



Rail Accident Investigation Branch

Rail Accident Report



**Fatal accident involving a train passenger at
Twerton
1 December 2018**

Report 14/2019
October 2019

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 or incident that is being investigated. However, where the RAIB is less confident about the existence of a factor, or its role in the causation of the accident or incident, the RAIB will qualify its findings by use of words such as '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 or incident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, words such as 'probable' or 'possible' can also be used to qualify 'underlying factor'.

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

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

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

Any information about casualties is based on figures provided to the RAIB from various sources. Considerations of personal privacy may mean that not all of the actual effects of the event are recorded in the report. The RAIB recognises that sudden unexpected events can have both short- and long-term consequences for the physical and/or mental health of people who were involved, both directly and indirectly, in what happened.

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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Fatal accident involving a train passenger at Twerton, 1 December 2018

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Summary

At about 22:04 hrs on Saturday 1 December 2018 a passenger was leaning out of the window of a moving train when her head came into contact with a lineside tree branch near Twerton, a suburb of Bath. The passenger suffered fatal injuries. The train, a Great Western Railway service from London Paddington to Exeter St David's, was travelling at approximately 75 mph (120 km/h) at the time.

On the type of coach making up the train, opening windows are provided to allow passengers to reach through and operate the external door handles when the train is in a station. This is the only means by which passengers can open the train doors. However, other than warning signs, there is nothing to prevent passengers from opening and leaning out of such windows when trains are away from stations and moving. The accident occurred because the passenger did this when branches from a lineside tree were in close proximity to the train.

A possible underlying factor was that Great Western Railway's risk assessment process had not historically identified the risk of passengers or staff being injured as a result of putting their heads out of windows on moving trains. Consequently, Great Western Railway had not provided adequate mitigation measures to protect against the risk.

The RAIB has made four recommendations and identified two learning points.

One recommendation is addressed to operators of mainline passenger trains, including charter operators, and seeks to minimise the likelihood of passengers leaning out of droplight windows when a train is away from stations. A second recommendation, is addressed to operators of heritage railways and seeks to improve their management of the risks associated with passengers leaning out of vehicles.

The third recommendation is addressed to Great Western Railway and seeks to reduce the potential for hazards associated with its operations being overlooked.

The fourth recommendation is addressed to RSSB and seeks to ensure that its advice on emergency and safety signs reflects the level of risk associated with the hazard being mitigated.

The learning points reinforce the importance of undertaking regular tree inspections and the value of train operators having well briefed procedures for dealing with medical emergencies on board trains.

Introduction

Definitions

- 1 Metric units are used in this report, except when it is normal railway practice to give speeds and locations in imperial units. Where appropriate the equivalent metric value is also given.

The accident

Summary of the accident

- 2 At about 22:04 hrs on Saturday 1 December 2018 a passenger was leaning out of a train window when her head came into contact with the branch of a tree near Twerton, a suburb of Bath. The passenger suffered fatal injuries. The train, a Great Western Railway service from London Paddington to Exeter St David's, was travelling at approximately 75 mph (120 km/h) at the time.

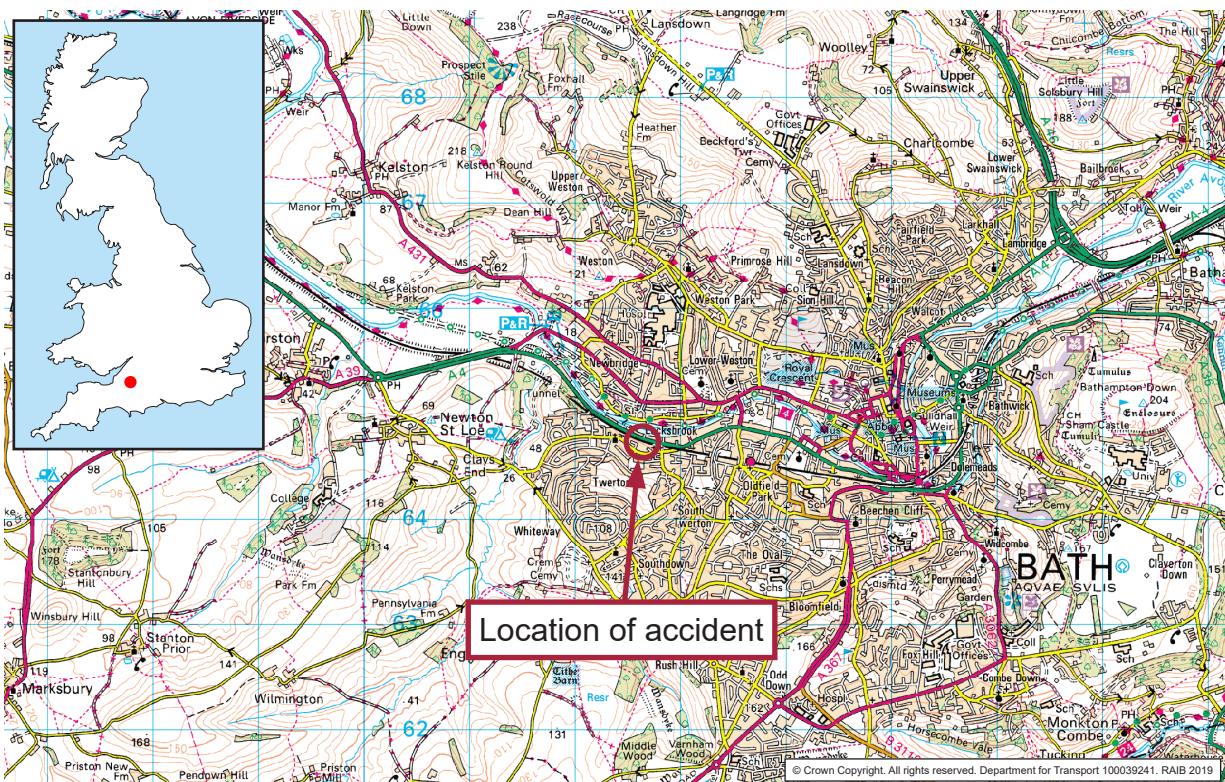


Figure 1: Extract from Ordnance Survey map showing location of accident

Context

Location

- 3 The accident occurred around 108 miles and 36 chains¹ from London Paddington on the line to Bristol via Bath. At this location, the railway comprises two non-electrified tracks, the 'up' and 'down' main lines.
- 4 The railway is elevated from the surrounding land on a brick structure. The north side is defined by a vertical brick wall which runs alongside the A36 road. The ballasted area of the railway runs right up to this wall and so affords limited opportunity for the growth of substantial trees. On the south side, where the tree involved was growing, the railway drops down a soil slope to the railway boundary and private properties that back onto the railway. The soil slope has numerous trees growing on it as well as smaller plants and bushes.

