal operations except for door closing.

31 However, fault conditions may require manual driving of the trains. For this purpose, an Emergency Driving Position (EDP) is provided at the front of each car (figures 5 and 6). From the EDP, the PSA is able to manually drive the train.

Procedures for control of train doors on DLR

32 On arrival at a station, the central computer system will verify that the train has stopped in the correct location; this is referred to as docking. If a train is docked correctly, the passenger doors on the platform side of the train are enabled automatically, allowing passengers to open the doors using the push buttons provided.

Figure 5: Location of EDP (with cover lifted) at the front of a DLR car

Figure 6: Controls provided at the EDP on a DLR car. The ‘Door Close’ and ‘Start’ buttons are indicated.

33 The decision as to when to close the doors on a DLR train is made by the PSA. The PSA has two means at their disposal for the control of train doors:

- From a Door Control Panel (DCP) (figure 7). A DCP is provided adjacent to each passenger door. When working from a DCP, the PSA is able to close all the other doors on the train while keeping the door local to the DCP open, allowing the PSA to continue monitoring the platform-train interface (PTI). Once the other doors are closed, the PSA can then close the local door. When all doors are detected by the train systems as correctly closed and locked, the train can depart under automatic computer control.
- Doors can also be controlled from the EDP, even if the train is being driven by the computer system. Door controls are provided for the use of the PSA if working from an EDP (figure 6). In addition to closing the doors, the PSA must also press a ‘Start’ button to allow the train to depart from a station under computer control.

34 When dispatching from a DCP, the PSA is able to directly observe the train doors by looking along the train from his/her position at the local door. No such direct view is available when dispatching from the EDP. A PSA working from the EDP is dependent on platform mirrors or CCTV monitors to provide visibility of the train doors. At Bank station platform 9, CCTV monitors are provided for this purpose. The procedures which govern when a PSA can dispatch from the EDP are discussed later in paragraph 50.

Operation of door systems on B2007 cars

35 A DLR car has four doors on each side. Each door comprises two sliding door leaves. On B2007 cars, the doors are electrically operated. An electric motor turns a shaft which moves the door leaves.

Figure 7: Door Control Panel on a DLR car

36 The door system on the B2007 cars is able to automatically detect and react to an obstruction. In the event that an obstruction is detected, the affected door will partially re-open (to allow the obstruction to be removed) before attempting to re-close. The re-open and re-close cycle takes approximately 3.5 seconds. Three attempts at closure are made automatically before the door requires manual intervention.

Identification of the immediate cause

37 **The train departed with the passenger's coat trapped in a closed door.**

Identification of causal factors

38 The incident occurred due to a combination of the following causal factors:

- the drawstring on the passenger's coat became trapped in a closed door (paragraph 39);
- the trapped drawstring was not detected by the door control system (paragraph 43);
- the PSA was unaware that an object had become trapped in the leading door (paragraph 48); and
- the passenger was unable, in the available time, to release the coat or to raise the alarm (paragraph 57).

Each of these factors is now considered in turn.

The coat drawstring becoming trapped

39 The drawstring on the passenger's coat became trapped in a closed door.

40 The PSA had started the train door closure sequence before the passenger entered the platform. However, the leading door had been obstructed by another passenger (paragraph 22) and had automatically re-opened.

41 The train door was therefore re-closing automatically as the passenger approached the train.

42 The passenger intended to board the train, but she recognised that the doors were starting to close. She stopped close to the train. The coat drawstring (paragraph 25) became trapped between the leaves of door B1/B2.

The door obstacle detection system

43 The trapped drawstring was not detected by the door control system.

44 The specification for the door system fitted to the B2007 cars states that the smallest object which can be detected by the door system is a test block 30 mm wide (in the fore/aft direction) and 60 mm deep (in the vertical direction).

45 The door system detects obstructions in two ways:

- Excess current demand from the door motor; or
- A low rate-of-travel by the door leaves when closing.

46 Testing carried out by the RAIB (figure 8) demonstrated that the door system was able to detect a rigid object significantly smaller than the 30 mm x 60 mm standard test block. Provided that the object was rigid, the door system was able to detect objects as small as 1 mm wide (such as a steel ruler).

