



Rail Accident Investigation Branch

Rail Accident Report



**Collision between train 1C84 and a tree at
Lavington, Wiltshire
10 July 2010**

Department for
Transport

Report 08/2011
April 2011

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.

© Crown copyright 2011

You may re-use this document/publication (not including departmental or agency logos) free of charge in any format or medium. You must re-use it accurately and not in a misleading context. The material must be acknowledged as Crown copyright and you must give the title of the source publication. Where we have identified any third party copyright material you will need to obtain permission from the copyright holders concerned. This document/publication is also available at www.raib.gov.uk.

Any enquiries about this publication should be sent to:

RAIB	Email: enquiries@raib.gov.uk
The Wharf	Telephone: 01332 253300
Stores Road	Fax: 01332 253301
Derby UK	Website: www.raib.gov.uk
DE21 4BA	

This report is published by the Rail Accident Investigation Branch, Department for Transport.

Collision between train 1C84 and a tree at Lavington, Wiltshire, 10 July 2010

Contents

Summary	5
Preface	6
Key Definitions	6
The Accident	7
Summary of the accident	7
Organisations involved	7
Location	8
External circumstances	9
The train involved	9
Staff involved	9
Events preceding the accident	9
Events during the accident	10
Events following the accident	11
The Investigation	13
Sources of evidence	13
Key facts and analysis	14
Identification of the immediate cause	14
Identification of causal and contributory factors	14
Identification of underlying factors	16
Previous occurrences of a similar character	17
Severity of consequences	18
Observations	21
Summary of conclusions	24
Immediate cause	24
Causal factors	24
Contributory factors	24
Underlying factors	24
Additional observations	24
Actions reported as already taken or in progress relevant to this report	25
Previous recommendations relevant to this investigation	26

Recommendations	28
Recommendations to address causal, contributory and underlying factors	28
Recommendations to address other matters observed during the investigation	28
Appendices	30
Appendix A - Glossary of abbreviations and acronyms	30
Appendix B - Glossary of terms	31
Appendix C - Key standards current at the time	33
Appendix D - Extract from Network Rail's tree survey remit	34

Summary

At around 14:09 hrs on Saturday 10 July 2010, the 13:06 hrs First Great Western service from Paddington to Penzance collided with a tree which had fallen from adjacent land at Lavington, Wiltshire. The train was travelling at about 90 mph (145 km/h) at the time the collision occurred and the leading cab was extensively damaged. The train was disabled by the collision and was subsequently hauled to Westbury station, arriving at 19:03 hrs.

The driver sustained minor injuries, but no-one else was injured.

The RAIB has made four recommendations. Two recommendations have been made to Network Rail concerning the evaluation of risk from trees on adjacent land and communicating with landowners. A further recommendation has been made to Network Rail regarding the actions of signallers when undertaking safety-critical communications. One recommendation has been made to First Great Western regarding their policy on the use of mobile telephones by traincrew.

Preface

- 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.

Key Definitions

- 3 All dimensions and speeds in this report are given in metric units, except speed and locations on Network Rail, which are given in imperial dimensions, in accordance with normal railway practice. In this case the equivalent metric value is also given.
- 4 Mileages are measured from London Paddington.
- 5 The terms 'up' and 'down' in this report are relative to the direction of travel; the down line runs from Reading to Taunton.
- 6 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report). These are explained in appendices A and B.

The Accident

Summary of the accident

- 7 At 14:09 hrs on Saturday 10 July 2010, the 13:06 hrs First Great Western (FGW) service from Paddington to Penzance (train reporting number 1C84) was approaching the Lavington area on the Down Westbury line at about 92 mph (148 km/h). On rounding a curve, the driver saw that the line was obstructed by a fallen tree. He applied the emergency brake but the train collided with the tree at about 90 mph (145 km/h).



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

- 8 The train involved was a High Speed Train (HST)¹, which did not derail and came to a stand on an embankment approximately 1 km from the point of collision. The location where the accident occurred is shown in figure 1.
- 9 The leading cab of the HST was extensively damaged and the train was disabled by the collision. The train was subsequently hauled to Westbury station, arriving at 19:03 hrs, where the passengers (approximately 200 in number) were provided with a replacement train to continue their journey.
- 10 The driver sustained minor injuries in the collision; he was later taken to hospital for examination and released the same day. No-one else was injured.

Organisations involved

- 11 Network Rail owns and maintains the track and infrastructure, including trees within the railway boundary. It employs the signallers and control centre staff.

¹ Also known as an InterCity 125

- 12 FGW operated train 1C84 and employs the traincrew and FGW control centre staff.
- 13 The land adjacent to the railway, from which the tree involved in the collision had fallen, is a privately owned farm.
- 14 All parties freely co-operated with the investigation.

Location

- 15 The collision occurred on the Down Westbury line, between Reading and Taunton, 85 miles and 77 chains² from London Paddington. The tree fell from an area of woodland adjacent to the railway, known as Parham Wood. The front of the train came to a stand at about 86 miles and 46 chains, a few metres from the eastern end of Lavington viaduct (figure 2).