¹ A unit of length equal to 66 feet or 22 yards (20 m).



Figure 2: General photograph of the scene before the accident showing the tree branch involved (circled) (courtesy of Network Rail)

- 5 The train was travelling on the 'down' main line (i.e. towards Bristol). At Twerton the maximum permitted speed for the class of train involved is 100 mph (161 km/h).

Organisations involved

- 6 Great Western Railway (GWR) is the trading name of First Greater Western Limited, a wholly owned subsidiary of FirstGroup plc. GWR operated the train, employed the driver, train manager and other staff working on it.
- 7 Network Rail is the owner and maintainer of the infrastructure, including trackside vegetation.
- 8 GWR and Network Rail freely co-operated with the investigation.

Train involved

- 9 The train was a High Speed Train (HST) and comprised eight Mk3 passenger coaches with a class 43 power car at each end. The window which the passenger leaned out of was at the leading end of coach 'D' (number 42508), which was near the middle of the train.

- 10 HSTs were designed and built by British Rail Engineering Limited from the mid-1970s and have been in continuous use across the British rail network since then. Mk3 coaches are referred to as having 'slam doors' because the passenger doors, located at the coach ends, are hinged and are opened or closed manually. In order to reduce the risk from doors being opened inadvertently whilst in motion, the only handle is fitted to the outside of the door.
- 11 To open a door, passengers inside the train have to open a 'droplight' window in the door and reach outside to operate the handle. Centrally operated secondary door locking was introduced in the 1990s to further reduce the risk of people on board opening a door while a train is moving.
- 12 Droplight windows are also used by train staff during the dispatch process. As such, there are times when the train staff need to lean out of them. However, GWR instructs its staff to only do this within the limits of station platforms where there is little or no risk from lineside vegetation and structures.
- 13 Droplight windows are a simple vertical sliding window pane which is opened by pulling down a horizontal lip attached to the top edge of the pane. The droplight window is not locked when the train is in motion.
- 14 When fully opened, HST droplight windows create an opening that is 48 cm wide and 50 cm high, with the bottom edge located 106 cm above the coach floor. The current design of the mechanism is such that the window will remain in whichever position it is raised or lowered to. It is intentionally not self-closing, to avoid the window closing on passengers or staff undertaking legitimate activities with their heads out of the window.

The tree

- 15 The branch which the passenger came into contact with was attached to a stem that was growing from the stump of an ash tree.



Figure 3: Satellite view of the accident location

- 16 After the accident, Network Rail commissioned an arboricultural consultant to investigate the history of the tree. The consultant's report identified that the tree involved was an ash tree which had been growing on the embankment approximately 5.5 m from the nearest running rail of the 'down' main line.
- 17 The report describes how the tree was either felled or coppiced² around 1998 and after that seven stems grew out from the stump. Eventually the stump became colonised by two or three types of wood decay fungi which ultimately led to the failure of the stems. The stem involved then fell towards the railway, coming to rest on a chain link fence at the top of the embankment.
- 18 From a review of historical aerial photographs and video footage, the RAIB has concluded that the stem involved did not fail before 18 April 2015. However, by 4 February 2017, it had fallen and was resting on the fence with some branches extending out towards the railway line. The photographs and video footage also show that the tree remained largely unmoved in this position until at least late on the afternoon of the day of the accident. Given that the tree had been in this position for at least 22 months without moving significantly, it was not a particularly windy day and the RAIB is not aware of any other events that could have affected its position, the RAIB believes it is likely that it was still in that position at the time of the accident.



Figure 4: Forward Facing CCTV from July 2018, showing tree amongst growing vegetation (courtesy of Network Rail)

Passenger involved

- 19 The passenger was a 28 year-old woman travelling to Penarth via Bristol Temple Meads from Bath Spa station where she joined the train with a group of friends. She had spent the latter half of the day socialising in Bath.

² Coppicing is the practice of cutting trees back to near ground level to promote new growth.