47 However, the RAIB found that objects which were thin and flexible, such as a coat drawstring or fabric, were deflected around the door *nosing rubbers* (paragraph 64) and were not detected by the door system.

The PSA was unaware of the trapping incident

48 The PSA was unaware that an object had become trapped in the leading door because he was operating the doors from the EDP and the CCTV monitor he was relying on did not show the leading door.

The PSA was controlling the train doors from the EDP

49 KAD's documented procedures for the operation of trains on DLR require that the PSA normally carries out the control of the train doors from the DCP. Use of the DCP means that the PSA can observe the train doors directly, whereas use of the EDP requires mirrors or CCTV monitors to observe the doors (paragraph 34).

50 KAD's procedures permit PSAs to use the EDP in certain circumstances, such as:

- heavy passenger loading preventing access to the DCP;
- bad weather;
- report of individuals being on the track; and
- a specific request from the system control centre.

None of these circumstances were applicable at the time of the incident.

Figure 8: Testing of the door system

51 The PSA reported that he believed the train had a fault in its automatic operation, and that he therefore needed to be present at the EDP in order to monitor the operation of the train. The PSA therefore used the door controls provided at the EDP instead of the controls at the DCP.

52 The PSA did not report his concern to the system control centre and he did not record the matter in his logbook. The train remained in automatic operation at all times.

53 The RAIB and KAD carried out analysis of the data recorder systems on both the train and within the system control computer system. No evidence was found during this analysis to indicate any abnormalities in the automatic operation of the train.

The CCTV monitor relied on by the PSA did not show the leading door on the train

54 To allow observation of the platform and doors of a three-car train at platform 9 at Bank station, two CCTV monitor screens are provided for the use of PSAs located at the EDP. The monitors are located at the entrance to the tunnel at the eastern end of the station. One screen shows an image of the eastern end of the platform and the train. The second screen shows a similar image from the western end of the platform.

55 The camera showing the image from the eastern end was incorrectly angled. The effect of this defect was that the image shown on the CCTV monitor did not show the leading door (figure 9). As a result, this door and the adjacent platform area could not be observed by a PSA when located at the EDP.

Figure 9: Platform CCTV image at the time of the incident (image courtesy of Keolis Amey Docklands)

Figure 10: Platform CCTV view after camera adjustment following the incident (image courtesy of Keolis Amey Docklands)

56 The RAIB has been unable to establish what caused the camera to be incorrectly angled or when it became so. Following the incident, the camera was angled to show the leading door (figure 10). The management of the CCTV system defect at platform 9 is discussed further at paragraph 68.

Forces required to remove the coat trapped in the door

57 **The passenger was unable, in the available time, to release the coat or to raise the alarm.**

58 The passenger attempted to release the coat drawstring from the closed door. She was an experienced user of the DLR system, and was aware that there was likely to be only a very short time delay between the doors closing and the train moving away from the station. She quickly decided to remove the coat before the train started moving.

59 The specification for the door system fitted to the B2007 cars states that it should be possible to withdraw a test block measuring 10 mm wide x 50 mm deep from between the closed door leaves with a force of less than 150N.

60 Testing undertaken by the RAIB (paragraph 46) showed that a 10 mm x 50 mm test block caused the door obstacle detection system to operate, and hence the door leaves re-opened, allowing the object to be removed.

61 The RAIB measured the forces required to withdraw a drawstring similar to that on the passenger's coat from the same closed door (B1/B2) of the car involved in the incident. The average force required was around 100 N.

62 It was found during the testing that the presence of an *aglet* on the end of a drawstring had the effect of increasing the peak force required to pull the drawstring[1] because the aglet impeded the passage of the drawstring through the nosing rubbers.

63 The passenger tried and failed to pull the drawstring from the closed door, and then took the decision that her best option to avoid harm was to remove the coat, rather than trying to pull harder at the drawstring.

[1] The drawstring involved was never recovered, and therefore it could not be confirmed that it was fitted with an aglet. However, other drawstrings on the coat were fitted with aglets and hence it is likely that the drawstring involved was also fitted with one.