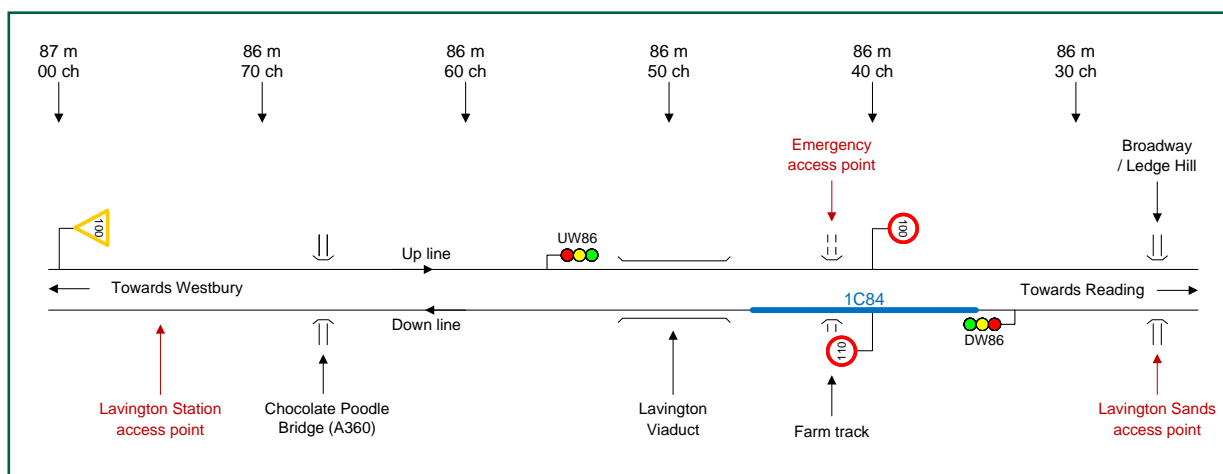


Figure 2: Track layout, showing key features in the vicinity of train 1C84 after the collision

- 16 After the collision, the train came to a stand *beyond* signal number DW86, within the associated *signal overlap*. This was about three miles east of the boundary between the areas controlled by the Thames Valley signalling centre (TVSC) and Westbury signal box, ie it was still in the area controlled by TVSC (figure 3).

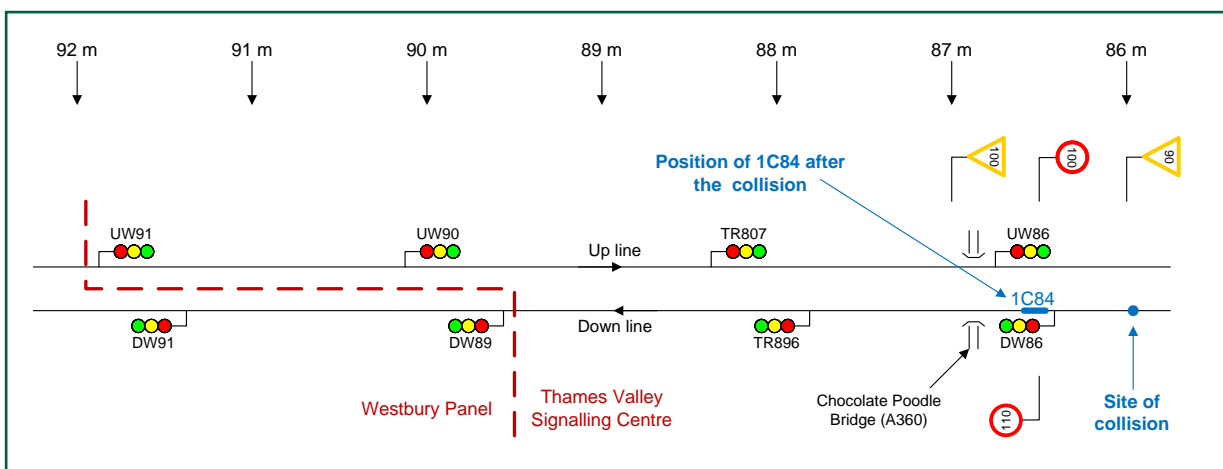


Figure 3: Overview of area showing location of train 1C84 and the signal box boundary

² There are 80 chains in a mile.

- 17 The nearest *access point* was at Lavington Sands bridge, approximately 200 m from the rear of the train (figure 2). An alternative access point was at the former Lavington station, approximately 600 m from the front of the train and beyond both Lavington viaduct and 'Chocolate Poodle Bridge'.³
- 18 The Lavington Sands access point is about 10½ miles (17 km) from Westbury station and 54 miles (88 km) from Reading station by road.

External circumstances

- 19 The weather was dry and sunny with a light wind.
- 20 The RAIB believes the external circumstances affected neither the cause nor the consequences of the accident.

The train involved

- 21 The train involved in the collision was HST set LA06, with power car 43041 leading, eight passenger coaches and power car 43135 trailing.
- 22 The RAIB has found no evidence to link the condition of the train, or the way it was driven, to the accident.