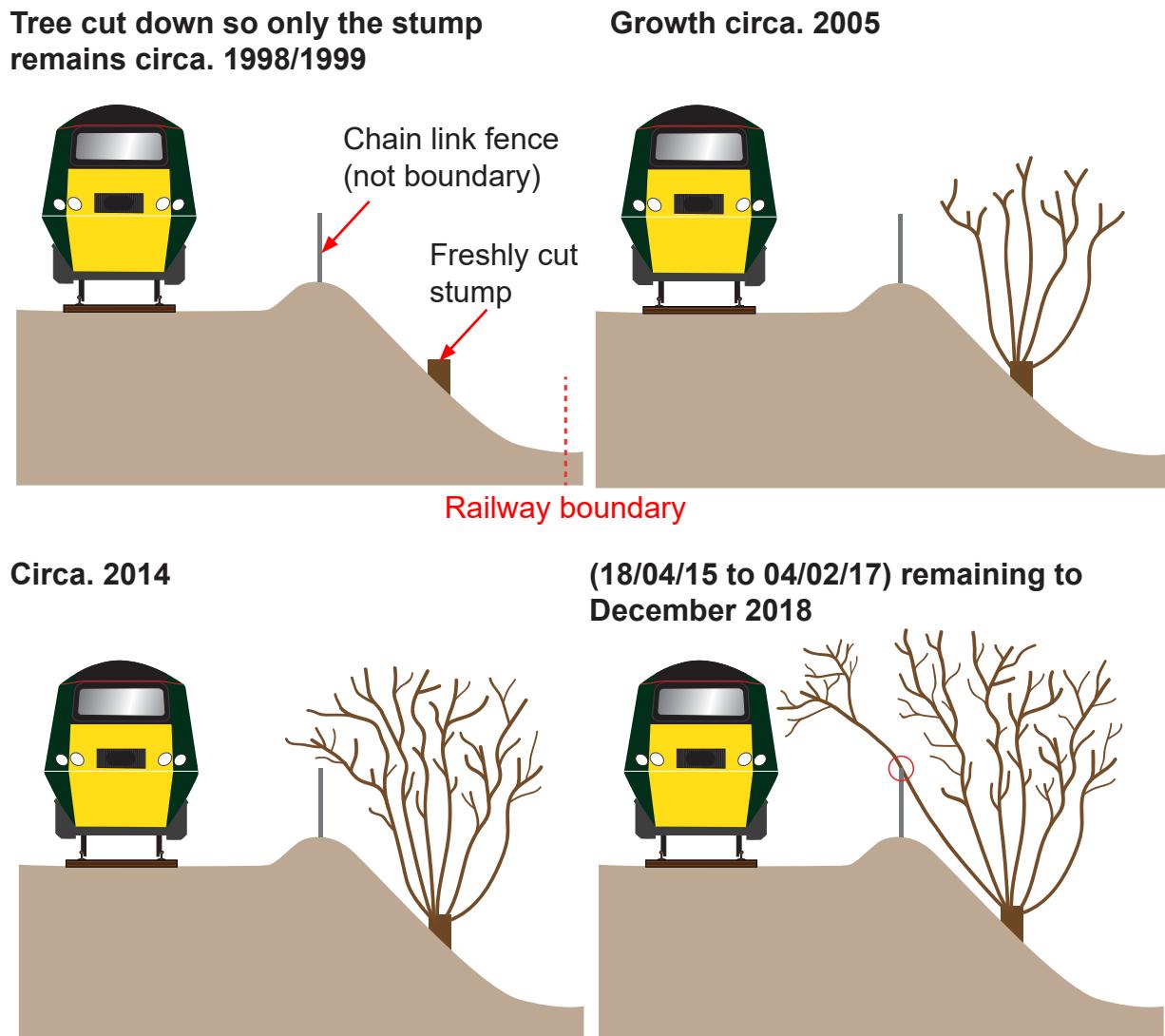


Figure 5: Tree history

External circumstances

- 20 It was dark at the time of the accident. Although some strong winds were experienced in the area three days before, the RAIB found no evidence that the weather or other external influences contributed to the cause of the accident.

The sequence of events

Events preceding the accident

- 21 At 20:30 hrs the train departed from London Paddington on time. It arrived at platform 1 at Bath Spa station at 21:59 hrs, with a timetabled departure time of 22:02 hrs. Its next scheduled stop was at Bristol Temple Meads station at 22:14 hrs. After the passengers who left the train at Bath Spa had done so, the door at the leading end of coach 'D' remained open. Platform CCTV shows the window in that door was open, at or near to its fullest extent.
- 22 Bath Spa station was busy. At 22:00 hrs the passenger and her friends boarded the train through the door at the leading end of coach 'D', having been in the station building for around 10 minutes. CCTV shows that just before departure, platform staff partially closed the window and then closed the door. At that time, the window opening was not big enough for a person to put their head out of.
- 23 At 22:02 hrs the train departed from Bath Spa station. Witnesses report that the train was busy, with few empty seats. The passenger and two friends remained in the vestibule area between coaches 'C' and 'D'. A third friend moved into an adjacent passenger compartment.

Events during the accident

- 24 Analysis of the on-train data recorder indicates that the accident happened around two and a half minutes after the train departed from Bath Spa station. By this point the train was travelling at around 75 mph (120 km/h) and accelerating.
- 25 From witness accounts to the British Transport Police (BTP), the events immediately before the accident are not fully clear. However, the RAIB is satisfied that one of the group of friends opened the window and at least one other friend leant out of the window before the passenger who was injured did so. Witness evidence indicates that the passenger had her head out of the window for a few seconds before falling back into the vestibule having sustained a serious head injury.

Events following the accident

- 26 At least one passenger rang 999 and informed the South West Ambulance Service (SWAS) of the accident. Others came directly to the injured passenger's aid. An off-duty GWR train manager travelling on the service became aware of distressed passengers in the vicinity of the vestibule. As a result of hearing comments made by them, he believed that someone was trying to leave the train, so he pulled the train's 'emergency alarm'³ handle which stopped the train.

³ Alarm handles are provided for people to use in an emergency. On the train type involved operation of the handle causes the train's brakes to apply and will bring the train to a stop. It can be reset by the train crew, but requires them to locate the particular handle that has been activated and reset it.

- 27 The on-duty train manager was alerted to the activation of the emergency alarm when he felt the unexpected application of the train's brakes. He made his way along the train in an attempt to identify what had caused someone to use the alarm. On arrival at the vestibule he quickly ascertained the nature of the accident and made an announcement on the train's public address system for passengers with medical training to assist. A number of passengers, some with extensive medical qualifications and experience, attended and did all they could to help the passenger.
- 28 The off-duty train manager implemented GWR's 'ambulance to train'⁴ procedure for dealing with ill and injured passengers and used a mobile telephone to call a dedicated number that facilitated a simultaneous conversation with both the train control centre and SWAS. This procedure allows train crews, train controllers, signallers and emergency services to agree the most appropriate railway station for a train to stop at so ambulance crews can attend to ill or injured passengers as quickly as possible.
- 29 It was agreed that the train should proceed directly to Bristol Temple Meads station. The train arrived at Bristol at 22:21 hrs and was met by SWAS crews who were assisted by station staff and officers from the BTP.
- 30 Despite the efforts of the passengers on the train and SWAS staff, the passenger could not be saved.

⁴ This is supplementary to the Rail Delivery Group Guidance Note, RDG GN018 –'Responding to ill / injured passengers on trains' which contains guidance on how train operating companies should prepare for medical emergencies on trains.

Key facts and analysis

Identification of the immediate cause

- 31 The passenger leant out of a window while the train was moving and her head came into contact with a lineside tree branch.
- 32 Network Rail arranged for a local Mobile Operations Manager⁵ (MOM) to ride in the cab of a later train with a view to identifying the object that the passenger had come into contact with. At approximately 00:15 hrs that train set out from Bath Spa travelling at low speed. Around 15 minutes later, when at 108 miles and 36 chains, the MOM saw the freshly broken end of a tree branch at window height, close to the train. The train was stopped and he got out and found a corresponding section of tree branch on the ballast underneath the tree.
- 33 While at the scene, the MOM took photographs and recovered the branch. It is approximately 55 cm long and 4 cm in diameter. It was handed to the BTP which was subsequently able to confirm, by way of a forensic examination, that it was the branch that the passenger had come into contact with.