Design of the door nosing rubbers

64 The doors on DLR cars have seals called 'nosing rubbers', along the vertical edges of the door leaves (figure 8). One door leaf seal has a convex cross-section. This engages with a concave cross-section (figure 11) on the opposing door leaf. The seals reduce draughts, water ingress and noise.

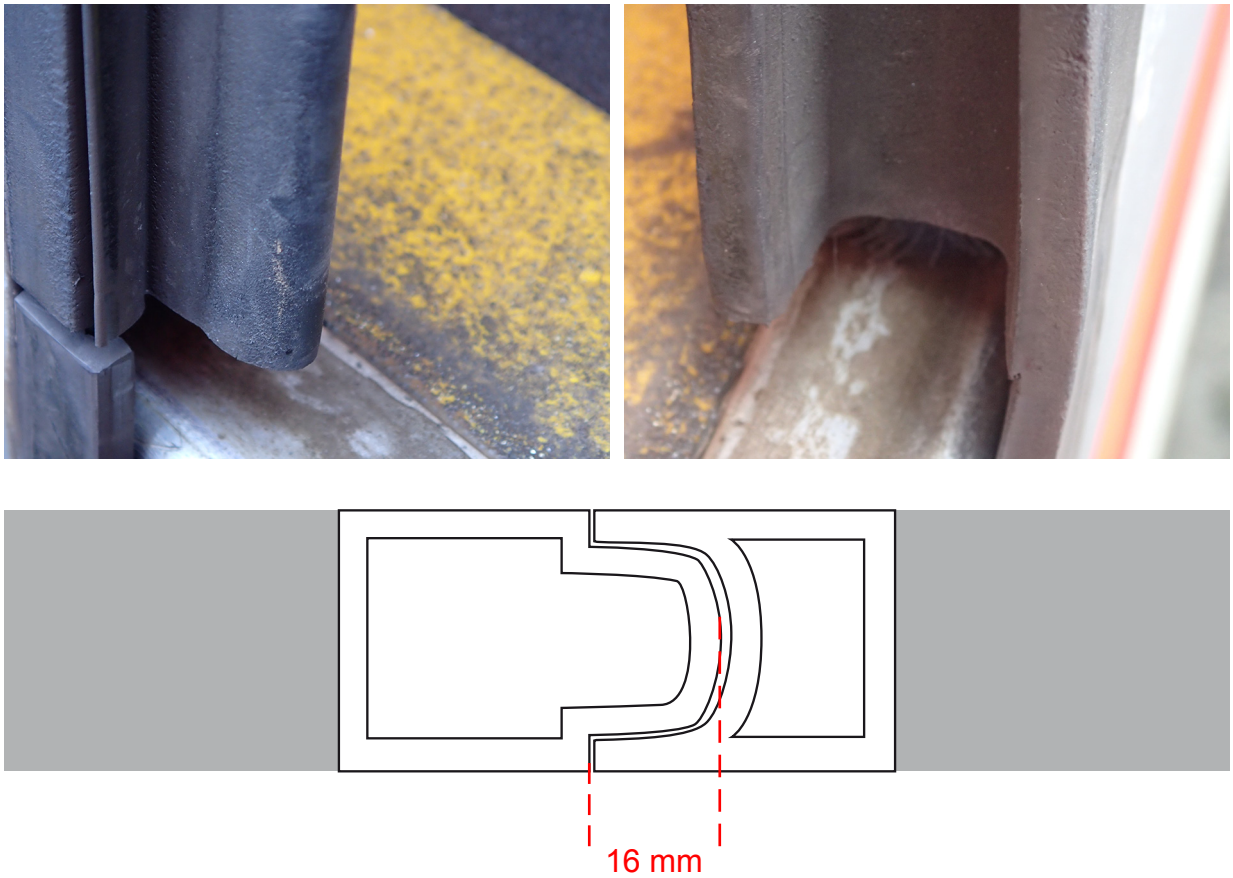

Figure 11: Nosing rubber element used on DLR cars

65 The nosing rubbers are able to compress around small objects when the doors close, but are intended to have sufficient flexibility, when combined with a *pushback mechanism*, to allow trapped objects to be withdrawn. The shape, flexibility and friction characteristics of the nosing rubbers affects the ease with which trapped objects can be pulled from the doors. The interlocking between the two halves of the nosing rubbers on the DLR cars is around 16 mm. It is greater than that on LUL vehicles[2] (figure 12), which is around 3 mm. Although the RAIB has not carried out any comparative tests, it is evident that the more convoluted the path that a flexible object, such as a piece of trapped clothing, has to take to be extracted the greater the extraction forces are likely to be, for a given type of nosing rubber design.

66 The RAIB also carried out testing using a piece of clothing trapped in the doors of DLR cars and found that forces in excess of 200 N were required to withdraw a fabric test piece. By comparison, the maximum force criteria used by LUL in its tests using a fabric test piece is 90 N.

[2] See Paragraph 66 of RAIB report 04/2016.

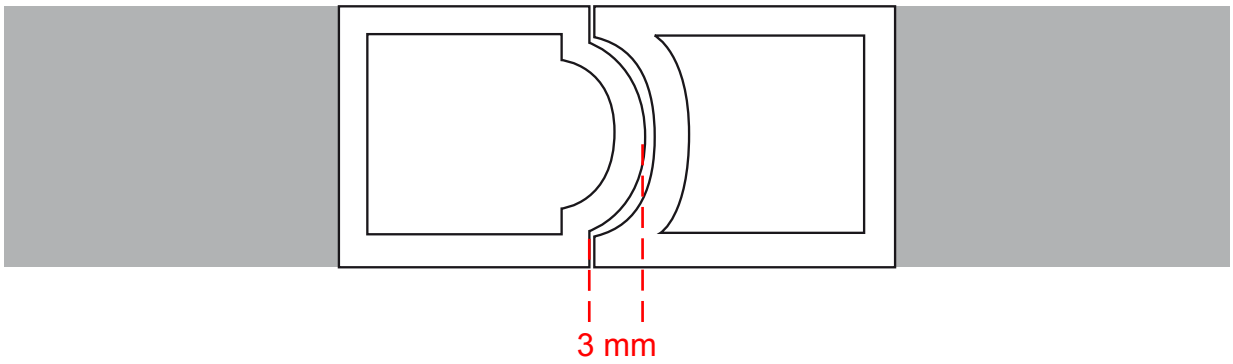

Figure 12: Nosing rubber elements on the LUL trains

No opportunity to raise the alarm

