Rail Accident Investigation Branch

Rail Accident Report

Huntingdon train door incident
15 February 2006

Department for Transport

Report 11/2007
v2 - April 2007

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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Contents

Introduction

1 The sole purpose of a Rail Accident Investigation Branch (RAIB) investigation is to prevent future accidents and incidents and improve railway safety.

2 The RAIB does not establish blame, liability or carry out prosecutions.

3 Access was freely given to West Anglia and Great Northern Ltd. staff, data and records in connection with the investigation.

4 Appendices at the rear of this report contain the following:

- acronyms and abbreviations are explained in the glossary at Appendix A;
- technical terms (shown in *italics* the first time they appear in the report) are explained in the glossary at Appendix B; and
- A list of documents referenced is shown at Appendix C.

Summary

Key facts about the incident

5 On Wednesday 15 February 2006 at 15:59 hrs a member of the public was standing on the edge of platform two at Huntingdon station seeing a passenger off when he became trapped by the edge of his coat in the leading door of the third vehicle of train 1P71, the 15:44 hrs Peterborough to Kings Cross West Anglia and Great Northern (WAGN) service. The location of Huntingdon station is shown in Figure 1. The *Driver Only Operated* (DOO) train departed and the person ran, then was pulled along the platform before falling down the gap between the train and platform edge. The person sustained serious injuries to his left arm and hand.

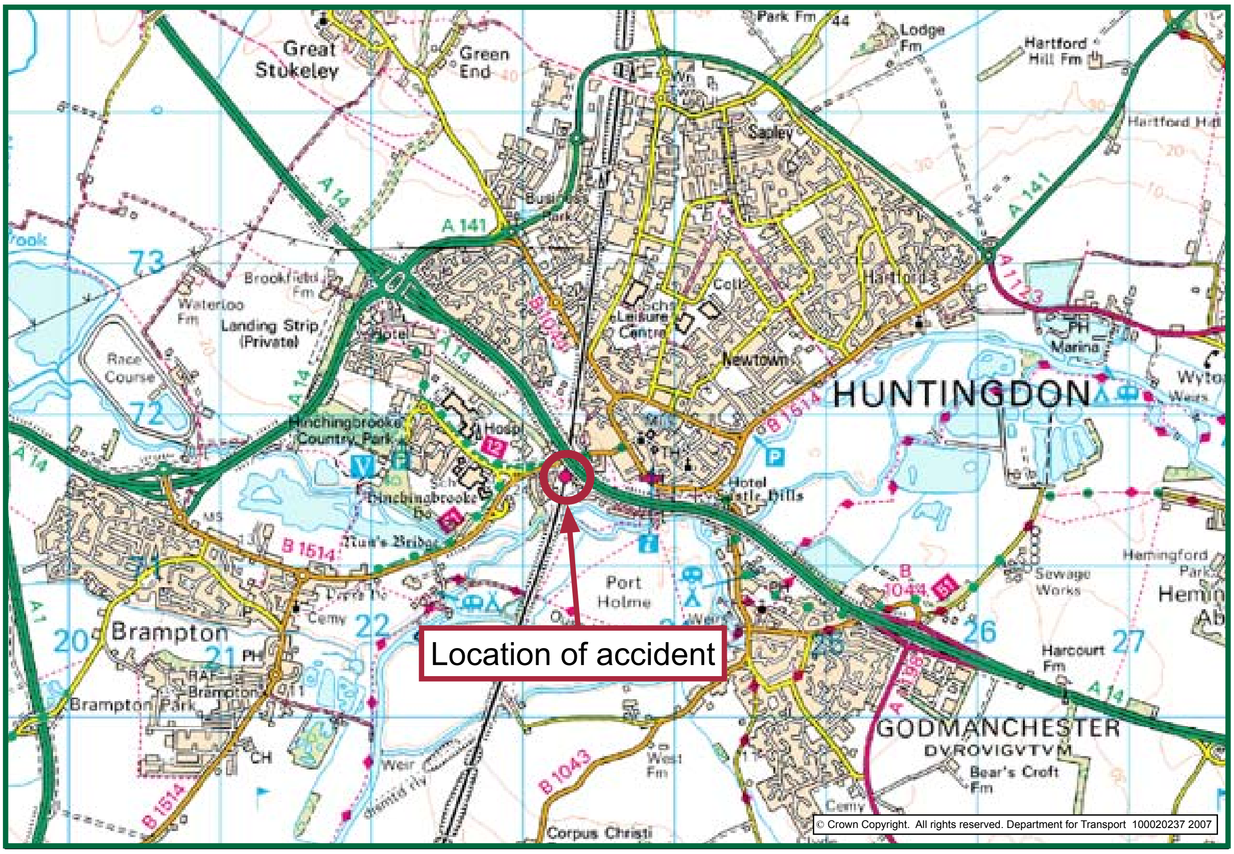

Figure 1: Extract from Ordnance Survey map showing Huntingdon station

6 The passenger that was accompanying the injured person prior to boarding the train had difficulty in following the correct procedure for stopping the train in the emergency. The person was not aware of the passenger emergency communication system on the train and ran towards the leading end to find and alert a member of staff, the *Revenue Collection Officer* (RCO). The train was brought to a stand when the RCO entered the cab and asked the driver to stop.

Immediate cause, contributory factors and underlying causes

7 The unit was brought to a stand at the platform approximately 1.4 m short of the centre-line of the DOO four-car *monitor bank*. This affected the driver's viewing angle and hence is likely to have affected the contrast of the images seen on both monitors.

8 The design of the DOO monitors were such that the quality of the viewed image is not symmetrical about the centre-line and that the image contrast is reduced when seen from left of the centre-line of the monitor screen as viewed by the driver.

9 The actions of the injured person prior to the incident placed his coat fabric between the leaves of the pneumatically operated closing door of the Class 365 Unit.

10 The door mechanism of the Class 365 Unit provided sufficient closing force to trap the coat and prevent it from being easily removed by the wearer. The design and construction of this door permitted the door interlock signal to be given to the driver despite the presence of trapped fabric.

11 There is evidence that another person on the platform at the time of the incident may have obscured or partially obscured the image of the trapped person from a DOO monitor.

12 The driver became fleetingly aware that a person was in close proximity to the side of the train but misinterpreted the situation and continued to drive the train away.

Recommendations

13 Recommendations can be found at paragraph 113. They relate to the following areas:

- driver training;
- performance of the DOO monitor system;
- performance of the Class 365 Unit door seal closing mechanism;
- appropriateness of current Railway Group Standards; and
- interior signage on Class 365 Units.

The Accident

14 Huntingdon station is located almost 59 miles (95 km) from London (Kings Cross) on the line to Peterborough and York. In February 2006 the station was operated by WAGN, who also operated the trains that stop there.

15 At 15:59 hrs on Wednesday 15 February 2006 a member of the public was standing on the edge of platform two at Huntingdon station seeing a passenger off when he became trapped by the edge of his coat in the leading door of the third vehicle of train 1P71, the 15:44 hrs Peterborough to Kings Cross WAGN service. The train departed and the person was pulled along the platform before falling down the gap between the train and platform edge. The person sustained serious injuries to his left arm and hand.

16 The train continued for 1.5 miles (2.5 km) before coming to a stand. The train then went on to St Neots station for the passengers to be detrained.

17 The injured person was attended to at the scene by the Emergency Services before being taken to Addenbrooke's Hospital, Cambridgeshire.

The Investigation

Investigation process

18 The RAIB investigated:

- the stopping position of the Class 365 Unit on the platform;
- why the injured person was in close proximity to the closing door;
- why the door interlock mechanism did not detect the presence of the trapped coat;
- why the closed door held the coat;
- why the driver pulled away with a person trapped in the door; and
- why the train travelled a significant distance before it was brought to a stand.