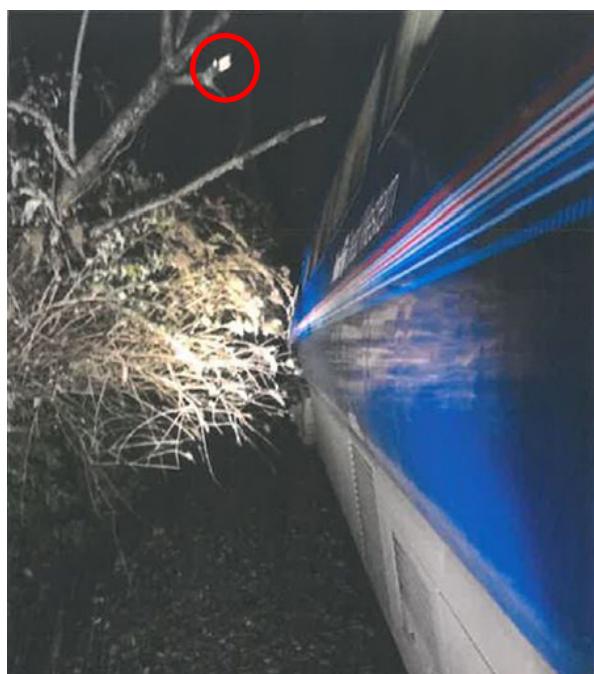


Figure 6: The train's proximity to the tree (courtesy of Network Rail)

- 34 The end of the branch that had been nearest the railway had marks consistent with having being sawn through. The cut was not recent and the RAIB was not able to determine when the branch had been cut. It is possible that it was done on 2 January 2018 when a tree in the vicinity was cut back after a train crew reported that their train had struck a branch in that area; no damage was reported to that train. The sawn branch end did not show any signs of having been in contact with trains.

⁵ A Network Rail employee who responds to operating incidents that occur on the railway.

Identification of causal factors

- 35 The accident occurred due to a combination of the following causal factors:
- the passenger leant out of a droplight window while the train was moving (paragraph 36);
 - the risk to passengers from leaning out of droplight windows had not been adequately mitigated (paragraph 40); and
 - a tree branch was close enough to the train for a passenger who was leaning out of a window, to come into contact with it (paragraph 60).

Each of these factors is now considered in turn.

The actions of the passenger

- 36 **The passenger leant out of a droplight window while the train was moving.**
- 37 The evidence confirms that the head injury sustained by the passenger was as a result of her head coming into contact with the tree branch (paragraph 31). Witness evidence confirms that her head was out of the window at the time she sustained the injury.
- 38 The window was partially open when the train left Bath Spa. One of the group of friends opened the window and at least one other friend leant out of the window before the passenger who was injured did so (paragraph 25).
- 39 The toxicology report concluded that the passenger's blood contained 142 milligrams of ethanol per 100 millilitres. This is nearly twice the UK legal driving limit of 80 milligrams in 100 millilitres of blood. It is generally recognised that this would cause a level of intoxication in the average social drinker which may affect their co-ordination and judgement. However, the actual effect on the passenger involved is unknown.

Management of the risk from droplight windows

- 40 **The risk to passengers from leaning out of droplight windows had not been adequately mitigated.**
- 41 This causal factor probably arose due to a combination of the following:
- the warning signs and their arrangement did not deter the passenger from leaning out of the window while the train was moving (paragraph 42); and
 - there were no other measures in place to mitigate the risk to persons from leaning out of windows on moving trains (paragraph 50).

Warnings provided to passengers

- 42 **The warning signs provided and their arrangement did not deter the passenger from leaning out of the window while the train was moving. Their design and content, although in accordance with industry guidance, did not maximise the chances of passengers being fully informed about the risk.**
- 43 The warning signs on display (figure 7) were fitted in 2007 following a refurbishment of the coaches. The signs relating to not leaning out of the window was the smallest of four signs on or around the door. One of the other related to the risks associated with trains stopping at short platforms and the dangers of leaning against or trying to operate doors while the train is moving. The other two related to emergency door operation and ventilation.



Figure 7: Warning signs (courtesy of the Office of Rail and Road)

- 44 The RAIB considers that the sign relating to the risk from leaning out of the window did not adequately convey the level of risk for the following reasons:
- the wording used, in particular the word ‘caution’⁶, suggests that leaning out of the train window is something that may be done safely if a degree of care or precautions are taken⁷;
 - the use of a yellow background to the sign is a recognised characteristic of a warning sign as opposed to the more appropriate use of a red background to convey danger or a prohibited activity⁸; and
 - the sign is much smaller than the other signs around it, one of which is not safety related.
- 45 It is not possible to say with any certainty whether the content, colour and size of the signs was a factor in this accident. Even prominent, clear warning signs are not guaranteed to be effective.

⁶ The Health and Safety Executive guidance on The Health and Safety (Safety Signs and Signals) Regulations 1996 describes yellow ‘Warning’ signs as informing people to ‘be careful’, ‘take precautions’ or ‘examine’.

⁷ Research, e.g. <https://www.who.int/fctc/guidelines/ArtElevenWogalterNine.pdf> suggests that there may also be value in including a statement as to the possible consequence of non-compliance.

⁸ The Health and Safety Executive guidance on The Health and Safety (Safety Signs and Signals) Regulations 1996 describes how signs relating to ‘danger’ or the prohibition of ‘dangerous activity’ should be red.