67 During the incident, the passenger was unable to stop the train or raise the alarm. Passenger Help Points are provided on DLR station platforms. These Help Points contain an emergency stop button[3] which will prevent a train departing from the station or cause a moving train to come to a halt. On platform 9 there are several Help Points spaced at intervals along the platform; the nearest to the leading door was around 20 metres away. In this case there was little opportunity for the use of such an emergency stop button because the incident lasted only four seconds. No one on the train appears to have noticed the trapping. The PSA on board the train was unaware that the incident had taken place and the train continued to the next station.

Identification of the underlying factor

Management of the CCTV system defects

68 **The process used by KAD to detect, mitigate and rectify CCTV system defects was not robust.**

69 LUL owns the CCTV system on the DLR platforms at Bank station. However, KAD is responsible for the detection of defects and, in some cases, the rectification works.

70 Defects are detected in two ways:

- Reactively: defects are reported by staff, usually PSAs, and entered into a defect management system; or
- Proactively: members of KAD staff known as the 'mirrors and monitors team' travel on the network to carry out audits of the equipment and identify defects. Such audits are carried out at six-monthly intervals. This team includes PSAs, because they have the necessary competencies to judge correct alignment of mirrors and CCTV equipment.

71 On 7 November 2016, a defect was entered into the KAD defect management system stating 'Bank 9 – Adjusting of monitor to cover all train doors'. This defect originated from a proactive audit process carried out by KAD.

[3] The Passenger Help Points also contain an alarm button. Use of the alarm button will not stop trains, but will allow a passenger to contact the system control room.