Sequence of events

19 References to persons involved in the incident are by a simple code as shown in Table 1.

Identifier	Person and their location prior to the incident taking place
P1	Driver of Unit 365502.
P2	The injured person – standing on the platform adjacent to the leading doors of vehicle [72243].
P3	The person standing inside at the leading door vehicle [72243] accompanying P2.
P4	The person standing on the platform at the trailing door of the second vehicle [72242].
P5	The person standing inside at the trailing door of the second vehicle [72242] accompanying P4.
P6	The person working on the station construction adjacent to the station buildings.
P7	The Platform Host – located in the station buildings adjacent to the passenger footbridge.
P8	Revenue Collection Officer (RCO) on the train.

Table 1: Identification of persons involved in the incident

20 The timeline of significant events from when members of the public were seen to access the platform to when the injured person (P2) was taken off the platform by the Emergency Services is shown in Table 2. This timeline was derived from the video download taken from security camera 7 mounted at the end of Huntingdon station's platform two.

21 The view of platform two from security camera 7 is shown in Figure 2. The camera is looking south towards the London end of the platform. This frame was taken approximately one hour after the incident and shows an eight-car Class 365 Unit at a stand in the platform before travelling on towards London. Figure 3 is a schematic showing platform two and the train immediately before the incident. The key persons and the arrangement of security cameras are shown. Also shown are the positions of the relevant DOO cameras and monitors.

22 The train involved in the incident was a Class 365 *Electric Multiple Unit* (EMU) (Unit 365502) (Reference 1). The unit, shown in Figure 4, was a four-car set comprising:

- 65936 – Driving motored vehicle (leading end);
- 72242 – Trailer vehicle;
- 72243 – Trailer vehicle (with pantograph); and
- 65895 – Driving motored vehicle (trailing end).

Figure 2: General view from security camera 7 – platform two

23 The security camera 7 video record time marks were found to be incorrect by approximately five minutes. This has been corrected and all times in Table 2, and elsewhere in this report, are in Greenwich Mean Time. All activities involving P2 have been highlighted in pale green. Key activities of P4 are highlighted in pale yellow.

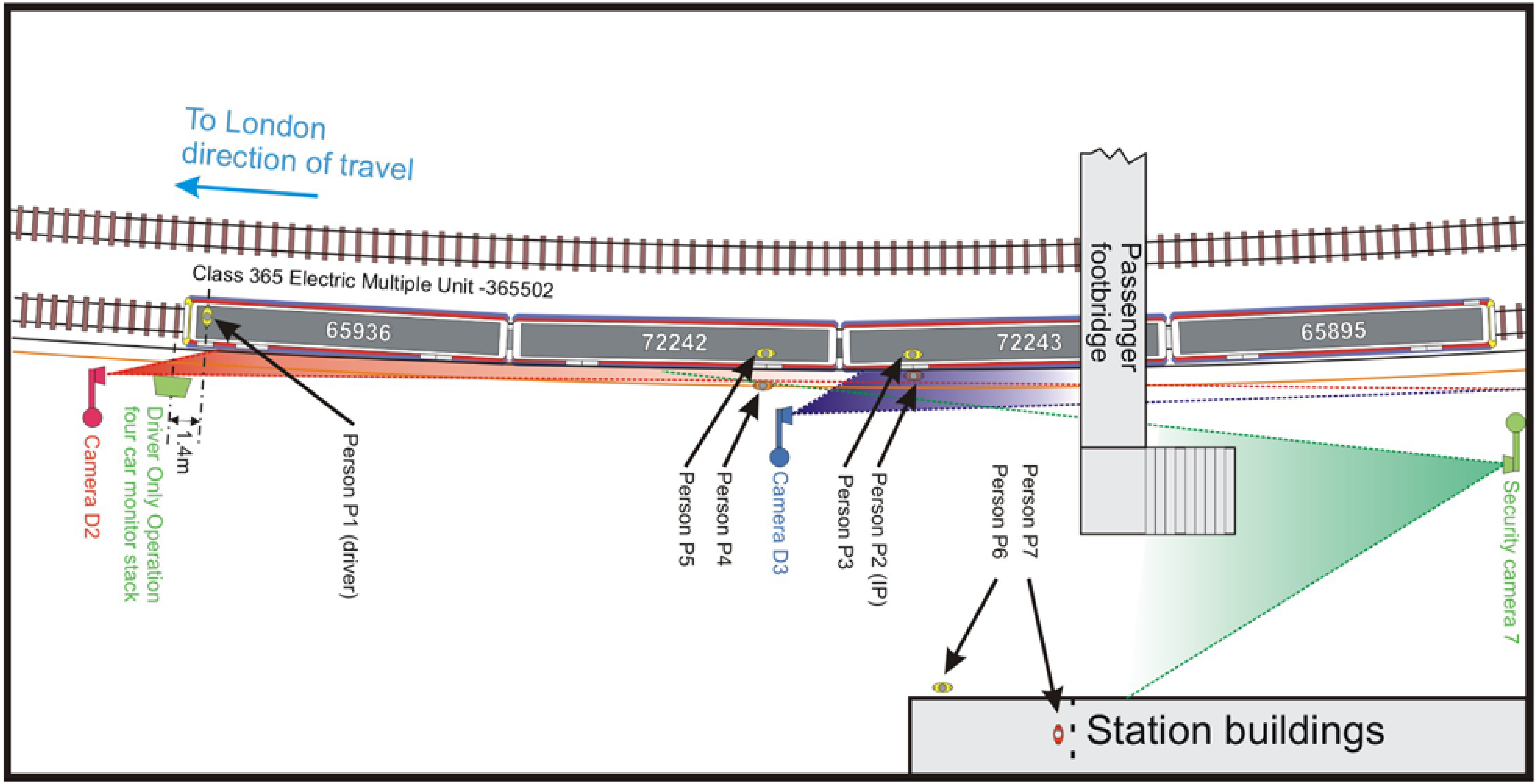

Figure 3: Schematic showing Huntingdon station - platform two

True Time Hrs:mins:secs	Event
15:43:00	Start of available video sequence.
15:54:16	The video shows P2 come into view at the bottom of the video image and walk at a steady pace towards the London end of platform two. P2 was seen to be carrying a large guitar case or similar on his back. P2 is also accompanied by another person (P3).
15:54:21	P6 arrives on platform and proceeds to undertake tasks adjacent to the station buildings.
15:54:29	P2 and P3 walk out of view of the camera but from their shadows it can be seen that both persons have stopped walking just behind the footbridge.
15:54:40	P4 and P5 arrive in the foreground, walk to the right hand side of the footbridge steps and continue out of view behind the steps.
15:57:32	The leading end of unit 365502 train appears in view from right hand lower edge of the video image.
15:57:32	P2 and P3 approach the moving train towards the leading doors of vehicle [72243]. P3 is now seen to be carrying the guitar case or similar.
15:57:32	P4 and P5 approach the trailing door of the second vehicle [72242].
15:57:46	P1 brings the train to a stand.
15:57:52	P1 initiates left hand side door opening sequence. Both sets of doors on the trailing end of the second vehicle [72242] and the leading doors of the third vehicle [72243] are seen to open simultaneously. Two persons exit the leading door of the third vehicle [72243]. The person standing adjacent to the stairs enters the train through the leading doors of the third vehicle [72243].
15:57:58	P3 leaves P2 and enters the train through leading doors of the third vehicle [72243]. P2 steps away from the open door beyond the yellow marker line and out of view.

True Time Hrs:mins:secs	Event
15:57:58	P5 gets onto train through trailing door of the second vehicle [72242]. P4 passes 'red luggage' through door to (possibly) P5. P4 steps back and stands between yellow line and platform edge.
15:58:16	P2 returns to the open leading door of the third vehicle [72243] but does not enter the vehicle.
15:58:31	P2 enters the third vehicle [72243] through the leading door and disappears from view.
15:58:41	P2 leaves the third vehicle [72243] through leading door, turns to the right and stands between the yellow line and the platform edge.
15:58:44	P2 returns towards the open leading door of the third vehicle [72243] and stands close to the platform edge facing open door.
15:58:52	P2 raises both hands and places them on the inner edge of both door leaves, approximately just below shoulder height. Both the second vehicle [72242] trailing door and the third vehicle [72243] leading door start to close. P2 bends his knees slightly.
15:58:53	Second vehicle [72242] trailing door closes – P4 moves away from door and stands between yellow line and platform edge.
15:58:54 (0 s)	Third vehicle [72243] leading door closes later than the trailing door second vehicle [72242] – P2 lowers arms and looks down.
15:58:54 (0 s)	P4 is seen moving backwards and forwards between the yellow marker line and the edge of the platform.
15:58:55 (+1 s)	P2 starts gently tugging at the right hand side of his coat.
15:58:59 (+5 s)	P1 receives the door interlock and applies power - recorded on the *On Train Monitoring Recorde*r (OTMR). The unit moves forward. P2 stops tugging at his coat as train starts to move and walks alongside the train with both hands raised.
15:59:00 (+6 s)	P4 moves clear of yellow platform edge marker line.

