Rail Accident Investigation Branch

RAIB Bulletin 06/2011

Train door incident on the West Coast Main Line, 19 July 2011

Description of the incident

1 On Tuesday 19 July 2011, shortly after train 1S94, the 17:57 hrs service from London Euston to Glasgow Central had begun its journey, one of the doors on the left-hand (looking in the direction of travel) side of the train came fully open. The train had just passed Wembley Central and was travelling at 109 mph (175 km/h) on the down fast line at the time.

2 The train manager, who was checking that the door was secure when it opened, had to grab an adjacent handrail to stop himself falling out. He was shocked, but otherwise unhurt. No other persons were put at risk.

3 The train's brakes were applied automatically when the door opened, and it came to a stop near North Wembley station.

Description of the equipment

4 The train was operated by West Coast Trains Ltd (trading as Virgin Trains), who employed the driver and the on-board staff. It consisted of a nine-car class 390 'Pendolino' electric multiple unit, which was designed, manufactured and maintained by Alstom.

5 The door involved in the incident was door 1A on vehicle 69517, the seventh vehicle in Pendolino set 390017. The train doors are of the sliding plug type, and are operated by electric motors, through a toothed belt for the sideways travel and with a direct drive[1] for the locking and unlocking action (figure 1). The door mechanism and door control unit (DCU) were manufactured in Austria by IFE.

6 In normal operation, the door is held closed by catches actuated by the over-centre[2] action of an operating shaft which is driven by the door motor. When the train is moving at more than 7 km/h (4 mph) a second solenoid-operated catch (known as the speed bolt) automatically bolts the door closed.

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[1] The door motor drives, through a clutch, a vertical shaft which operates retaining catches. These catches lock the door closed. The other end of the motor drives a toothed belt which moves the door sideways to complete the opening and closing action.

[2] A mechanism in which work is done on a linkage to move it past a peak position, after which the mechanism moves into a secondary stable position in which it is locked until the input action is reversed.

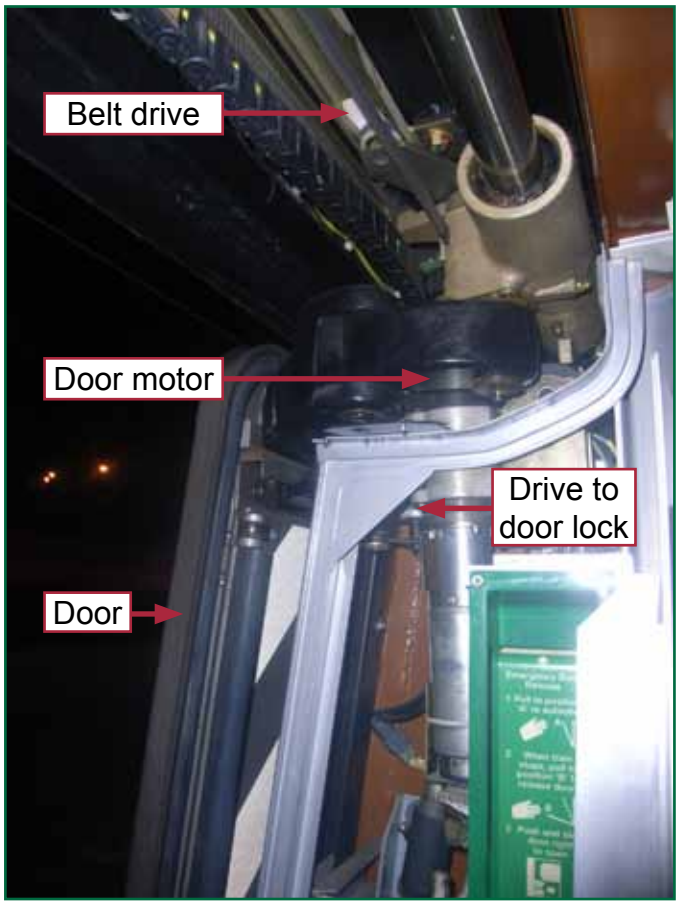

Figure 1: door drive and locking mechanism

7 The position of the door is detected in the control circuits of the train by microswitches, and the design is such that traction power cannot be applied, or brakes released, if the doors are not closed. If a door is detected as open while the train is moving, power is automatically cut off and the train brakes are applied.

8 If the door mechanism becomes defective for any reason, the door can be secured by a manual lock at the base of the door, which consists of a substantial catch-bolt which locates into a box on the inside of the door frame (figure 2). It is operated by a square key. Use of the manual lock by-passes the microswitches that detect the door position, enabling the train to be moved with a defective or damaged door. It also disables the door motor and illuminates a 'Door Out of Use' sign adjacent to the control buttons in the vestibule and on the outside of the train. Use of the manual lock does not disable the speed bolt, but if the door is not fully closed (figure 3) the speed bolt may not engage even though it may still be possible to engage the manual lock (figure 2 inset).