- 46 Railway Group standard GM/RT2130 mandates requirements for emergency and safety information on trains. It is supported by a guidance document, GM/RC2533, which makes recommendations on the design of emergency and safety signs. GM/RC2533 recommends that signs comply with The Health and Safety (Safety Signs and Signals) Regulations 1996.
- 47 GM/RC2533 has a section dedicated to external doors, in particular those fitted with opening windows. It describes the general nature of warning signs intended to discourage passengers from leaning on or attempting to open doors on moving trains. It also describes the type of sign that should be used to discourage people from leaning out of the windows of moving trains.
- 48 It states that the risk from passengers trying to open doors merits a red 'prohibition' sign (which was present, see figure 7 above) and that the risk from leaning on the door or out of the window while the train is moving merits a yellow 'warning sign' (which was also present, see figure 7 above). In this respect, the signs on and around the door were consistent with the guidance contained in GM/RC2533.
- 49 GWR was not able to produce any evidence to support the reasoning behind the choice of signage. However, given that the design of signs fitted closely followed the advice within GM/RC2533, it is likely that it was used to inform GWR's decision.

Absence of other measures

- 50 **There were no other measures in place to mitigate the risk of people leaning out of the windows of moving trains.**
- 51 In August 2016 a train passenger was fatally injured at Balham, south London as a result of striking his head on a signal gantry, having put his head out of a droplight window. Although this accident involved a railway structure, rather than a tree, and a different type of train, the RAIB recommendation to train operators (including GWR) is relevant. This recommendation (paragraph 99) was specifically intended to reduce the risks to passengers from structures which are close to trains, but actions to address it could have had an effect on the circumstances of this accident. Additionally, GWR's hazard identification process in place prior to the accident at Balham did not identify the risk of passengers leaning out of the windows on moving trains and no additional risk mitigation measures had been introduced. GWR's risk identification process is considered to be an underlying factor to this accident and is discussed in paragraphs 82 to 88.
- 52 In response to the Balham recommendations GWR recognised that the intended replacement and modification of its HSTs to trains without droplight windows would not be completed for some time. In particular, GWR recognised that while it had already started the handback of its HST sets from August 2017 and continued to hand back around approximately 2 sets per month, that process was not scheduled to be completed until 30 November 2019. The conversion of the 6-unit HSTs (2 (powercars) + 4 (coaches)) remaining in service would not be modified to sliding doors trains without droplights until December 2019 and its sleeper trains would remain in service. It therefore undertook a formal risk assessment of 'operating Mk3 rolling stock with droplight windows' to consider risk mitigation measures for the risk posed by droplight windows.

- 53 Published in September 2017, this assessment considered nine options to reduce the risks of operating Mk3 rolling stock with droplight windows. They ranged from engineering based solutions (such as sealing the windows and providing an internal door handle, fitting bars to windows and the reintroduction of self-closing windows) through to additional staff, enhanced warning signs, on-board announcements and enhanced staff awareness of the issues.
- 54 GWR decided to implement four of the options. Two of the four related to the risks from lineside structures, but the other two are relevant to the risk from trees. For special events, additional train managers were to be rostered to support guards on what were expected to be busy trains; GWR planned to brief its guards to make sure that any such additional managers were made aware of the risks presented by passengers leaning out of windows and to support the guards in discouraging it by closing windows and being vigilant to vulnerable groups.
- 55 The other option to be implemented was to design, cost and fit enhanced warning signs consistent with a design that had been discussed and agreed by the HST User Group following the Balham accident. This included replacing the yellow warning sign with a red 'prohibition' sign along with a pictogram to enhance its effectiveness. GWR also considered fitting an additional sign to the sill of the window.
- 56 Although GWR intended to implement all four options by May 2018, it did not implement either of the two that were relevant before the accident at Twerton occurred. As a result, the warning signs remained unchanged and staff awareness of droplight window risks had not been refreshed.
- 57 GWR has stated that this situation arose because two members of staff tasked with progressing these actions left the company before they were completed. Importantly, part of the action tracking system intended to notify GWR of overdue actions had failed so that no one was notified of outstanding or overdue actions. This meant that GWR did not know that the actions were outstanding.
- 58 GWR heads of department attend a Safety Steering Group (SSG) and its directors attend an Executive Safety Group (ESG); both meetings are held 13 times per year. All RAIB recommendations are considered by GWR's Head of Operations who collates them into a meeting paper that is considered by the SSG. Where a recommendation is considered to have a significant business impact for GWR, the SSG escalates the recommendation to the ESG for its consideration. GWR stated that it believed that the recommendations from the RAIB's report into Balham were discussed by the ESG in May 2017, although it could not find any minutes demonstrating that they had been considered.
- 59 GWR's risk assessment prepared in September 2017 (paragraph 53) identified actions that GWR stated would not have significant business impact and as such were not further escalated by the SSG to the ESG. GWR has stated that the SSG was dependent on the action tracking system for identifying progress of the actions, and, due to the problems with it (paragraph 57), the SSG was not aware that the actions were not progressing. Therefore, the SSG could not inform the ESG, nor did the ESG have access to any additional data or records that it could use to identify that the actions had not been implemented.

Vegetation management

- 60 A tree branch was close enough to the train for a passenger who was leaning out of a window to come into contact with it. A possible reason for this is that Network Rail had not undertaken a tree inspection in the area of the accident since 2009.
- 61 The management of vegetation on Network Rail infrastructure is governed by Network Rail standard NR/L2/OTK/5201/01 ‘Lineside Vegetation Management Manual’. It was issued in March 2018 with a compliance date of April 2019, and replaced NR/L2/TRK/5201/01 ‘Management of Lineside Vegetation’. Network Rail stated that, although not in force at the time of the accident, it expected that staff would be operating in accordance with it from its date of publication.
- 62 The two standards are broadly similar, except the way in which the railway is ‘zoned’ when assessing the risks from vegetation, and the maximum interval allowed between inspections. Relating to the zoning of the railway, NR/L2/TRK/5201 also included a requirement to ensure that, for line speeds of 60 mph (97 km/h) and above, the ground area up to 5 metres from the running rail and the area vertically above it should be maintained clear of vegetation: this requirement was not included in NR/L2/OTK/5201, which instead allows routes to set immediate action zones based on risk inputs. However, the requirement in NR/L2/TRK/5201 had been the subject of a temporary variation (paragraph 75).
- 63 NR/L2/OTK/5201 sets out four different types of inspection. They are the ‘vegetation on foot’, ‘cab ride’, ‘tree inspection’ and ‘leaf fall’ inspection. The ‘leaf fall’ inspection is not relevant to this accident.
- 64 The ‘vegetation on foot’ and ‘cab ride’ inspections are undertaken to assess the impact of vegetation on the sighting of signals, level crossings and signs. They also identify any risk of obstruction to refuges, walking routes and positions of safety, and any vegetation that is sufficiently close to the running line to be in danger of coming ‘into contact’ with trains (i.e. not just in close proximity).
- 65 The standard also requires that these inspections identify hazardous trees, defined as those with the capability to cause derailment or harm to a train. It provides guidance that trees or branches of 150 mm or greater diameter are known to be capable of causing derailments.
- 66 The ‘vegetation on foot’ and ‘cab ride’ inspections require a member of staff, with a basic awareness of vegetation, to note any issues they believe require attention. ‘On foot’ inspections are done by a person walking the track; the ‘cab ride inspections’ are done by a person riding in the cab of a train. In both cases, a paper copy of a Track Engineering Form (TEF) is completed and submitted to a supervisor. The information gained during the inspections is assessed and work arising from those inspections prioritised accordingly.
- 67 The ‘vegetation on foot’ inspections should be carried out at intervals of between 36 and 44 months. At Twerton the last ‘vegetation on foot’ inspection was carried out on 29 March 2018. Although a stem from the tree involved had failed and was resting on the fence, it was not identified in this inspection. This was because it did not affect sighting distances, was not causing an obstruction, was not in danger of coming into contact with trains and would not have been considered as posing a hazard to trains. Other than the presence of an invasive weed the inspection did not identify any concerns around the location of the accident.