Staff involved

- 23 The key members of Network Rail staff involved were:
 - TVSC workstation 4 signaller – 'signaller A';
 - TVSC signaller (meal relief) – 'signaller B';
 - Westbury signaller; and
 - Route control manager, located at Swindon.
- 24 The key members of FGW staff involved were:
 - Driver of train 1C84 (referred to in this report as 'the driver');
 - On-duty driver travelling as a passenger on train 1C84 (referred to in the report as the 'assisting driver');
 - Train manager; and
 - Senior controller, located at Swindon.

Events preceding the accident

- 25 The last trains to pass the site before the collision on 10 July 2010 were train 1A81 (in the up direction) at about 12:37 hrs and train 1C83 (in the down direction) at about 13:51 hrs.

³ The bridge over the A360 is unofficially known as 'Chocolate Poodle Bridge', named after a public house which has now closed.

- 26 Sometime between the passage of train 1C83 and 14:09 hrs, a common ash tree (*fraxinus excelsior*) fell across the boundary fence from woodland within farm property adjoining the railway. The tree is estimated to have been about 27 m tall and to have stood 17 m from the railway (10 m from the boundary fence). It fell across both running lines from the south (down) side.
- 27 Train 1C84 approached the area at around 14:09 hrs. Having slowed for the 90 mph (145 km/h) speed restriction which exists between the 85 and 85½ mileposts, the driver passed the 85½ milepost and started to accelerate towards the limit of 100 mph (161 km/h) which exists from there to the 86½ milepost.

Events during the accident

- 28 The tree had fallen across the line at 85 miles and 77 chains, and was obscured from the driver of train 1C84 by a left-hand curve (figure 4). The RAIB estimates that the tree might have been visible to the driver for five to six seconds before the collision occurred. The driver immediately applied the emergency brake using the brake control handle; this was recorded by the *on train data recorder* (OTDR) two to three seconds before the collision, which happened at 14:09:22 hrs.



Figure 4: View of the fallen tree after the collision, looking towards London

- 29 The upper branches of the tree were struck by the cab of the leading power car and entered it through the windscreen. The left-hand half of the windscreen and the upper portion of the windscreen pillar bore the brunt of the impact.
- 30 The main control circuit breaker of the leading power car was tripped as a result of collision damage to the driver's desk. This resulted in a loss of electrical supply to both the *National Radio Network* (NRN) radio and the *wheel slide prevention* (WSP) system, as well as other systems on the train, including the OTDR on the leading power car.

- 31 Data from the OTDR on the trailing power car indicates that both of the recorded axles on this vehicle stopped rotating within 9 seconds of the collision. Damage to the wheels indicates that they all started to slide after the collision (paragraph 68). The RAIB estimates that the overall average braking rate was 7.9% g from the time that the emergency brake was applied⁴. Since HSTs were originally specified to deliver a 9% g braking rate, the actual braking rate achieved indicates that the loss of WSP and the subsequent wheel slide had a minimal effect on braking performance.
- 32 The train did not derail and subsequently travelled for about 1 km before coming to rest, which the RAIB estimates to have been at 14:10:11 hrs, assuming a constant rate of deceleration.

Events following the accident

- 33 Once the train came to a stand, the driver had to push the windscreen away from him in order to extricate himself from the wreckage in the cab. He was unable to reach the NRN radio to contact the signaller because it was obstructed by debris (it was not operational in any case, paragraph 30).
- 34 The train manager alighted from the train and applied a *track circuit operating clip* to the adjacent up line two minutes after the train came to a stand. Confirmation of this action was provided by the Control Centre of the Future (CCF) display, used by control centre staff, which shows signal TR807 reverting to danger at 14:12:16 hrs. The signaller cancelled the route from this signal 2½ minutes later, having observed that the track circuit on the up line was showing occupied, and maintained the signal at danger. The 09:55 hrs Penzance to Paddington service, train 1A83, which had been due to pass Lavington in the up direction at about 14:12 hrs, had been delayed by an earlier track circuit failure and was subsequently diverted.
- 35 Meanwhile, the assisting driver had alighted from the train and agreed with the driver that he would carry out *protection duties* (protection of the up line was necessary in case parts of the fallen tree were obstructing it). They also agreed that the driver would telephone the signaller. The driver contacted the Westbury signaller using his mobile telephone 5½ minutes after the train came to a stand. The driver knew that TVSC was the controlling signal box, but did not have the telephone number for TVSC stored on his telephone. He advised the Westbury signaller that his train had collided with a tree; he did not state that it was an emergency call.
- 36 The assisting driver walked past the *signal post telephone* on signal number UW86 on his way to apply *detonators* to the up line just beyond the 87½ milepost⁵. The assisting driver telephoned FGW Control in Swindon 4½ minutes after the train stopped using his mobile telephone; he stated that it was an emergency call. This conversation was overheard by Network Rail's route control manager, who relayed details of the emergency call to the controlling signaller at TVSC (signaller A) 6½ minutes after the train had come to a stand.

⁴ As the collision happened on a falling gradient of 1:222, this is equivalent to 8.4% g on level track.

⁵ The application of detonators forms part of the emergency protection required by Rule Book Module M1 if the signaller cannot provide signal protection or if the driver has not been able to contact the signaller directly.