True Time Hrs:mins:secs	Event
15:59:02 (+8 s)	P2 starts to run alongside train with his coat now obviously trapped at the lower right hand corner. The coat is unbuttoned.
15:59:06 (+12 s)	Speed of train starts to quicken with P2 now being dragged by train. P2 seen to fall alongside train at edge of platform approximately 20 m away from point where the door closed.
15:59:08 (+14 s)	P2 falls out of view between platform edge and side of the third vehicle [72243]. (Subsequent frames when the Emergency Services arrive indicated that P2 is on the track within view of the security camera 7 but obscured by the edge of the platform).
15:59:09	P6 runs from side of building towards where P2 is on the track.
15:59:13	P7 runs from the Platform Host's office after seeing the event on close circuit television CCTV but rapidly returns to the Platform Host's office to call the signal box to protect the track and P2.
15:59:14	Trailing end of train disappears from cameras view.
16:05:24	Police officers arrive.
16:06:26	Paramedics arrive.
16:32:40	P2 moved off site by medical personnel.

Table 2: Timeline of significant events

Actions of the injured person

24 P2 was observed on leaving the train to turn around and stand close to the door. When the door started to close he placed his hands on each door leaf at about chest height. He removed his hands just before the doors closed completely. The closing door trapped his unbuttoned coat at the lower right-hand side corner. He was then observed to place his left hand on the left-hand door panel at about chest height as the train pulled away.

Performance of the train doors

25 Following the incident the unit was taken to Hornsey Depot. The performance of the door operation and closing mechanism was examined and tests were carried out to determine whether the door system functioned as specified.

26 The hustle alarm was also checked and found to function correctly. This observation agrees with the observations and comments of P2 and P3 that the hustle alarm was audible at the time of the incident.

27 Additional tests were undertaken to check the maximum closing force that could be generated by the incident Class 365 Unit door. Following these checks, further tests were undertaken to determine the force required to extract a sample of P2's coat fabric following trapping.

Figure 4: Unit 365502 at Hornsey depot

28 On Thursday 16 February 2006, the day after the incident, the door operating mechanism for both platform side doors (left-hand side D1/D2 and C1/C2) on the third vehicle [72243] were checked out in accordance with the designated testing process (Reference 2).

29 The test results (identified in Reference 3) showed that the door mechanism met the test requirements; however, the functionality tests as defined did not require a closing force measurement.

30 A key feature of the incident investigation was the ability of the Class 365 Unit doors to trap and hold the fabric from the coat worn by P2. The video records from security camera 7 confirm that it was the right-hand side of the open coat that became trapped in the closing door. Figure 5 shows the right-hand corner of the coat worn by P2.

31 The coat was made from a heavy suede type fabric lined with a fur type material, as shown in Figure 6. It is possible that one of the coat buttons became trapped either in the door or behind the closed door during the incident. For the purposes of assessing the force required to extract the trapped fabric it was assumed that this button had not played a part in the trapping process. Had it been trapped behind the closed door then the extraction forces would have been greater than those recorded during the tests. The tests were configured to establish if the lower force to extract the coat in the scenario where the coat button was not trapped were significant.

Figure 5: Right-hand corner of coat worn by P2

Figure 6: Coat material

32 In order to determine the trapping characteristics of the incident door a series of tests were carried out.

33 The purpose of these tests was to:

- Determine the closing forces a door system can exert on a trapped piece of the incident coat fabric.
- Determine if the door closing forces were affected by the height above the bottom of the door.
- Determine what force is required to pull out a trapped sample from the incident coat and a second fabric sample, made from an artificial leather that was much thinner and more flexible than the incident coat material.
- Assess the characteristics of the Class 365 Unit door seal.
- Compare the performance of the incident door with both another reference Class 365 Unit door and also with the door on an older Class 317 vehicle. The Class 317 has a twin sliding leaf arrangement and a simpler seal. A comparison of the two types of seal is shown in Figure 8.
- Determine if the door interlocked fully when the coat fabric was trapped.
- Compare the results from the tests with the requirements of the current Railway Group Standard and the Railway Group Standard applicable at the time of manufacture.

<u>Tests to determine maximum door closing force on closure</u>

34 The door closing forces were recorded from two door sets. These were the trailing doors - vehicle [72242] and the incident leading door – vehicle [72243]. The forces were recorded at a number of positions as shown in Figure 7. It should be noted that 1.0 m from the door tread was the estimated position where P2's coat became trapped in the door.

35 The results, which are listed in detail in Reference 3, show a variation in door closing forces. The door mechanism required approximately five seconds on initiating closing and contact with the load cell before the force reached a peak level.

36 The incident door had a significantly lower closing force, ranging from 441 N to 219 N (average 309 N) than the trailing door of vehicle [72242] which ranged from 507 N to 209 N (average 462 N).

37 The Railway Group Standard applicable at the time of manufacture GO/OTS300 (Reference 5) advises in Appendix C – Code of Practice C.2.1 'The force capable of being exerted in the direction of travel by any part of the door, or exposed door mechanism, during either opening or closing, should preferably be in the range 80 – 100 N and as far as is reasonably practicable should not exceed 120 N'. It should be noted that whilst the standard was applicable at the time of manufacture it did not come into force until 01/04/1994 which indicates that the guidance given was not available at the time of the fleet design and procurement.

38 For clarification, obstacle detection as defined by GO/OTS300 is the feature by which a door mechanism will detect a trapped object. If the object equals or exceeds 25 mm thickness then the mechanism should reduce the door closing forces or automatically re-open the door. If the trapped object is thinner than 25 mm then the trapped object should be capable of being easily withdrawn. A door not fitted with obstacle detection will just close on a trapped object with no requirement for force reduction or reopening.

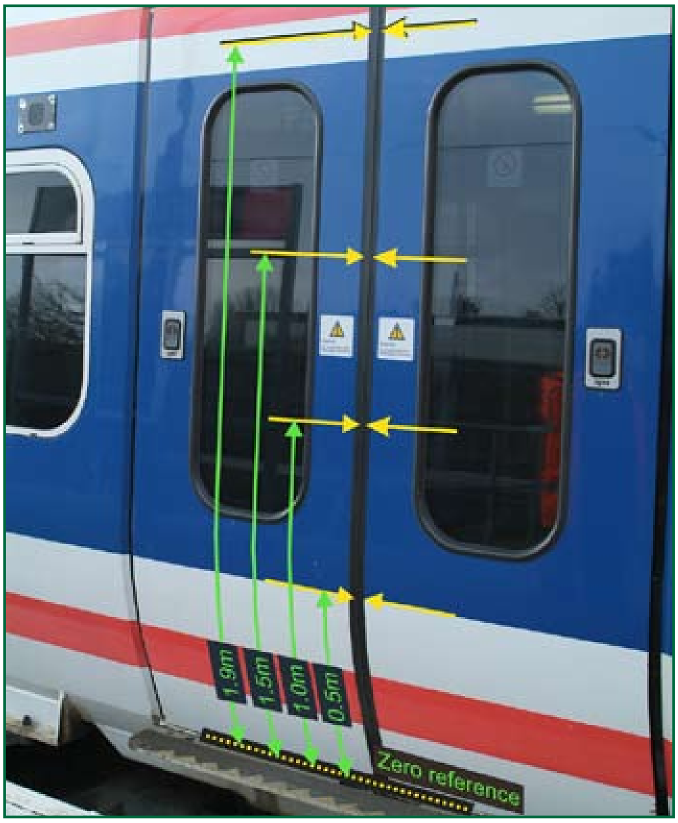

Figure 7: Positions where door closing forces were measured

<u>Tests to determine the force to extract a sample of coat fabric</u>

39 Once the closing forces for the incident door had been determined it was important to derive the coat fabric extraction forces. Determining the extraction forces was a key factor in determining why P2 appeared not to be able to pull his coat from the closed door.