72 This was a safety-related defect, because it affected the safe dispatch of trains. Despite this, the defect was not identified as such on the defect management system. No risk mitigations (such as briefing PSAs or prohibiting train dispatch from the EDP) were carried out to mitigate the risk until the defect was repaired.

73 On 28 November 2016 a KAD communications technician worked on the defect. His report to the defect management system noted that he 'reset monitor via fused spur', and 'Screen working correctly. No further action'.

74 Because the technician was a KAD employee, he was not authorised to adjust the camera to change its field of view. Such an action could only have been carried out by LUL, the asset owner.

75 The action taken on 28 November 2016 did not address the reported defect; the images displayed to a PSA while sitting at an EDP still did not show the leading train door. Despite this, the defect was shown as 'Closed' in the KAD defect management system, because an action had been taken.

76 KAD did not carry out any further checks to confirm that the actions of 28 November 2016 had rectified the reported defect. No further reports of any defects were raised in relation to the CCTV system at Bank station until after the incident of 6 February 2017. KAD has reported to the RAIB that it does not have a documented process for defect reporting, although its staff are briefed on how to report defects.

Previous occurrences of a similar character

77 The RAIB has investigated several previous incidents in which passenger's clothing have become trapped in the closing doors of a train and then been dragged as the train departs.

78 On 15 February 2006, a passenger was seriously injured at Huntingdon station (RAIB report 11/2007) after his coat became trapped in the closing door of a train. The passenger was unable to remove the coat because the design of the door nosing rubbers was such that excessively high forces were required to pull it out. He was pulled along the platform by the departing train before falling down the gap between the train and platform edge.

79 On 1 November 2007, at Tooting Broadway station on the LUL Northern Line, a passenger's coat became trapped in the closing doors of a train from which she was alighting (RAIB report 17/2008). The passenger fell onto the platform and was unable to extract the coat from the closed door. As the train began to move, she struck the side of the train with her hand to attract attention and was dragged for a short distance before the train was stopped by the activation of a passenger emergency alarm. She sustained injuries.

80 On 3 February 2014, a passenger was dragged a short distance by a Piccadilly line train at LUL's Holborn station (RAIB report 22/2014). The passenger's scarf had become trapped in a closing door and she was dragged a distance of about 10 metres along the platform until she was caught by a member of staff and fell onto the platform, sustaining injuries.

81 On 12 March 2015, a passenger's coat became trapped in the closing doors of a departing LUL Northern Line train at Clapham South (RAIB report 04/2016). The passenger was dragged by the departing train and fell first onto the ground and then between the train and platform. The passenger was injured.

Summary of conclusions

Immediate cause

82 The train departed with the passenger's coat trapped in a closed door. (paragraph 37).

Causal factors

83 The causal factors were:

a) The drawstring on the passenger's coat became trapped in a closed door (paragraph 39, **no recommendation**).

b) The trapped drawstring was not detected by the door control system (paragraph 43, **no recommendation**).

c) The PSA was unaware that an object had become trapped in the leading door because he was operating the doors from the EDP and the CCTV monitor he was relying on did not show the leading door (paragraph 48, **Recommendation 3**).

d) The passenger was unable, in the available time, to release the coat or to raise the alarm (paragraph 57, **Recommendations 1 and 2**).

Underlying factor

84 An underlying factor was that the processes used by KAD to detect, mitigate and rectify CCTV system defects were not robust (paragraph 68, **Recommendation 3**).

Previous RAIB recommendations relevant to this investigation

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

Passenger trapped in train doors and dragged at Clapham South station, 12 March 2015

Recommendation 1

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

- *improving detection of objects trapped in train doors;*
- *improving the ability of passengers to pull out objects trapped in doors (including by improving door seal arrangements);*
- *improving train operator views of the PTI at despatch (eg increasing the number of CCTV cameras, repositioning cameras and providing larger monitors);*
- *enhancing the methods available to staff performing SATS 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.

86 On 8 March 2017, the Office of Rail and Road (ORR) advised RAIB that the London Underground PTI strategy had been published on 17 June 2016 and identified six overall objectives, one of which was to ensure knowledge is shared across TfL and the industry to develop best practice.