9 There is an external step associated with each door, which is extended automatically when the door is opened under power. The extended step is outside the limits of the vehicle's gauge envelope, so the train is not permitted to move with the step in the extended condition. Locking the door out of use does not ensure that the step is in the retracted condition, and this must be checked visually before the train is moved.

Figure 2: Internal view of door (Inset: Close-up of key in door, and bolt engaged (panel removed to show mechanism))

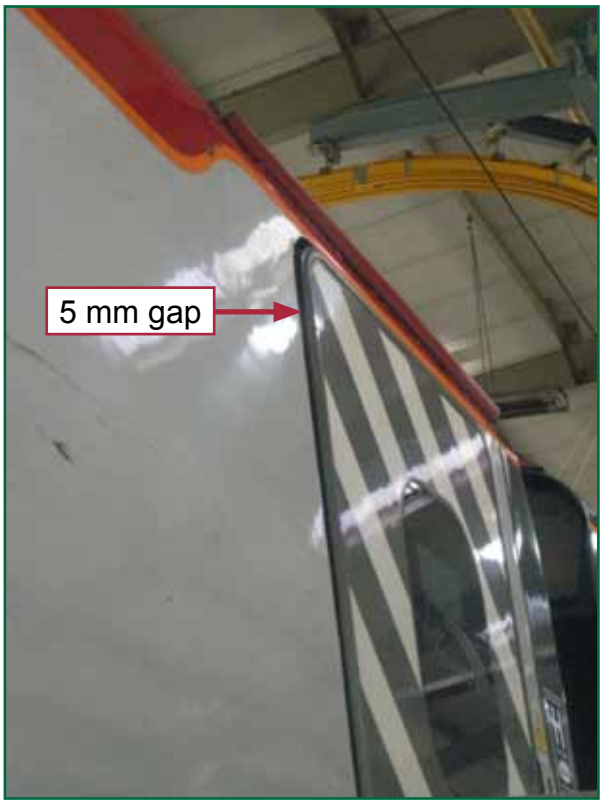

Figure 3: external view of door, locked out of use but not fully closed

Sequence of events

10 Set 390017 was stabled at Oxley depot, Wolverhampton, at the end of service on 18 July. Door 1A of car 69517, which had been locked out of use that day because of a fault, was adjusted to improve its speed of operation at Oxley. The door was tested and put back into use. However, it is likely that the work done at Oxley did not fully correct the fault.

11 The RAIB found during testing after the incident that one of the two door catches had been set up incorrectly. This may have contributed to the door being slow to operate on the morning of the incident.

12 On 19 July the set left Oxley depot at 05:03 hrs. Door 1A of car 69517 was found to be slow to open when the doors were first used at Wolverhampton station, and because of this the train manager on duty at the time locked it out of use. The door remained out of use throughout the day, during which the train ran from Wolverhampton to Euston, and then did a return trip to Glasgow, arriving back at Euston at 17:40 hrs.

13 A fresh crew took over the train at Euston in readiness for the 17:57 hrs departure. The driver noted that a door was shown as out of use on the Train Management System (TMS). Instructions require that when a door is out of use, the associated external step must be checked to ensure that it is not extended (paragraph 8). If the door is on the non-platform side of the train (as in this case), the step can only effectively and practicably be checked by opening the door and looking down. The driver went to carry out this check. He used a key to unlock the door, and then used the emergency release handle to open it. He checked the step (which was not deployed) and then closed the door manually and locked it with the key. The door appeared to the driver to be secure.

14 The train departed on time. A short distance into the journey, the driver began to receive repeated alerts from the TMS that there was a door control fault. He was concerned that this might indicate that the door which he had locked was no longer secure, so he contacted the train manager via the public address system and asked him to check that the door was correctly indicated and labelled as out of use.

15 The train manager went to the door. He found that the 'out of use' indicator was flashing. He had not seen this condition before. He also noted that there was some wind noise, which made him think that the door might not be fully closed. He put his key in the lock. The door moved outwards suddenly, slid open, and then began to cycle back and forth under power. The train manager held onto the handrail and retreated into the carriage, then went through the gangway into the next vestibule and pulled the passenger communication handle.

16 The on-train data recorder from the train shows that the brakes were applied as soon as the door opened, when the train was travelling at 109 mph (175 km/h). The train stopped 43 seconds later, after travelling 0.7 miles (1.1 km), at a braking rate of 1.13 ms^{-2} (11% g). This is consistent with the normal emergency braking rate for this type of train.

17 The train manager closed the door manually and secured it with the key. The driver communicated with the signaller at Watford signal box and re-started the train. Details of the incident were passed to Virgin Trains Control, who decided that the train should be terminated. It proceeded as far as Hemel Hempstead where it arrived at about 18:20 hrs. The passengers were transferred to other trains to continue their journeys, and the train was returned to Wembley depot.

RAIB investigation and findings

18 The RAIB examined the train at Wembley depot and in conjunction with Virgin trains and Alstom, carried out detailed tests on the door involved in the incident and others of the same type.