40 Tests were carried out to examine the force required to extract the coat fabric. Reference 3 contains details of the test method and the recorded results.

41 Samples were obtained from the coat involved in the incident and from a synthetic flexible fabric similar to leather, with an overall thickness of approximately one millimetre. The latter was selected to determine if fabric characteristics were an issue.

42 The results show that a force ranging from 716 N to 636 N (average 675 N) was required to extract the trapped coat from the incident door. It is likely that the weight of P2 was sufficient to finally release the trapped coat as he fell. The amount of visible damage to the coat fabric following the tests was minimal which concurs with the condition of the coat following the incident.

43 The pullout tests on the thinner fabric also showed that it required a significant force ranging from 484 N to 344 N (average 429 N) to extract this sample. The results also indicated that this fabric, if trapped, would require an extraction force that may be difficult for the average person to achieve.

44 The tests showed that there were differences between the two doors tested and these are summarised in Table 3. The pullout forces for the incident door were generally higher than the reference door but both sets of results indicate that a significant force is required to extract either of the types of fabric from both doors.

	Vehicle 72242 – trailing door		Vehicle 72243 – leading door (incident)	
Fabric type	**Force range (N)**	**Average (N)**	**Force range (N)**	**Average (N)**
Incident coat	620 to 408	488	716 to 636	675
Reference (thinner fabric)	450 to 422	432	484 to 344	429

Table 3: Summary of coat fabric pullout force tests

45 Additional tests were done using the incident coat fabric to ensure that the door interlock functioned when the fabric was trapped. Even when the incident coat fabric was doubled in thickness the interlock was made and the unit could have been driven away with the coat trapped.

46 For comparison a more significant difference was recorded between the two types of rolling stock. The maximum recorded force required to pull out the incident coat fabric from the incident door was between 408 N and 716 N whilst a single test on a Class 317 vehicle door recorded a force of 82 N. This is a significantly less extraction force.

47 Group Standard GO/OTS300 dated December 1993 (Reference 5) – Section 4.3.2 states that 'when an obstacle of smaller dimensions than that in Clause 4.3.1 (25 mm by 50 mm) is inserted between the door leading edge and the frame, or between door leaves, it shall be capable of being easily withdrawn'. This standard cannot be interpreted to indicate the extraction force required to withdraw a fabric with a wider (375 mm) and thinner (approximately 3 mm) cross section as found in the coat trapped at Huntingdon.

48 Tests undertaken at Hornsey depot showed that the doors from a sample of two Class 365 Units, with one exception, did not meet the requirements of the current Railway Group Standard - GM/RT2473 (Reference 4) in that the extraction force exceeds the stated limit. Section B6.3 of this Standard - Requirements for obstacle detection - states when an obstacle, in the form of a smooth bar, with maximum dimensions of 10 x 50 mm is trapped with its long edge vertically between the leading door edge and the frame or between the door panels, it shall be capable of being withdrawn with a force not higher than 150 N, measured perpendicular to the door surface. The Hornsey tests recorded a range of forces from 220 N to 80 N with an average over 36 tests of 164 N. The current Railway Group Standard does not require compliance by stock predating the standard's introduction.

Class 365 Unit door seal design

49 During the door closing tests the seals from the incident door were measured and casts were taken. Figure 8 shows a plan section through the seals taken from these casts.

50 The Class 365 Unit has a door seal design such that when the door is closed the two seals interlace. This improves the sealing and reduces any lateral movement but has the effect that when any fabric or clothing is trapped the forces required to extract the trapped material are likely to be greater than the simpler seal found on the Class 317 Unit.

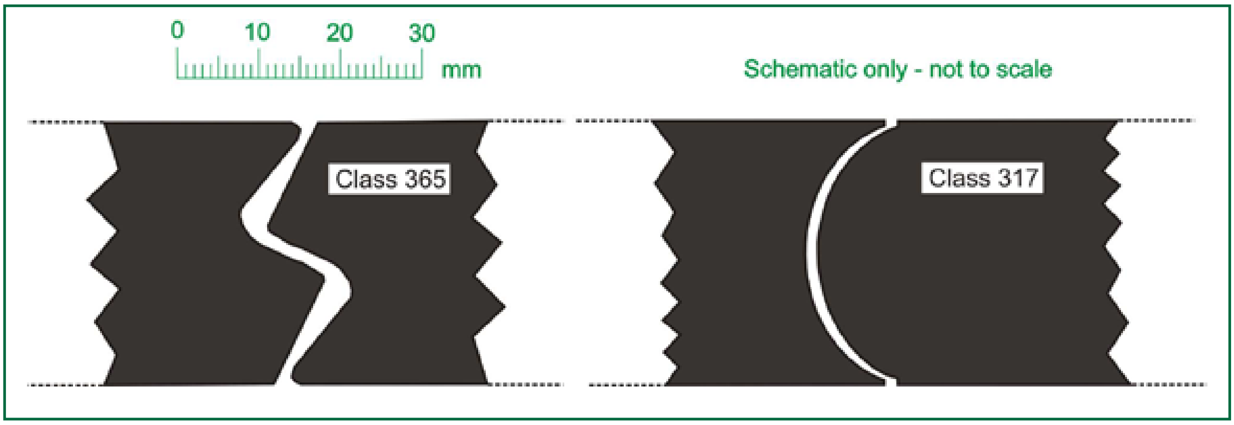

Figure 8: Schematic of Class 365 and Class 317 door seal configurations

51 Group Standard GO/OTS300 (Reference 5), to which the Class 365 Units were built, makes no mention of seal design. The current Group Standard GM/RT2473 (Reference 4) states in Section B7.9 – Door closing edges – 'The design of the closing edge shall minimise both the risk of trapping objects and the risk and extent of injuries caused by the door equipment'.

52 It is concluded that the door seal of the Class 365 Unit does not comply with the current Railway Group Standard. The current Railway Group Standard does not require compliance for stock predating the standard coming into force.

Driver performance and training

53 The WAGN service from Peterborough to Kings Cross operates without the need for any additional staff on the train other than the driver (Driver Only Operation). Station operation at Huntingdon relies on a series of CCTV cameras mounted at various points along the platform.

54 The driver's training record was examined and there was no evidence of any issues regarding the competence of the driver.

55 On platform two at Huntingdon station there are two sets of DOO CCTV monitors. The set furthest along the platform towards the London end has four monitors and is used when an eight-car set arrives at the platform.

56 Another set consisting of a pair of monitors was positioned nearer the centre of the platform and is used when a four-car set approaches and stops. It is the performance of this monitor bank that has been evaluated as part of the investigation.

57 For DOO the driver was instructed (Reference 6) where to stop the train such that they should have good visibility of the DOO monitors. The monitors are used to determine if the platform edge and doors are clear of staff or members of the public before the driver moves the train. There is some overlap with the system such that objects and people can appear on both monitors particularly at the trailing end of the second vehicle and the leading end of the third vehicle.

58 The four-car monitor bank, as viewed from the left-hand side driver's window, is shown in Figure 9. Drivers are instructed, trained and assessed on their abilities to bring their train to a stand alongside the monitor banks with good visibility of the DOO monitor screens and what to do in the event of an overrun (Reference 7). The side view of this monitor bank looking towards the platform buildings is shown in Figure 10. This view shows the angle of the monitor bank.