- 68 'Cab ride' inspections should be done at intervals of between 12 and 16 months. No issues were identified near Twerton from the last cab ride, undertaken on 22 July 2018. This inspection was video recorded. A post-accident review of the footage, paying particular attention to the accident location, revealed a dead tree branch amongst the green leaves of other trees. However, since this inspection was focussed on sighting and obstruction issues it would have been unusual if it identified the dead tree as a hazard.
- 69 The 'tree inspection' should be undertaken at intervals between 60 and 68 months. It is undertaken by trained staff with a high level of knowledge and specialist training in identifying tree species, tree defects and other clues that may indicate that a tree is in poor health. Network Rail has historically contracted out these inspections to specialist companies.
- 70 The standard describes a quality known as 'diameter at breast height' (dbh). This is the diameter of the tree at 1.3 metres above the ground. Inspection of trees with a 'dbh' of more than 750 mm is mandated. Trees with a 'dbh' of between 150 mm and 750 mm are to be inspected if they also appear hazardous to the railway, i.e. have significant defects and the potential to cause derailment or harm (paragraph 65).
- 71 The arboricultural report (paragraph 16) indicates that the tree at Twerton had a 'dbh' of 225 mm at 1.5 metres above its connection to the stump (between 150 mm and 750 mm), so would have merited a detailed inspection only if identified as being 'hazardous'. Network Rail informed the RAIB that it does not consider the tree stem would have posed a derailment risk since the size of stem that could have fallen onto the track was insufficient to pose a risk of derailment (<150 mm diameter). However, two senior members of Network Rail staff with expertise and experience of vegetation management both considered that, had the tree been detected during an inspection, it would have been assessed as needing remediation or re-inspection within 12 months.
- 72 The arboricultural report commissioned by Network Rail after the accident reported that the stem involved was in poor health, growing from a severely decayed stump which had been colonized by readily visible fungal fruit bodies. The report states '*A competent inspection of the tree undertaken at any time since at least 2014 would have identified the decay and, from this time onwards, the fungal fruit bodies. The decay alone, confirms the tree to have been in hazardous condition for several years, and prior to January 2018 at least three stems would have been clear threats to the railway.*'
- 73 Network Rail engaged a contractor to undertake a tree inspection at Twerton in 2009. This was funded centrally by Network Rail. However, this requirement was subsequently the subject of a temporary variation (paragraph 75).
- 74 Given that the tree had been visibly (to an expert) in poor health for around 5 years prior to the accident, it is possible that had a tree inspection been carried out and the incident tree considered for a specialist tree inspection in the 5 years prior to the accident it might have been identified as needing felling or pruning. However, Network Rail had not undertaken a tree inspection in the area of the accident since 2009 and this is possibly causal to the accident.

Temporary variations

- 75 The route requested a temporary variation against Clauses 5.3, 5.4 and 5.5, 'Generic vegetation clearance requirements', of NR/L2/TRK/5201/01 in November 2015; it was granted in October 2017. It also requested a temporary variation against Clause 4.2, '5 year tree inspection', in November 2015; it was granted in December 2017.
- 76 Each of the clauses referred to in these temporary variations are designated 'red requirements' by Network Rail. A 'red requirement' is defined as one that shall always be complied with and against which deviations should not be allowed; corrective actions shall be enforced if any deviations are discovered.
- 77 The submissions for the temporary variations explain that the route was endeavouring to address ongoing non-compliances which had arisen due to the quantity and relative priority of the related work. Network Rail explained that issuing these temporary variations with explicit compliance dates was a means of creating a time-bound action plan to bring them back into compliance. Both submissions explained the mitigating actions that were to be taken, the plan to achieve compliance and included a safety justification that the risks were to be controlled to a tolerable level. The submissions were reviewed by Network Rail's Head of Lineside and approved by its Referred Variation Review Panel.

Identification of underlying factors

Risk identification

- 78 A possible underlying factor was that GWR's risk identification process had not historically identified the risk of passengers (and staff) being injured by leaning out of windows on moving trains.
- 79 GWR has a Safety Management System (SMS) which details specific hazards that it has identified, along with assessments of the associated risks and measures in place to mitigate them. GWR conducted a review of its 'major risks' in 2007, 2012 and again in 2015. However, it was not until after the fatal accident at Balham in 2016, that GWR specifically examined the risks arising from its operation of Mk3 coaches with opening windows.
- 80 GWR published that risk assessment in September 2017 (paragraph 53). However, it did not complete the actions relevant to its own operation of coaches with droplight windows (enhanced signage and staff briefings) before this accident. So, at the time of the accident, it was effectively operating on the basis of its pre-2017 understanding of the risks, which did not include the risk to people from leaning out of the windows of a moving train.
- 81 GWR was aware of the issues associated with 'slam doors' and droplight windows. It had participated in industry-led trials of an engineering modification (internal door handles) as far back as 2001 and it reports that in 2007, the refurbishment of its Mk3 coaches was taken as an opportunity to declutter the signage around passenger doors.