- 37 The train manager observed smoke coming from underneath the leading passenger coach. He used a fire extinguisher to extinguish some smouldering draught excluder material. This may have been caused by sparks resulting from the sliding contact between the wheels and the rails.
- 38 The first direct communication between the traincrew and the controlling signal box occurred 26 minutes after the collision, when signaller A telephoned the assisting driver.
- 39 Conflicting information was given about the location of the train after it had stopped; this involved numerous conversations between the traincrew, both signalling centres and the control centre in Swindon.
- 40 A rescue locomotive was despatched from Westbury and coupled to the damaged HST at about 17:15 hrs. The train was hauled to Westbury, arriving at 19:03 hrs, where the passengers (approximately 200 in number) were able to alight and join a replacement train.
- 41 It therefore took nearly five hours from the time of the collision until passengers were able to leave the train at Westbury, which is about 9 miles (14½ km) away by rail.
- 42 During this period:
 - a. Control centre staff were reluctant to carry out an evacuation of the train on site. The train manager reported to FGW control that conditions on the train were comfortable: the air conditioning was working (powered from the rear power car) and there was a well-stocked buffet.
 - b. FGW sent some technical riding inspectors (colloquially known as 'fitters') to inspect the damage to the train and make it fit to be moved. Two fitters came by taxi from Reading (54 miles / 88 km away), and arrived at the site about two hours after the collision.
 - c. Meanwhile, the assisting driver and FGW's on-call manager carried out an inspection of the train. After a detailed assessment and consideration of different options for moving the train, they decided that it had been too badly damaged to be able to travel under its own power.
 - d. A rescue locomotive was requested at 15:31 hrs and arrived at the front of train 1C84 about 90 minutes later, having travelled at slow speed in the *wrong direction* from Westbury. A third fitter was brought to site from Westbury on the rescue locomotive, and arrived about one hour after the first two.
 - e. The locomotive was attached to the train using an emergency coupler.
 - f. Once the rescue locomotive had been attached to the front of the damaged HST, the severe wheel flats meant that speed was limited to 10 mph (16 km/h) for the journey to Westbury to minimise further damage to the train or track.
- 43 Throughout this period, witnesses indicate that the train manager communicated effectively with the passengers, ensuring that they were aware of steps being taken to get the train moved.

The Investigation

Sources of evidence

44 The following sources of evidence were used:

- witness statements;
- the train's OTDR data;
- site photographs;
- control centre / signal box voice recordings
- video recordings of the route
- track plans
- arboricultural reports
- historic data on incidents involving trees
- Railway Group, Network Rail and FGW standards & procedures; and
- a review of previous RAIB investigations that had relevance to this accident.

Key facts and analysis

Identification of the immediate cause⁶

- 45 **The immediate cause of the accident was that the line was obstructed by a fallen tree and the driver of the train had insufficient warning of the obstruction to enable him to stop his train before the collision occurred.**
- 46 The tree had fallen across both up and down lines. Due to the speed of the train and the curvature of the line, the driver had only a few seconds warning of the obstruction and was unable to stop the train before colliding with the tree.

Identification of causal⁷ and contributory factors⁸

The unidentified dangerous condition of the tree

- 47 **Prior to the accident the tree was in a dangerous condition but, as this had not been identified, no action had been taken to remove it before it fell. This was a causal factor in this accident.**
- 48 A specialist, who reported on the condition of the tree after it had fallen, stated that in his opinion, “the severely deteriorating condition of the subject tree’s lower stem would have been readily identifiable on inspection from close at hand (certainly up to 3 m away) for several years prior to its collapse” and that “the decay was seated substantially on the far side of the stem base relative to the railway” (figure 5).
- 49 If the dangerous condition of the tree had been identified, the risk it presented to the railway might have been apparent and steps could have been taken to fell it in a controlled way.

The landowner’s awareness of the risk to the railway

- 50 **The landowner was not conscious of the risk that trees on his land could present to the railway. This was a contributory factor.**
- 51 The ownership of Parham Wood has been unchanged since 1971. While the landowner was aware that the railway was located beyond the wood, there is no evidence to indicate that he had considered whether the trees on his land might pose a risk to the railway.

⁶ The condition, event or behaviour that directly resulted in the occurrence.

⁷ Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

⁸ Any condition, event or behaviour that affected or sustained the occurrence, or exacerbated the outcome. Eliminating one or more of these factors would not have prevented the occurrence but their presence made it more likely, or changed the outcome.

- 52 There are earlier remains which show that some branches and/or trees had fallen across the boundary fence since 1971, possibly in both directions (ie from the railway side of the fence as well as from the adjacent wood). Previous incidents involving trees at the boundary in this location may have been managed by railway maintenance staff, possibly without discussion with the landowner; the RAIB understands that this approach is common practice. However, the RAIB has been unable to establish what action was taken by any party in relation to these previous incidents at Parham Wood. Historically, local maintenance teams have been responsible for managing lineside trees. The local track section manager has worked in this area since 1976; he has had no experience of any similar incident with trees in that time.