Figure 9: The four-car DOO monitor bank – monitors screens D2 and D3

Figure 10: Side view of the four-car DOO monitor bank

59 In order to check the position of the train at the time of the incident a similar Class 365 four-car unit was brought to Huntingdon station on 16 March 2006. The platform was marked out in 0.5 m steps for 2 m on the approach to the four-car monitor bank and the train was moved up in 0.5 m steps and recorded by CCTV.

60 The recorded images from security camera 7 were then downloaded. These images were first of all checked to ensure that the camera position and lens setting had not changed since the incident. From the downloaded images suitable frames were extracted. These frames were then overlaid using proprietary image handling software. Figure 11 shows an image of this test train in the correct position, that is, with the driver's left-hand window alongside the four-car monitor bank. Figure 12 shows the test train at a stand 1.5 m before the correct position.

61 The monitor images were also photographed as viewed from the driving position. Whilst images could be seen on both monitors it was uncertain if the quality of these images was different to those on the day of the incident because the position of the sun and the intensity of the sunlight could not be replicated on the test day.

62 The image taken from security camera 7, when the incident train was stationary with P2 trapped in the door, was then overlaid on the scale. As can be seen in Figure 13 the incident train stopped short of the optimum platform position alongside the four-car monitor bank by approximately 1.4 m. For clarity the images from Figures 11 and 13 have been enlarged and are both shown in Figure 14. P2 and P4 have also been identified in Figure 14. The manufacturer of the CCTV video equipment has indicated that stopping short of the optimum position can result in a significant reduction in image contrast levels. The possible significance of stopping short of the optimum position is discussed – in paragraphs 81 - 90.

63 The London Lines Safety Manual (Reference 6) showed that whilst drivers received initial comprehensive formal driver training and ongoing Formal Driving Assessments, over a two year frequency, covering all aspects of driving, the significance of stopping a driving cab within an optimum range of the monitor banks is not covered. It was indicated by WAGN that the Formal Driving Assessments with a Driver Manager in the cab would identify any aspects of poor braking and positioning.

64 The Rule Book covering Station Duties (Reference 7) indicates to the driver (Section 8.5) that:

'when the train is ready to start, you must check the whole length of the train to make sure that it is safe to close the doors by using the Closed Circuit Television (CCTV)';

'after you have closed the doors, you must check that the door interlock light is lit' – 'You must then carry out the train safety check';

'you must check the whole length of the train by using CCTV'.

65 The training Rule Book or guidance does not indicate specifically what a driver must do if a person is in close proximity to the side of the train after the door interlock is received.

66 The driver (P1) of train 1P71, stated that on moving off, he briefly saw a person in close proximity to the train. He was aware that this person had both hands in view on the side of the train and decided to continue his journey.

Figure 11: Image from security camera 7 showing train at optimum stopping point

Figure 12: Image from security camera 7 showing train 1.5 m before optimum stopping point

Figure 13: Image from security camera 7 showing train position at the time of the incident

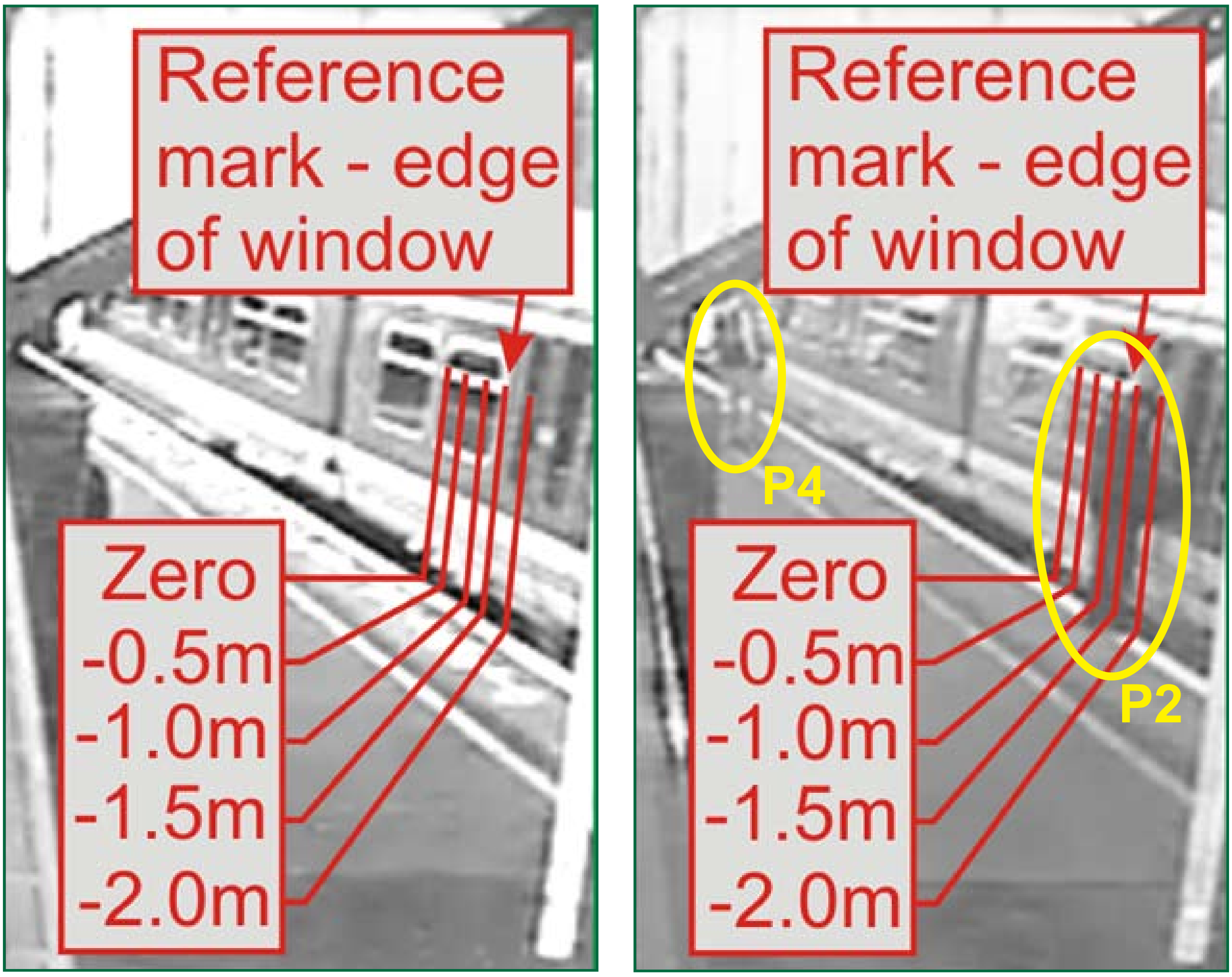

Figure 14: Enlarged images showing train comparison positions – incident train right-hand image – reference test train left-hand image

Performance of the DOO CCTV system

Description of the DOO video system

67 The video display used at Huntingdon station platform two was manufactured by TEW Engineering of Nottingham UK (Reference 8) using CPT monitor screens modified with backlights supplied by Landmark Technology, San Jose, California, USA (Reference 9). The type of monitor used at Huntingdon is one of a number of types in use on the Kings Cross outer suburbs line of route.

68 The system was installed by British Rail in 1992 and renewed by Network Rail in 2004.

69 The four-car monitor bank used two monitor screens which were maintained by Railtrack/ Network Rail to the guidance given in a Railtrack Company Specification – RT/E/30023 (Reference 10), RSSB Railway Group Standard – GT/EH H804 (Reference 11) and to the procedure identified in the Network Rail Maintenance Procedure covering DOO CCTV Systems (Reference 12). These documents identify in detail the required performance of the cameras and in particular the effectiveness of the monitor images. It was reported by Network Rail that the system was inspected in accordance with the Network Rail Maintenance Procedure on 9 January 2006 with no deficiencies recorded.