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

87 KAD has issued instructions to PSAs which state that only DCPs may be used to close the doors on DLR trains at Bank station.

88 KAD has informed the RAIB that the CCTV camera at Bank station platform 9 has been correctly angled to show the leading door.

Recommendations and learning points

Recommendations

89 The following recommendations are made[4]:

1 *The intent of this recommendation is to reduce the risk of trap and drag incidents on current Docklands Light Railway rolling stock, caused by clothing and other thin, flexible objects becoming trapped in the closing doors.*

Keolis Amey Docklands should, in conjunction with Docklands Light Railway Ltd:

a) measure the forces required to pull out thin flexible objects trapped by train doors in its current fleet to determine the range of forces, and assess the risk of trap and drag incidents;

b) investigate changing the design of the door nosing rubbers on its current fleet to reduce the forces required to pull out trapped objects so that they are in line with good industry practice; and

c) where practicable, change the door nosing rubbers on its trains to reduce the pull-out force to the target level identified in (b).

2 *The intent of this recommendation is that safety learning from this investigation about minimising extraction forces for objects accidentally trapped in doors, is addressed when new trains for the Docklands Light Railway are specified.*

Docklands Light Railway Ltd. should ensure that the specification for its forthcoming new trains gives adequate consideration to minimising the force required to remove objects trapped in passenger doors. Particular consideration should be given to the risk of thin, flexible objects such as items of clothing, becoming wrapped around door nosing rubbers.

This recommendation could apply to other organisations involved in the specification and procurement of new trains.

[4] Those identified in the recommendations have a general and ongoing obligation to comply with health and safety legislation, and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail and Road to enable it to carry out its duties under regulation 12(2) to:

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

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

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

3 *The intent of this recommendation is that Keolis Amey Docklands has a robust process in place to detect and rectify faults in platform observation equipment used by its PSAs.*

Keolis Amey Docklands should:

a) examine the integrity of its processes for detecting and rectifying defects in platform observation equipment used by PSAs such as mirrors, monitors and CCTV systems. The review should include consideration of:

- training and reminders given to staff on the timely reporting of defects;
- how defects which can impact upon the safe operation of the system, are identified, recorded and addressed in a timely manner;
- risk mitigation measures in the period between detection and correction for safety-critical defects; and
- monitoring processes to verify the effective correction of reported defects.

b) implement a documented procedure to address the shortcomings identified in its existing processes.

Learning points

90 The RAIB repeats the following key learning point[5]:

1 Staff responsible for the dispatching of trains should be aware that door obstacle detection systems are not always able to detect small objects. It is therefore vital that a final, visual, safety check is made to ensure that no object is trapped in the closed doors prior to a train being allowed to depart from a station.

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

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed Circuit Television
DCP	Door Control Panel
DLR	Docklands Light Railway
DLRL	Docklands Light Railway Ltd
EDP	Emergency Driving Position
KAD	Keolis Amey Docklands
LUL	London Underground Ltd
ORR	Office of Rail and Road
PSA	Passenger Service Agent
PTI	Platform-Train Interface
TfL	Transport for London

Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (*), have been taken from Ellis's British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com.

Aglet	A small sheath, made from metal or plastic, fitted to the end of a drawstring. The purpose of an aglet is to prevent the end of the drawstring fraying.
Articulated	A rail vehicle arranged so that two or more adjacent cars share a common bogie or axle.*
Headshunt	A length of track used by trains to reverse their direction of travel.
Nosing Rubbers	Flexible strips fitted to the edges of sliding doors. Their purpose is to ensure a seal between the door leaves when the door is closed.
Pushback mechanism	A mechanism allowing a door leaf to be pushed slightly open even when the door is nominally closed.

Appendix C - Investigation details

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

- information provided by witnesses;
- information taken from the train's on-train data recorder (OTDR);
- closed circuit television (CCTV) recordings taken from Bank station and from on-board the train;
- site photographs and measurements; and
- a review of previous RAIB investigations that had relevance to this incident.

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