Figure 5: Base of the fallen tree, looking towards the railway

- 53 After the accident, members of Network Rail's off-track team visited Parham Wood and marked up about 30 trees which they considered might present a risk to the railway, and recommended that the landowner should obtain specialist advice. He arranged for 5 trees to be felled within a few days, and then engaged a specialist who inspected the trees along the railway boundary, including the remaining trees which had been marked up by Network Rail. The specialist recommended felling 17 trees within 6 months and another 9 trees within 18 months⁹.

⁹ Not all of these 26 trees were included in the 30 that had been marked up by Network Rail staff.

Identification of underlying factors¹⁰

Network Rail's process for inspecting trees

- 54 **Network Rail's process for the inspection of lineside trees was unlikely to have identified the condition of this tree. Network Rail cannot effectively inspect such trees without entering its neighbours' land and cannot enter its neighbours' land without their permission. This was an underlying factor.**
- 55 Network Rail has a significant population of trees on its land. Apart from the issues associated with leaf-fall, these trees present a risk to both railway neighbours and the operational railway. In consequence, Network Rail has commissioned a national survey of trees on its land, and has developed a risk assessment process for potentially *dangerous trees*¹¹. The survey started in February 2009 and is due to be completed in March 2011. Network Rail is currently planning to repeat the survey on a rolling five-yearly basis.
- 56 The risk assessment process now used by Network Rail is referred to in Network Rail standard NR/L2/TRK/5201 *Management of lineside vegetation*. The process is detailed in TEF/3077 *Tree Hazard: Risk Evaluation and Treatment System*, which quantifies risk to both railway and non-railway *targets*. For railway targets, the assessment is weighted to take account of linespeed, multiple lines and the presence of switches & crossings or significant trackside structures.
- 57 The responsibility for the safety of trees on land adjoining the railway lies with the landowner and Network Rail has no powers to inspect trees on neighbours' land. However, the remit for the national tree survey (see appendix D) does require surveyors to record any 'third party tree of concern when observed during visual assessment'; such trees may also require short-term risk mitigation such as the lopping of branches or stabilisation.
- 58 Where a tree on a neighbour's land is identified as potentially dangerous, standard NR/L2/TRK/5201 requires that steps should be taken to inform the owner using a template letter. This draws the landowner's attention to the risk to the railway, and to their liability for any damage that the tree causes; it also encourages the landowner to obtain specialist advice and to notify their insurers.
- 59 Since the Lavington accident, Network Rail has developed a protocol which defines the actions to be taken for a dangerous third party tree, depending on its categorisation using the TEF/3077 scoring system. In the highest category, the actions include immediate protection of the line and the steps necessary to remove the tree.

¹⁰ Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

¹¹ See appendix B for definition, taken from NR/L2/TRK/5201.

- 60 The section of line where the collision occurred had been surveyed as part of the national tree survey 11 months before the accident. Network Rail had not identified this tree, or any others in Parham Wood, as a threat to the railway. The tree stood approximately 10 m from the boundary fence, and it is probable that the base was obscured by undergrowth. The decay was, in any case, located substantially on the far side of the tree relative to the railway (paragraph 48).
- 61 If Network Rail is faced with a danger from trees on adjoining land, its remedy is to apply to the court for an order. Such an order may compel the adjoining landowner to take action, or empower Network Rail to take action and recover the costs from the landowner. Alternatively Network Rail may seek to persuade the local authority to take action under its statutory powers. However, this relies on prior identification of a tree as being potentially dangerous.
- 62 The national tree survey presents an opportunity for Network Rail to identify adjoining land which might contain dangerous trees, and to make the relevant landowners aware of their responsibilities and/or liabilities. The current remit does not explicitly require the surveyors to look for dangerous trees on third party land (appendix D). Approximately one quarter of the trees identified in the national tree survey as presenting risk to the railway are on neighbours' land.

Previous occurrences of a similar character

- 63 Data used in the *Safety Risk Model (SRM)*, version 6, indicates that the national frequency of “train collision with tree” events is 349 per year. However, this data does not distinguish between minor brushes with overhanging branches and collisions with fallen trees. The model predicts that these events will result in 0.0043 *fatalities and weighted injuries (FWI)* per year, which represents 0.06% of the total risk from train accidents. In comparison, passenger train collisions with road vehicles on level crossings are predicted to cause 2.4 FWI per year (32% of the total risk from train accidents).
- 64 Network Rail assesses the severity of events involving fallen trees using the TEF/3064 *Hazard Report for Permanent Way Assets* process. Any event which scores above a threshold of 50 points¹² is included in the *wrong side failure* and hazard reporting system. There were 14 such events in a 23 month period from January 2008 to November 2010, of which 6 involved collisions with trains.
- 65 There were four derailments caused by trains colliding with the remains of trees in early 2007; these occurred at:
- a. Merstham, between Redhill and East Croydon, on 13 January 2007 – a Class 377 electric multiple unit (EMU) was derailed after running into a landslip north of Merstham Tunnel. This was caused by the fall of debris, including a root ball, from the cutting side following heavy rain. The accident was investigated by the RAIB (RAIB report 05/2008).
 - b. Duncraig, on the Kyle of Lochalsh line, on 15 January 2007 – the leading *bogie* of a Class 158 diesel multiple unit (DMU) became derailed in wet and windy weather after striking debris, including two trees.