70 The two monitors showing the images from two separate cameras are shown in Figure 9. Monitor D2, the left-hand side, shows the image from a camera mounted on the platform in front of the stationary train driver's cab and is set up to cover the first two vehicles of a four-car unit. The right-hand monitor, D3, is set up to show an image of the last two vehicles of a four-car unit. The position of the camera covering the first two vehicles is shown in Figure 15 with the position of the second camera covering the last two vehicles shown in Figure 16. Images from these cameras, with a person stood at the leading door of the third vehicle of a four-car unit, are shown in Figure 17. It should be noted that the photograph has been edited to remove the photographer from the scene. This was done to improve picture clarity.

71 The left-hand monitor in Figure 17, D2, shows that a person standing at the leading door of the third vehicle should, under good daylight conditions, be visible to the driver. This photograph gives an indication as to where the D3 camera is positioned and the extent of the platform two curve.

72 The right-hand monitor in Figure 17, D3, shows clearly the person standing at the leading door of the third vehicle. Under good visibility conditions a person standing at this door should have been readily observed (the orange flare in each image is from the jacket worn by the RAIB Inspector photographing the scene).

73 These images also show that the cameras had not been disturbed since installation and setting up. The targeting diamonds are visible at the centre of the lower edge of each frame. These diamonds are painted on to the platform edge such that when they aligned with the monitor centre line the camera is in the correct position. Therefore the cameras were set up correctly with the target diamonds approximately in mid-screen at the time of the incident.

Figure 15: Location of CCTV camera covering first two vehicles of the train

Figure 16: Location of CCTV camera covering last two vehicles

Figure 17: View from four-car monitors with a person stood at the incident door

Factors affecting monitor image visibility

74 The weather on the day was reported as being cold with bright sunlight and good visibility. This can be observed in Figure 18 which is an image recorded at 15:57 hrs (corrected time) and shows bright sunlight from the setting sun at a low angle approximately from the west. The effects of bright sunlight on the monitors was considered. After discussion with the manufacturer this was thought not to be significant because the monitors were fitted with filters and the monitor hood was designed to reduce the effects of sunlight. Figure 24 shows the likely position of the sun and the shadow from the leading end of the unit when the incident occurred. The sun therefore was shining onto the two monitors, particularly the right-hand side D3 monitor.

75 The right-hand image in Figure 14, shows the presence of a person, P4, stood in close proximity to the trailing door of the second vehicle [72242]. P4 appears to be dressed in an anorak with a light coloured stripe down each arm. The security camera video frames reveal that P4 also appears to be seeing someone off (P5). When the train doors close P4 moves away from the closing doors and stands within the area bounded by the painted yellow stripe and the platform edge.

76 There was the possibility that P4 could have masked the view of P2 from the cameras associated with the four-car monitor bank. This was simulated by having a person stand where the leading door of the third vehicle would be when a four-car unit had stopped alongside the four-car monitor bank. A further person was then asked to stand at various positions where the trailing door of the second vehicle would have been located. These positions were marked out earlier when in-service units halted at the station. Although these tests were carried out with the stationary unit in the correct position calculations show that the masking effect, when a person is standing at the rear door of the third vehicle, is not affected by moving the train back 1.4 m.

Figure 18: Image from security camera 7 at 15:57 hrs

77 One set of observations is shown in Figure 19. In the image on the D2 monitor only one person appears to be in view and that person appears to be within the edge of the platform edge and the yellow line and well clear of the door/platform edge. The view from the right-hand D3 monitor also indicates that only one person is present but this person is now in closer proximity to the edge of the platform edge. For clarity the image of the photographer has been removed from the D2 monitor image. Figure 19 shows that the person at the trailing door of the second vehicle can readily obscure the driver's view of a person at the leading door of the third vehicle. The effect is highlighted further in Figure 20 which is an enlargement of the image from the D2 monitor with two persons in view.

78 The exercise was then repeated when an in-service unit arrived. Photographs were taken showing what appeared on the monitor bank (Figure 21), ie what the driver could observe through his open window as shown in Figure 22.

79 The left-hand side driving cab window of the incident unit was reported as being open on arrival and departure from the station and therefore the optical requirements for cab side window glass were not an issue.

80 The physical factors that may have affected the DOO monitor screen visibility and the images have been identified in paragraphs 74-79. It is likely that the position of P2 was holly or partially obscured by the position of P4 immediately before the driver applied power. This does not explain why the driver did not see the potentially larger image of P2 on monitor D3.

81 That the driver came to a stand approximately 1.4 m short of the monitor bank centre line may have affected the quality of the image seen by the driver showing on the right-hand (D3) monitor.

Figure 19: Volunteers at the relevant door positions

Figure 20: Enlargement of image showing on monitor - with two persons evident

Figure 21: Monitor bank images with volunteers in position and a service unit at the platform

Figure 22: View from driver's seat

82 The manufacturer of the monitor equipment identified that the particular monitor screen used at Huntingdon had a reduced contrast when viewed from one particular side. This is because the screen was developed from a standard computer display where the specification calls for good visibility from the top and sides. Viewing from the lower edge is not required of a computer application.

83 For the DOO railway application this standard computer screen is rotated 90^{o} to give the required portrait format. This means that the lesser contrast viewing angle has moved from a view from underneath to a side, depending on the rotation.

84 It was reported by the equipment manufacturer that there was an agreement with Network Rail that for DOO applications the reduced viewing angle would be to the left of the monitor bank centre-line on the understanding that if a unit were to stop short of the monitor bank it could readily be moved forward for a clearer view.

85 The clearer viewing angle was therefore reserved for when a unit slightly overruns the monitor bank. Setting back a unit that overruns is operationally more difficult.

86 The driver in stopping short, is likely to have stopped at a position where monitor D3 had reduced contrast. Qualitative tests undertaken at Huntingdon station using a similar Class 365 Unit and at TEW premises on the 13 March 2006, showed this tendency for the monitor screen contrast to be affected depending on the viewing angle. Figure 23 shows the four-car monitor bank taken from a position before the centre-line. The effect on the contrast in the right-hand side D3 screen was noticeable but not readily quantifiable.

87 The information supplied by TEW shows that the optimum viewing angle for this type of screen is 115°. However, the screen is biased towards the train travel, hence the viewing angle equates to 52.5° one side of the screen and 62.5° the other side of the screen as a nominal median between the best brightness and the best contrast from the centre-line of the monitor screen. The position of the monitor bank was measured in relation to the platform edge and the estimated position of the driver's head. This constructed sight line information is shown in Figure 24.

88 The sight line information indicates that the driver when set back from the nominal centre-line of the monitor by 1.4 m has a viewing angle of 20° with the left-hand side screen (D2) and 24° with the right-hand screen (D3).

89 Both viewing angles are well within the manufacturer's quoted maxima of 52.5° and 62.5° respectively see (Figure 24), but when the system was demonstrated at the TEW premises on 13 March 2006 there was a noticeable reduction in contrast level when the monitor screen was observed from the left-hand side.

90 It is therefore likely that in pulling up short of the centre-line of the monitor bank the driver would have seen a reduced contrast image in the right-hand side (furthest away) D3 monitor.