- 82 GWR was also collating data from reports of persons injured as a result of leaning out of windows. This data goes back at least as far as 2012 and includes information about the nature of injuries, whether the persons were staff or passengers and, where known, the mechanism of injury (some of which relate to impacts with vegetation).
- 83 GWR reported that for the period between April 2014 and January 2019 it recorded 16 occasions where passengers or staff were injured as a result of having parts of their body out of droplight windows. In addition to this accident it recorded 2 other major injuries and 13 minor injuries. Foliage was attributed to 11 cases. There was a fairly equal distribution of these events between staff and passengers, although 3 staff injuries were attributed to staff leaning out of train cab windows.
- 84 Had GWR specifically identified the hazard of passengers leaning out of opening windows and included it in its risk management process prior to the fatal accident at Balham, it is possible that it would have implemented additional mitigation measures which might have prevented the passenger leaning out of the window on 1 December 2018.

Observations

Competence and training of staff undertaking vegetation inspections

- 85 **Some of the staff responsible for maintenance of lineside vegetation at Twerton had a limited knowledge of the standards governing vegetation management and how to correctly complete records relating to inspections.**
- 86 The inspection and management of lineside vegetation at Twerton is undertaken by off-track staff from the Network Rail depot at Queen Anne Road, Bristol. The 'on foot' inspections (paragraph 67) are planned, arranged and resourced from that depot. The off-track staff also have responsibility for other areas such as drainage, boundaries and maintenance of level crossings.
- 87 Some of the off-track team had not been thoroughly briefed on the standards relating to vegetation management and did not understand how to correctly complete the associated TEF (paragraph 66). Although the supervisor was receiving the forms, he was not aware that the staff member submitting them was completing them incorrectly and did not have a good understanding of the new standard himself.

Timing of vegetation inspections

- 88 **Vegetation inspections were being undertaken all year round and not within the growing season (1 April to 31 October), as defined by the standard.**
- 89 Standard NR/L2/OTK/5201/01 'Lineside Vegetation Inspection and Risk Assessment' requires that inspections are carried out during the growing season, so that dead or dying trees stand out from those with strong leafy growth.

- 90 The staff at Queen Anne Road depot were doing all the triennial ‘on foot’ inspections in their area during one year. Because the amount of work was greater than they could achieve during the growing season they were carrying them out throughout the whole of that year. The most recent inspection at Twerton was carried out on 29 March 2018, two working days before the growing season, as defined by the standard. The RAIB does not consider this to be causal because regional variations in vegetation growth throughout the UK can be much greater than two days.

Previous occurrences of a similar character

- 91 Droplight windows and slam doors on trains have featured in accidents where passengers and train crew have been injured or killed for many years. More modern rolling stock is not fitted with passenger accessible opening windows. Mk3 coaches represent the last slam door coaches used on scheduled mainline passenger services in any significant numbers. However, heritage railways and a number of charter operators continue to operate rolling stock with droplight windows.
- 92 The fatal accident at Balham in 2016 ([RAIB report 09/2017](#)) is the most recent similar accident investigated by the RAIB. Although it involved a railway structure and a train window not intended for passenger use, it gave rise to the recommendations which caused GWR to review its risk assessment of Mk3 coach operation (paragraph 53).
- 93 Data from RSSB’s⁹ safety management information system (SMIS) going back over the last ten years identified 23 other accidents involving passengers being struck while leaning from a moving train. Fourteen of these involved vegetation (one major injury), four involved infrastructure (one fatality and one major injury), one involved an item thrown up by a train, while for the remainder (including one major injury) the cause was not recorded.

⁹ A not-for-profit body whose members are the companies making up the railway industry. The company is registered as Rail Safety and Standards Board Ltd, but trades as RSSB.

Summary of conclusions

Immediate cause

94 The passenger leant out of a window while the train was moving and her head came into contact with a lineside tree branch (paragraph 31).

Causal factors

95 The causal factors were:

- a. The passenger leant out of a droplight window while the train was moving (paragraph 36).
- b. The risk to passengers from leaning out of droplight windows had not been adequately mitigated. This causal factor probably arose due to a combination of the following:
 - i. The warning signs provided and their arrangement did not deter the passenger from leaning out of the window while the train was moving. Their design and content, although in accordance with industry guidance, reduced the chances of passengers being fully informed about the risk (paragraph 42, **Recommendations 1 and 4**).
 - ii. There were no other measures in place to mitigate the risk to persons from leaning out of windows on moving trains (paragraph 50, **Recommendation 1**).
- c. A tree branch was close enough to the train for a passenger who was leaning out of a window, to come into contact with it, possibly because Network Rail had not undertaken a tree inspection in the area of the accident since 2009 (paragraph 60, **Learning point 1**).

Underlying factors

96 A possible underlying factor was that GWR's risk identification process had not historically identified the risk of passengers (and staff) being injured by leaning out of windows on moving trains (paragraph 78, **Recommendation 3**).

Observations

- 97 Some of the Network Rail staff responsible for the maintenance of lineside vegetation at Twerton had a limited knowledge of the standards governing vegetation management and how to correctly complete records relating to inspections.
- 98 Vegetation inspections were being undertaken all year round and not only within the growing season (1 April to 31 October), as defined by the standard.

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

Accident at Balham, RAIB report 09/2017, Recommendation 2

99 Recommendation 2 read as follows:

Operators of trains which include rolling stock with droplight windows should assess the risk arising from reduced clearance outside those windows and implement any reasonably practicable measures to mitigate it. The review should be informed by obtaining from Network Rail the data referred to in recommendation 1 (reduced clearance structures), and include consideration of means of preventing people from leaning out of windows and/or improving warning signage. These measures should address the risks to both passengers and staff.

100 The actions taken by GWR in response to this recommendation are discussed in paragraphs 51 to 56.

101 On 24 May 2018 the Office of Rail and Road reported to the RAIB that eight Train Operating Companies (TOCs) had implemented the recommendation. Implementation was reported as 'on going' for one TOC with GWR and another TOC's implementation status reported as 'progressing'.