¹² The fallen tree at Lavington was given a score of 54.

- c. Hookagate, between Shrewsbury and Welshpool, on 18 January 2007 – the leading bogie of a Class 158 DMU was derailed after striking a fallen tree.
- d. Godstone, between Tonbridge and Redhill, on 6 March 2007 – the leading wheels of a Class 508 EMU were derailed after colliding with a tree which had fallen from the embankment in high winds.

All of these accidents occurred during periods of adverse weather (ie high winds and/or heavy rainfall). No injuries occurred in any of them and no derailments caused by fallen trees have been reported since.

- 66 One accident which occurred after the collision at Lavington involved a Class 142 DMU striking a tree between Starbeck and Knaresborough in Yorkshire on 10 March 2011. The tree had split into two and fell from third party land during a period of strong winds. The train sustained two broken windows in the collision and two passengers suffered minor injuries from flying glass. The train did not derail.

Severity of consequences

General

- 67 The driver sustained hairline fractures to his right wrist and the ring finger of his left hand, as well as multiple cuts and bruises in the collision. He was taken to hospital for examination at around 18:00 hrs, and released the same day. No-one else was injured.
- 68 The driving cab was extensively damaged and the train was immobilised. The application of the emergency brake, followed by loss of power to the WSP system and contact with debris from the fallen tree, probably caused all of the axles on the train to lock up and the train subsequently to slide to a stand. This caused severe *wheel flats* to all wheels along the train (figure 6).



Figure 6: Damage to the wheel tread of HST power car 43041

- 69 The trunk of the fallen tree lay well above rail level. As a result, the bulk of the tree did not go underneath the train and the train did not derail. If the train had derailed there was the potential for an accident with severe consequences to have occurred because of the speed of the train, curvature of the line and the local topography.

Crashworthiness of the driving cab

- 70 The cab was struck by the tree at a height of approximately 2.8 m above rail level. The tree penetrated a distance of approximately 1 m through the left side of the cab, starting at the windscreen pillar and extending to the leading edge of the left-hand door pillar (figure 7). The leading left-hand door pillar was cracked but the left-hand driver's side door remained relatively intact. The support provided by the door is likely to have helped the door pillar resist further penetration by the tree. The steel window frame on the left-hand side was distorted and the glass side window had broken and fallen out of its frame.



Figure 7: Damage to the driving cab, photographed on arrival at Westbury

- 71 There was also cracking to the glass reinforced plastic (GRP) cab roof, extending laterally from just above the windscreen centreline to the top of the right-hand side windscreen pillar. The severity of the damage to the upper left-hand portion of the cab was sufficient to distort the aluminium windscreen frame and cause the windscreen to become detached from the GRP structure. The shattered windscreen remained in one piece (held together by the interlayers¹³) and fell into the cab space.

¹³ The plastic film which is sandwiched between the layers of glass making up a laminated windscreen.

- 72 The RAIB estimates that the impact energy at Lavington was approximately 24 kJ and that the energy absorbed by structural deformation of the cab was around 19 kJ (approximately 80% of the impact energy). The remaining energy from the collision would have been absorbed by such factors as vibration, friction and deformation of the tree.
- 73 The HST cab was designed to absorb the energy of a 1.8 kg missile travelling at a closing speed of 250 km/h (69.4 m/s)¹⁴, which represents a concentrated impact energy of 4.3 kJ; the impact energy at Lavington was approximately 4 to 5 times greater. In comparison, modern UK rolling stock, compliant with the missile impact protection requirements of GM/RT2100 Issue 3, is designed to withstand a 0.9 kg missile impacting the cab at twice the maximum speed of the train (400 km/h in this case, or 111.1 m/s) . The impact energy in this design case would be 5.6 kJ; again several times less than the impact energy at Lavington.
- 74 The RAIB's assessment indicates that, while the ultimate strength of the HST cab pillar is broadly similar to that of a modern cab structure compliant with GM/RT2100 Issue 3, the energy absorption characteristic of a modern cab would be expected to result in less penetration than for an HST cab in a similar impact. However, no recommendations are suggested for the improvement of HST cab crashworthiness for the following reasons:
- The performance of the HST cab at Lavington was adequate to prevent life threatening injuries to the driver.
 - The costs associated with retrospective changes/modifications to HST cab structures are likely to exceed the benefits gained, even if continued use for another 15 years is assumed. The rolling stock leasing companies have previously concluded, in response to Recommendation 53 from the Ladbroke Grove Inquiry, that modifications to HST cabs to improve driver protection would not be reasonably practicable¹⁵.

Train radio systems

- 75 The HST involved in the collision was equipped with NRN train radios in both cabs. The radio in the leading cab was disabled in the collision. This may have been due to direct physical damage or to a loss of electrical supply when the control circuit breaker tripped (paragraph 30), or both. It was in any case inaccessible as it was buried under debris. The NRN radio in the rear cab was probably still operational after the collision, although the RAIB has found no evidence to indicate that it was used.
- 76 The NRN system provides the facility for the driver to make an emergency call. This is connected to the Network Rail route control centre rather than directly to the controlling signal box.