Figure 23: Four-car monitor bank with a Class 365 Unit at a stand taken before the centre-line

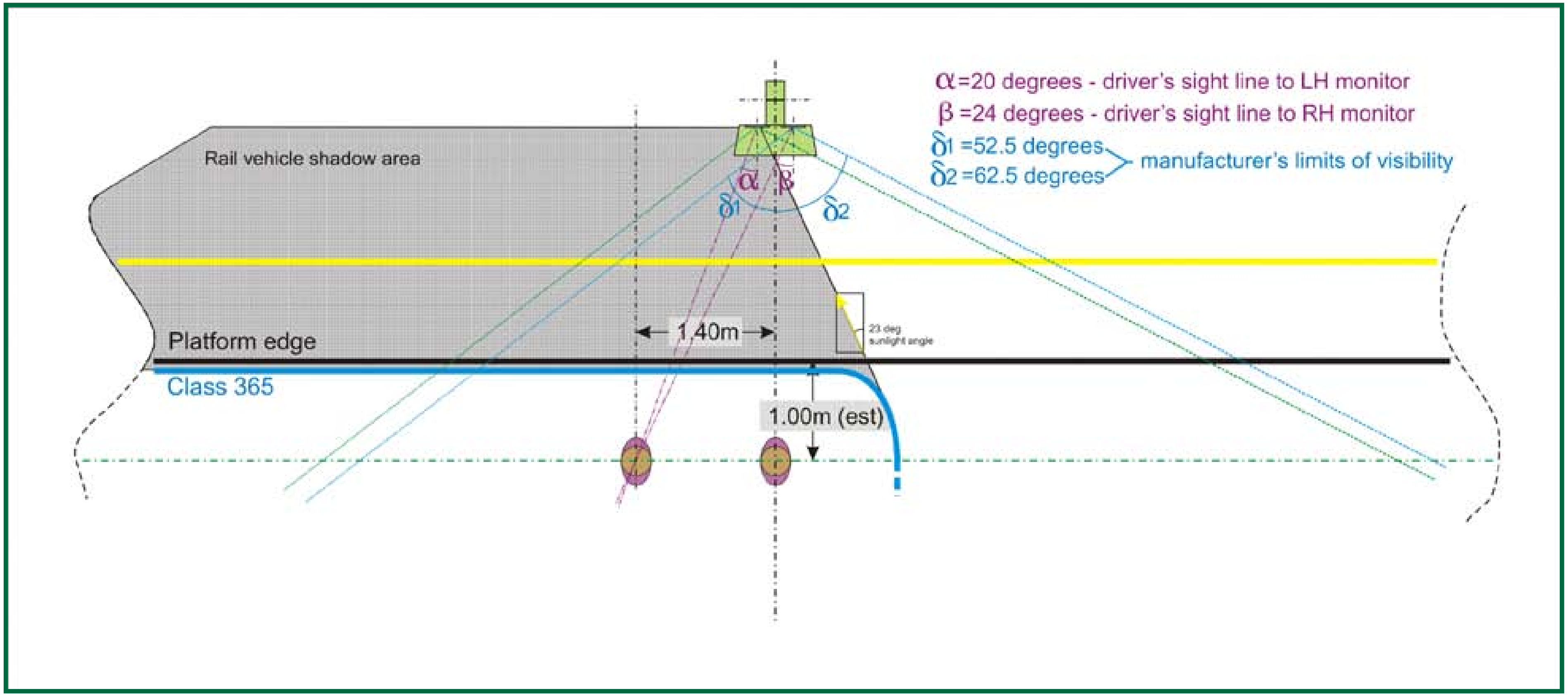

Figure 24: Driver sight line and position of sun/shadow information

Observations

The use of markers to assist stopping

91 The use of platform markers to assist the driver in bringing the train to a stand at the correct position was considered but it was considered that a simple painted stopping point at the platform edge would become invisible, or difficult to see, at the critical point.

92 Stopping markers were therefore not considered to be a solution. Ensuring that the drivers' are made aware of the critical nature of the stopping point as part of their training and the use of improved monitors are considered as better solutions.

Emergency actions of passengers

93 Immediately following the point where P2 became trapped, there was considerable confusion within the train as to how to stop it in the emergency.

94 Figure 25 and 26 show the immediate view a person would have of the inner door panels of the leading door of the incident Class 365 Unit. The warning notice located above each of the door closing controls has been enlarged for clarification and is shown in Figure 27. This notice refers to using the 'Emergency Alarm' in the event of a person being trapped in the doors.

95 Signs identifying the location of the 'Emergency Alarm' and to the 'Emergency Door Release' were attached to the upper portion of the door leaves D1 and D2 respectively and on the red alarm handle located in the horizontal panel immediately above the right-hand door. Figure 28 shows the location of these controls for the Class 365 Unit. The position of these labels and the Emergency Alarm and Emergency Door Release controls are shown in Figure 28.

96 The only sign in the vicinity of the incident door relating to the Emergency Door Release is found on the left-hand door leaf (D1). If this release had been activated the train would have stopped immediately; however, passengers are instructed not to use this release if the train is moving. Figure 29 shows the text associated with both the 'Emergency Alarm' and the 'Emergency Door Release'.

97 Both signs include indications 'penalty for misuse'

98 These instructions were not recognised or followed during the incident by any passengers. During the incident a passenger ran through the train to where the RCO (P8) was located. The RCO stopped the train by entering the driver's cab and instructing the driver to stop.

99 The whole event from the door closing and the person being trapped to when the person fell and was injured took 13 seconds. From when the train moved off to the fall took only seven seconds. It was therefore unlikely that any person inside the train, had they activated the Emergency Alarm when they had realised that the trapped person could not pull their coat clear, would have stopped the train before the person trapped in the door fell and was injured. The Emergency Alarm on the Class 365 Unit requires the person operating it to talk to the driver before the driver applies the brakes. There is also a possibility that, had they activated the alarm immediately the person had become trapped, and the driver had rapidly applied the brakes, that the unit could have come to a stand over the injured person.

Figure 25: Signage left-hand side of the Class 365 Unit door

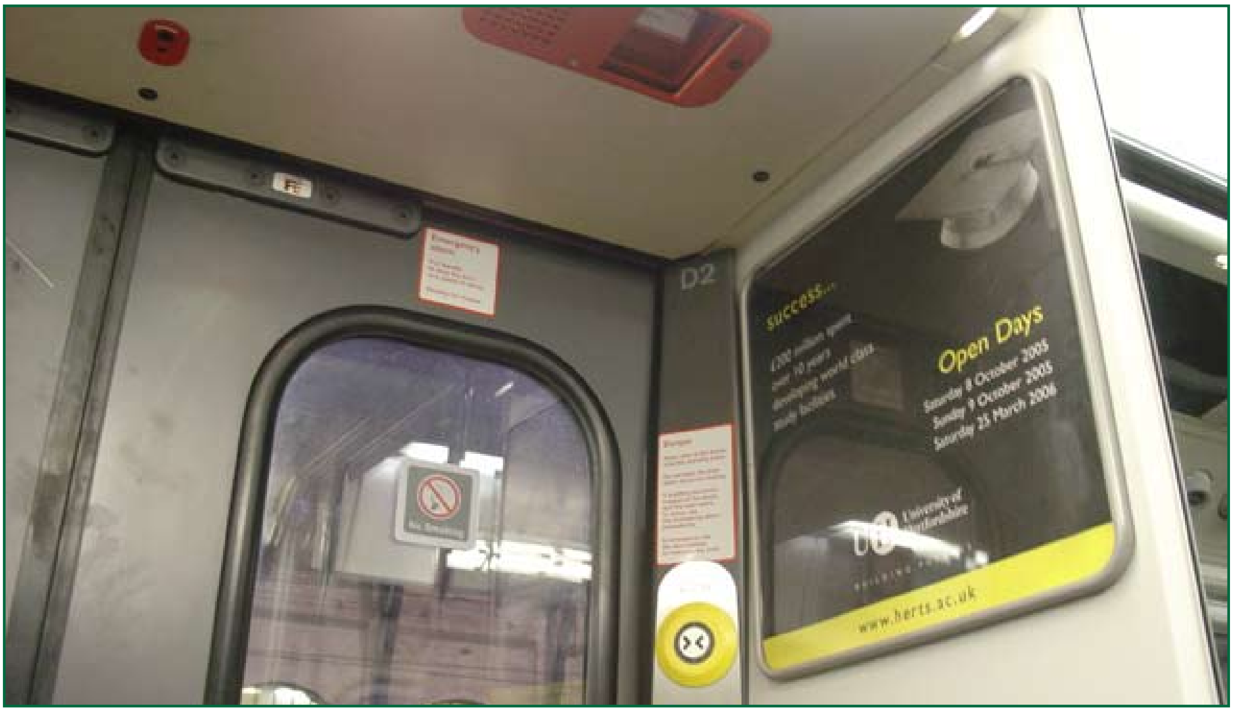

Figure 26: Signage right-hand side of the Class 365 Unit door

Figure 27: Close up of warning label above either door control

Figure 28: Door release and emergency controls over the Class 365 Unit door

Figure 29: Labels on closed door leaves

Figure 30: Labelling on the emergency alarm – Class 365 Unit door.