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

102 Prior to the accident, GWR had begun a programme of replacing some HSTs with new trains which do not have droplight windows¹⁰ and modifying the other HSTs to have power operated doors without opening windows. The intention is that by January 2020 GWR will have replaced or modified all of its HST sets. The only GWR trains with droplight windows that will remain in service will be a small number of locomotive hauled Mk3 coaches on its sleeper service.

103 As a direct result of this accident, GWR undertook a review of its risk assessment of the operation of Mk3 coaches with droplight windows. As a result, it implemented a series of measures intended to mitigate the associated risks in the interim period before they are eliminated. This included enhanced signage on doors (figure 8), train managers making announcements about the dangers of leaning out of open windows and briefing staff about challenging unsafe passenger behaviour and closing windows.



Figure 8: Photograph showing revised signage as fitted by GWR

104 GWR has implemented a new computer-based system to track actions that arise from safety related incidents and reviews. This system is linked to GWR's payroll system so that should a member of staff leave, the relevant managers are alerted, allowing an opportunity for outstanding actions to be reallocated accordingly.

105 GWR's Executive Safety Group meeting (paragraph 58) now includes a standing agenda item to consider relevant RAIB recommendations.

Other reported actions

106 Network Rail has started a programme of briefings and practical training for staff at the Queen Anne Road depot in Bristol. This is to improve their knowledge and understanding of the current vegetation management standard and includes practical sessions on vegetation inspection and TEF completion.

¹⁰ The Persons with Reduced Mobility Technical Specifications for Interoperability (PRM TSI) sets out accessibility standards which rail vehicles must comply with by 1 January 2020. Slam door stock with droplight windows will not be compliant.

- 107 Network Rail has divided the lines that the Queen Anne Road depot has responsibility for into three portions. Each year one of the portions will be inspected on foot which will ensure that the whole mileage is inspected every 36 months and the workload is more manageable. It is intended that this will enable all inspections to be undertaken during the growing season.
- 108 RSSB has reported to the RAIB that it has completed a review of, and is rewriting GM/RT2130, which is supported by GM/RC2533. It has decided to withdraw GM/RC2533 because much of the guidance contained is covered by the Technical Specifications for Interoperability for Persons with Reduced Mobility for Interoperability (PRM TSI) and the European Standards referred to within it. However, the PRM TSI does not cover all existing rolling stock and so RSSB intends to make a case to the railway industry for the creation of a guidance note to the PRM TSI which will incorporate revised guidance on emergency and safety signs.

Background to the RAIB's recommendations

- 109 The Network Rail standard for vegetation management seeks to ensure that vegetation is managed so that it is not a risk to trains. It does not seek to prevent injury to persons (staff or passengers) leaning out of windows on moving trains. The RAIB recognises that the risk to those leaning out of trains could be reduced by stricter vegetation management standards. However, given that few mainline passenger trains have droplight windows and that the numbers are still further reducing, the RAIB considers that this would place an unreasonable burden on those maintaining the network.
- 110 With respect to heritage railways, the RAIB recognises that they are generally more contained operations covering limited mileages. They also tend to operate a far greater proportion of rolling stock with droplight windows as well as open sided vehicles. Given the differences the RAIB has concluded that such railways could be reasonably expected to manage the risk by stricter control of the vegetation and other infrastructure features.
- 111 The ORR has written to the industry stating that it considers that warning signs alone are unlikely to be a sufficient mitigation given the potential consequences of passengers leaning out of the windows of moving trains (paragraphs 40 and 41).
- 112 The RAIB has therefore made separate recommendations to mainline passenger train operators and heritage railways.

Recommendations and learning points

Recommendations

113 The following recommendations are made¹¹:

- 1 *The intent of this recommendation is to prevent passengers leaning out of opening windows on trains operating on the mainline railway.*

Operators of mainline passenger trains, including charter operators, using stock with opening windows that passengers could lean out of, should review their risk assessments for operating those trains and implement any additional mitigation measures necessary to minimise the likelihood of passengers leaning out of the windows away from stations (paragraph 95b).

- 2 *The intent of this recommendation is to improve heritage railways' management of the risk associated with passengers leaning out of vehicles.*

Operators of heritage railways, using stock that passengers could lean out of, should review their risk assessments for people leaning out and implement any additional mitigation measures necessary to achieve an acceptable level of safety (paragraph 95b).

- 3 *The intent of this recommendation is to reduce the potential for Great Western Railway to overlook hazards associated with its operations.*

Great Western Railway should review its hazard identification process to understand why, prior to 2017, it did not result in identification of the hazard of passengers leaning out of a droplight window, or an assessment of the associated risk. It should take any necessary action to ensure that the possibility of other hazards being overlooked is minimised (paragraph 96).

¹¹ 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 (ORR) 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.

- 4 *The intent of this recommendation is to ensure that the advice contained in the relevant Railway Group Standards or Railway Industry Standards in relation to warning signs on rolling stock, accurately reflects the level of risk associated with the hazard to be mitigated.*

RSSB should review its existing guidance to train operators on the design of emergency and safety signs. It should then, as necessary, revise it and prepare new guidance (possibly associated with the Technical Specifications for Interoperability for Persons with Reduced Mobility). Guidance should be prepared in consultation with train operators and should suggest designs of emergency and safety signs that are appropriate and commensurate with the risk to passengers being managed. Specific consideration should be given to the types of warning signs to be displayed on and around external doors with opening windows (paragraphs 46 to 48).

Learning points

114 The RAIB has identified the following key learning points¹²:

- 1 This accident demonstrates the value of undertaking regular tree inspections within the interval specified in Network Rail standards to identify trees in poor health. These inspections provide specialist insight into the condition of trees growing adjacent to the railway and provide valuable intelligence that assists in their effective management (paragraph 71).
- 2 Although in this instance the passenger could not be saved, the train operator's response was a good example of how well briefed procedures can enable the effective management of medical emergencies on-board trains. It also demonstrates the value of having agreed processes that enable the emergency services to get rapid access to patients whilst ensuring the continued safe operation of the railway (paragraph 28).

¹² '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

BTP	British Transport Police
Dbh	Diameter at breast height
ESG	Executive Safety Group
GWR	Great Western Railway
HST	High Speed Train
MOM	Mobile Operations Manager
SSG	Safety Steering Group
SWAS	South West Ambulance Service
TEF	Track Engineering Form

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