¹⁴ Gotch T M, "The design and development of the British Rail high speed train cab", BR Research report TM PDU 48, July 1979.

¹⁵ *HSC report on overall progress as of March 2004 on the remaining recommendations from the Rail Public Inquiries*, Office of Rail Regulation (ORR).

- 77 NRN is being replaced by the *Global System for Mobile Communications – Railways* (GSM-R) system. The train equipment will be configured in a similar way to the existing NRN equipment: each cab will have separate ‘cab mobile’ equipment (handset and control head). GSM-R will have different emergency call functionality from NRN, and will allow a driver to initiate a *railway emergency group call* by activating a red button which will also send an “all trains stop” signal to any train in the same operational area.
- 78 The RAIB considers that if the HST had been equipped with GSM-R instead of NRN there would have been no discernible difference to the outcome of the accident. It is unlikely that the driver would have had time to initiate a railway emergency group call before colliding with the tree. Although GSM-R will have a separate uninterruptible power supply, it is likely that the cab mobile equipment would still have been disabled in the collision, either by direct physical damage or because it would have become inaccessible to the driver. If the cab mobile equipment had still been operational, it is however possible that the signaller might have been able to contact the driver as the equipment will have an ‘auto answer’ capability. The cab mobile equipment in the rear driving cab would have been unaffected by the collision, in the same way as the existing NRN equipment was.

Observations¹⁶

Identification of the exact location of the train

- 79 The actual location of train 1C84 was not established until 30 minutes after the accident. Although this did not affect the outcome of this accident, it could have caused a delay in the arrival of the emergency services, had their attendance been necessary.
- 80 Traincrew, signallers and controllers made at least sixteen telephone calls to exchange information during the first 48 minutes after the collision; there was a mix of correct and incorrect information relayed. The descriptions of the train’s location referred to various local features, rather than making reference to unique railway assets such as signal numbers and mileposts and when mileposts were used, they were sometimes used incorrectly. Examples of the references used to describe the location of the collision with the tree or the train’s stopping position included:
- the ‘Chocolate Poodle’ bridge and/or public house and/or viaduct;
 - the location of the former Lavington station;
 - a 90 mph curve (repeated back by the signaller as the 90 milepost);
 - a 90 mph speed restriction board; and
 - the train being reported as having stopped at or around the 85¾ and 85½ mileposts (it was actually standing alongside the 86½ milepost).

The train manager provided the FGW senior controller with a comprehensive and accurate description of the location of the train, half an hour after the train had come to a stand.

¹⁶ An element discovered as part of the investigation that did not have a direct or indirect effect on the outcome of the accident but does deserve scrutiny.

- 81 The RAIB has considered the reasons for the delay in establishing the exact location of the train. There were two principal reasons:
- signallers did not reach a clear understanding when conversing with traincrew (paragraphs 82 to 84); and
 - the assisting driver did not use the signal post telephone at signal UW86 to contact the signaller (paragraphs 85 to 87).

Signallers and traincrew did not reach a clear understanding

- 82 Paragraph 80 provides some examples of references used when traincrew were trying to describe the location of train 1C84. The traincrew and signallers did not reach a clear understanding about the location of the train. Rule Book Module G1, paragraph 5.3, places the responsibility on the signaller to lead communications with members of traincrew. It is thus the signaller who is required to take the necessary steps to ensure that a clear understanding is reached.
- 83 None of the three signallers involved in managing aspects of this accident effectively led their conversations with traincrew to ensure they had reached a clear understanding on the location of train 1C84, nor did they refer to the *Thames Valley Area Track Plans* book which was available at both TVSC and Westbury signal boxes. Had they done so, they would probably have been prompted to clarify the information being provided to them.
- 84 Where mileposts were referred to, signallers did not check the information they received before passing it on to others, for example:
- although the train came to a stand in the area controlled by TVSC, the Westbury signaller told TVSC that the collision had occurred at the 90 milepost (which is in the area controlled by Westbury signal box); in fact it had been at 85 miles and 77 chains;
 - TVSC signaller B advised Network Rail control that the train was confirmed as standing at the 85½ milepost – which had not been stated by the traincrew and was not consistent with other information known to TVSC.

The assisting driver did not use the signal post telephone at signal UW86 to contact the signaller

- 85 Rule Book Module M1 sets out the responsibilities of staff when a train is stopped by accident, fire or accidental division. The duties of the driver include contacting the signaller in the quickest way possible, and then carrying out emergency protection if the signaller cannot provide signal protection or if the driver has been unable to contact the signaller direct.
- 86 The assisting driver left the driver while he was trying to contact the signaller (paragraph 35) and set off to place detonators on the up line. He did not know whether the driver had been successful in his attempt to contact the signaller and therefore was unaware whether the signaller had been able to provide signal protection. The drivers did not establish that neither of them had access to the telephone number for the controlling signal box (TVSC).