19 The tests found that there was a fault with the DCU which probably caused the repeated messages received by the driver, and the unusual behaviour of the door when it cycled back and forth during the incident. The nature of this fault could not be established, and the unit was returned to the manufacturers for further analysis.

20 When he was checking the position of the outside step at London Euston, the driver had opened the door by using the emergency release handle. This rotates the door operating shaft by means of a pulley and cable mechanism. After checking that the step was not deployed the driver used the handle on the inside of the door to pull it shut. Unless this is done with some force, it is not certain that the door will close fully enough for the over-centre locking to become effective. This will have two effects: the door interlocks will not be made, and the speed bolt cam will be in the wrong position, so that when the train exceeds 7 km/h the speed bolt will not engage. However, in this condition the door can still be safely locked out of use by means of the key (thus by-passing the interlocks (paragraph 8)), and the 'out of use' indicator will illuminate.

21 The train manager was confronted with an abnormal situation, in that the 'out of use' indication was flashing. He had never seen this behaviour (which was probably caused by the faulty DCU) before. He assumed that the speed bolt would hold the door closed, and (incorrectly) that the interlocks which permitted the train to move depended on the speed bolt being engaged. He put his key in the manual lock with the intention of checking that the bolt was in the locked position.

22 The manual locks are located near the bottom corner of the door adjacent to the pillar which contains the operating mechanism. Alternate doors therefore have the keyholes on the right- and left-hand sides, and the key must be turned clockwise or anti-clockwise to lock the door, depending on which side the keyhole is on. A person using the key must work out for themselves which way to turn it, as there is no label provided. It is likely that the train manager turned the key anti-clockwise and thus withdrew the bolt, although he has no recollection of doing so.

23 The train manager's training had covered the processes for locking the doors out of use, but it had not given him a detailed understanding of how the door locking systems worked.

Observations

24 There are two situations in which the Virgin Trains instructions for use of the class 390 trains required revision:

- When services on the west coast main line were operated by Mk 3 coaching stock, there was a specific instruction to on-board staff not to unlock a door while the train was in motion. This instruction was not initially carried over to the Pendolino fleet.
- Under many failure conditions, use of the 'doors close' button will power the door closed. This is more likely to ensure that the door is fully closed than use of the manual handle as described in paragraph 16. At the time of the incident there was no instruction requiring this to be done.

In this incident, the actions of the driver and train manager were in accordance with the Virgin Trains procedures that were in force at the time. Since the incident, revised instructions (paragraph 28) have been issued to cover both these points.

Conclusions

25 When the train left Euston the door was locked out of use, although it was not fully closed and therefore the speed bolt did not engage. The conditions had been created for an incident to occur which could have been fatal for the train manager.

26 The immediate cause of the incident was that the door was inadvertently unlocked by the train manager. His training had not anticipated the indeterminate status described in paragraph 21, and thus the potential consequences of his action.

27 Factors in the incident were a probable fault in the DCU which created the conditions for the incident to occur (paragraph 19), the design of the door locking system, in particular the facility to lock the door out of use without the speed bolt being able to engage (paragraph 20), and the actions of the train driver in unlocking the door and then closing it manually (paragraph 20).

Actions reported as already taken

28 Virgin trains has issued revised instructions covering situations in which doors have to be locked out of use for any reason:

> *A class 390 train may enter or remain in service with a door locked out of use subject to the following instructions being applied.*
>
> *a. The door must have been powered shut.*
>
> *b. Doors must not be locked out of use whilst a train is in motion.*
>
> *c. If there is any doubt as to the fault status of a door, the train must be brought to a stand (using Pass-com if necessary) prior to the door being locked out of use.*
>
> *d. Arrangements will be made for any door locked out of use to be re-checked by a fitter prior to the train commencing a new journey.*
>
> *e. In the event that a door is locked out of use after it has been closed manually (ie it has not been powered shut), the train must be taken out of service at the first possible location.*
>
> *No doors are to be unlocked and reinstated other than at a maintenance depot.*

29 These instructions supplement Virgin Trains' existing procedures for dealing with a door fault, which require the external step to be checked from outside the train when a door is locked out of use.

30 Alstom, on behalf of Virgin Trains, is preparing a revised procedure for locking a door out of use. This will involve opening the cubicle door and rotating the operating shaft by hand, to check that the door catches have fully engaged.

31 Alstom is also issuing a revised procedure for the setting up of the door catches (paragraph 11).

Learning points

32 The actions reported as being taken by Virgin Trains and Alstom will address the issues that have been identified.

33 However, this incident acts as a reminder to all railway staff of the risks associated with train doors. In particular, operators should instruct staff that they should:

- not attempt to insert a key to check that a door is secure while a train is moving; and
- consider the potential consequences of closing power-operated doors manually rather than using power.

34 Operators of trains fitted with IFE sliding plug doors should ensure that staff are fully trained and instructed in procedures for dealing with door faults, and that they have an appropriate level of understanding of the systems which control and secure the doors, both in normal operation and in degraded modes.

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