Incidences of previous injuries to members of the public

100 As part of the investigation RSSB were consulted on the numbers of injuries to the public relating to door closing or operation. Table 4 gives a breakdown of incidents between 2001 and 2005 with 2005 being the latest date when data has been compiled.

Year	Minor injuries	Major injuries	Major injuries (clothes trapping related)	Major injuries (crushing – chest / arms/ hands)	Major injuries (legs and feet)	Major injuries (falling / other / not known)
2001	326	3	1	---	---	(2)
2002	278	7	---	5	1	(1)
2003	333	4	---	---	---	1 (3)
2004	341	6	---	2	1	1 (2)
2005	256	5	---	1	---	2 (2)
Total	1534	25	1	8	2	4 (11)

Table 4: Review of door related incidents involving injury to members of the public

101 Although the data shown in Table 4 indicates that there have been a measurable number of door related incidents in the period 2001 to 2005, only one incident in 2001 has been attributable to the injured person having clothing trapped in a train door before the train departed.

Conclusions

Immediate cause

102 The immediate cause of the accident was that the driver of train IP71 pulled away from platform two at Huntingdon station with a member of public trapped in a door.

Causal and contributory factors

103 The actions of the injured person as the door closed increased the likelihood that his clothing would be trapped between the leaves of the closed door (paragraph 24).

104 A combination of the design of the Class 365 Unit door seal and the closing forces of the Class 365 Unit door permitted the coat fabric to be trapped such that it could not be removed (paragraphs 34-52 and Recommendations 3 and 5).

105 The action of the Driver (P1) in pulling up short of the DOO four-car monitor bank is likely to have reduced the image contrast on the CCTV monitors (paragraphs 53-66 and Recommendation 1).

106 The design and construction of the Class 365 Unit door permitted the interlock to be given when the coat fabric was trapped (paragraph 45).

107 The position and actions of P4 at the trailing door of the second vehicle [72242] immediately before P2 was trapped and during the first few seconds after, are likely to have obscured, or partially obscured, the image of the trapped person in the CCTV monitor from the Driver (P1) (paragraphs 74-78 and Recommendation 4).

108 The design and construction of the display screens in the DOO monitors at Huntingdon station platform two was such, that if a driver pulled up short of the DOO monitor centre-line he would see a reduced image contrast. The driver's view of the trapped person in the more distant right-hand monitor was likely to have been affected by this reduction in monitor screen contrast (paragraphs 80-90 and Recommendation 2).

109 The driver did not see the presence of a person, likely to be P2, in close proximity to the side of a train as being unusual and elected to continue to drive away. The image of this person if the driver had been looking directly at the monitors, would have only been visible for a very short time as the cab left-hand side window passed the right-hand side monitor (paragraph 66 and Recommendation 1).

Other safety issues

110 The position of the DOO cameras are such that a person at the leading door of the fourth vehicle could also be obscured, so that the only image available to the driver would have been in the right-hand side monitor (D3). It is therefore possible that the trapped person could be wholly or partially obscured from the driver's view even if the driver had stopped the train at the optimum point for DOO monitor visibility (paragraph 77 and Recommendation 4).

111 The layout of the emergency signs, instructions and controls in the immediate vicinity of the Class 365 Unit door were of insufficient clarity for the person/s inside the train to take immediate actions to stop the train. Given the extremely short timescales involved the actions of the persons inside the train are unlikely to have exacerbated the trapped person's injuries (paragraph 98 and Recommendation 6).

Recommendations

112 As of the 1 April 2006 the responsibility for operating the London Kings Cross - Peterborough service transferred from WAGN to First Capital Connect. Therefore any recommendations that affect either the future operation of the Class 365 Units or their driving requirements have been directed at First Capital Connect (FCC).

113 The following safety recommendations are made[1]:

Recommendations arising from causal and contributory factors

1 FCC should ensure that driver training is reviewed with a view to increasing the emphasis placed on, and understanding of, aligning the unit correctly with the optimum viewing position of the monitor bank. The training should also identify what actions the driver should take if a person is observed to be in close proximity to the side of the train when the driver is taking power (paragraphs 102 and 105).

2 Network Rail should ensure that the specification for replacement and new CCTV monitors require improved image contrast when viewed at an angle. The specified viewing angle should make a reasonable allowance for variation in a driver's stopping performance (paragraph 108).

3 HSBC and FCC should jointly review the design of the Class 365 Unit door seal and the door control mechanism so as to reduce the door closing forces, with a view to reducing, so far as is reasonably practicable, the forces required to extract trapped objects. This review should take into account existing standards (paragraph 104).

4 Network Rail should review the position of the cameras associated with the CCTV system for DOO at Huntingdon station with the objective of minimising the likelihood that a passenger standing in close proximity to the train will obstruct the driver's view of passengers standing at other doors (paragraph 109).

5 Rail Safety and Standards Board (RSSB) should review Railway Group Standard GM/RT2473 in terms of the correlation between the obstacle extraction test, seal design and the forces required to extract trapped objects or materials (paragraph 104).

Recommendations arising from other safety issues

6 FCC should review and if necessary modify the signage and controls for emergency exits at doors on the Class 365 Unit in view of the passenger reaction in this accident so as to ensure 'best' passenger reaction in an emergency is achieved (paragraph 111). This review should be carried out in consultation with the Association of Train Operating Companies (ATOC) and with reference to the existing ATOC standard (Reference 13).

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[1] Responsibilities in respect of these recommendations are set out in the Railways (Accident Investigation and Reporting) Regulations 2005 and the accompanying guidance notes, which can be found on RAIB's web site at www.raib.gov.uk

Appendices

Glossary of abbreviations and acronyms — Appendix A

ATOC	Association of Train Operating Companies
CCTV	Close Circuit Television
DOO	Driver Only Operation
EMU	Electrical Multiple Unit
FCC	First Capital Connect
RSSB	Rail Safety and Standards Board
OTMR	On Train Monitoring Recorder
RCO	Revenue Collection Officer
WAGN	West Anglia and Great Northern

Glossary of terms **Appendix B**

Driver Only Operation	Passenger trains are crewed solely by a driver.
Monitor bank	The arrangement of video screens set at the driving cab stopping point in order that the driver can observe the length of their train during passenger movements.

Documents referenced   Appendix C

Reference 1	Locomotive and Coaching Stock 2004 Platform 5 – ISBN 1 902336 39 9
Reference 2	Bombardier Transportation AC 8.38 Saloon Bodyside Full Sequence Test Issue 1 – Revision B, Date 3/11/2005
Reference 3	RAIB Rail Accident – Huntingdon train door incident 15 February 2006 – Test Report.
Reference 4	Railway Group Standard GM/RT2473 Power Operated External Doors on Passenger Carrying Rail Vehicles
Reference 5	Railway Group Standard GO/OTS300 Power Operated External Doors on Passenger Carrying Rail Vehicles
Reference 6	London Lines Safety Manual Section 8 – Rules, Competencies, Licences and Permits. 8.15 Driver route knowledge 8.4 Assessment of Competence and Fitness – Train Drivers (version 3) – approved 19/02/2004
Reference 7	Rule Book GE/RT8000 – SS1 Station Duties and Dispatch – Issue 1 – June 2003
Reference 8	TEW Engineering, Crocus Street, Nottingham NG2 3DR.
Reference 9	Landmark Technology – 172 Component Drive, San Jose, California, USA, CA 95131
Reference 10	Railtrack Company Specification – 'Optical Requirements of CCTV Systems for Driver Only Operation – Passenger' – RT/E/S/30023 – Issue 2 – August 2001
Reference 11	RSSB Group Standard – 'Closed Circuit Television for Driver Only Operation (Passenger)' – GT/EH H804 – Issue 1 – Revision A – March 1994
Reference 12	Network Rail LNE – NR/LNE/JF/SM TE43 DOO CCTV Systems, Issue 2, January 02
Reference 13	ATOC Vehicles Standard - AV/st9005 - Vehicle Interiors Communication of Safety and Emergency Information

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