- 87 The assisting driver walked past the signal post telephone at UW86 signal without using it to contact the signaller at TVSC; this signal was approximately 200 m from the front of the train. There was also another signal post telephone at DW86 signal, 43 m from the rear of the train. If the assisting driver had used the signal post telephone to contact the signaller, the signaller would have been able to pinpoint the location of the train within a few minutes of it coming to a stand. In addition, the assisting driver would not have had to walk to the *full protection distance* to place detonators on the up line, because the signaller could have confirmed that he had already protected the line by manually replacing the protecting signal to danger (paragraph 34).
- 88 As the rule book clearly defines the requirement for staff protecting the line to contact the signaller in the quickest way (paragraph 85), the RAIB has made no recommendation to address this factor.

Traincrew did not have access to the contact number for the controlling signal box

- 89 None of the traincrew had ready access to the telephone number for TVSC, which had controlled the Up and Down Westbury lines at this location since 21 March 2010. Although this number had been published in the *Weekly Operating Notice* (WON) which each of them had with them on the train, neither of the drivers, nor the train manager, had the WON to hand when they each attempted to contact the signaller. In addition, none of them had the number for TVSC stored in their company-issued or private mobile telephones.
- 90 RIS-3776-TOM, *Rail Industry Standard on the Use of Mobile Telephonic Equipment in Driving Cabs* recommends that railway undertakings should ‘publish a company policy on the use of mobile telephonic equipment in driving cabs.’ It goes on to include the following guidance: ‘allowance should be made in the company policy for situations where cab radio systems have failed and the contingency plan may provide for use of a mobile phone by a driver to communicate with the signaller.’
- 91 The FGW procedure SM 0105 *Use of Mobile Phones and Pagers* predates the Rail Industry Standard. While permitting the use of mobile phones in an emergency, it does not cover the availability of emergency contact numbers to drivers if the WON is not accessible in an emergency situation. FGW had not taken any action to ensure that their drivers had the current contact numbers on their mobile phones.

Summary of Conclusions

Immediate cause

- 92 The line was obstructed by a fallen tree and the driver of train 1C84 had insufficient warning of the obstruction to enable him to stop his train before the collision occurred (**paragraph 45**).

Causal factors

- 93 A causal factor was that the tree was in a dangerous condition but, as this had not been identified, no action had been taken to remove it before it fell (**paragraph 47, no recommendation is made**).

Contributory factors

- 94 A contributory factor was that the landowner was not conscious of the risk that trees on his land could present to the railway and had not arranged for their safety to be assessed (**paragraph 50, Recommendation 2**).

Underlying factors

- 95 An underlying factor was that Network Rail's process for inspection of lineside trees was unlikely to have identified the condition of this tree. Network Rail cannot effectively inspect such trees without entering its neighbours' land and cannot enter its neighbours' land without their permission (**paragraph 54, Recommendation 1**).

Additional observations

- 96 Although not linked to the accident on 10 July 2010, the RAIB observes that:
- traincrew and signallers did not reach a clear understanding when conversing about the location of train 1C84 (**paragraph 82, Recommendation 3**); and
 - traincrew did not have access to the contact number for the controlling signal box (**paragraph 89, Recommendation 4**).

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

- 97 Network Rail has prepared a revised protocol for dealing with dangerous trees on neighbours' land (paragraph 59).
- 98 First Great Western has re-briefed its drivers and guards regarding the importance of:
 - a. contacting the controlling signaller as a priority when protecting their train in an emergency; and
 - b. reaching a clear understanding as to individual responsibilities and who will make contact with the signaller.
- 99 Details of the communication issues identified in this report (paragraphs 79-91) are to be published in 'Red Alert' magazine, which is published by Halcrow on behalf of the railway industry. This will enable the lessons learnt from the way that the accident was handled to be promulgated throughout the industry and discussed by relevant staff at a local level.

Previous recommendations relevant to this investigation

100 The following recommendations were made by the RAIB as a result of previous investigations, which address issues identified in paragraphs 62 and 82-84. They are therefore not remade so as to avoid duplication.

[Network Rail's Management of Existing Earthworks, RAIB Report 25/2008, published 23/12/08](#)

Recommendation 3:

'Network Rail should provide clear policy, information and guidance to staff, particularly those in the maintenance organisation, with regard to neighbours and problems related to the management of infrastructure risk.'

Network Rail response to the recommendation:

'The management of the interface between Network Rail and our neighbours especially with regards to the problems related to the management of infrastructure risk is a key deliverable of the Maintenance Protection Coordinator (MPC). The MPC is the key role here in monitoring such contact and, where necessary, in discharging their responsibilities working closely with colleagues in Network Rail's Community Relations teams. In February 2005, technical advice in the form of a memorandum (written in co-operation with Legal Services) was provided to the Maintenance organisation specifically addressing vegetation management issues.'

Office of Rail Regulation (ORR) response to Network Rail's actions:

'ORR accepts the duty holder's response to deliver the recommendation and will not therefore be pursuing through inspection work as we have confidence that this will be done'.

RAIB comment:

The investigation into the accident at Lavington on 10 July 2010 has revealed that the MPC's Job Description does not make reference to management of infrastructure risk and that there is no Network Rail standard which places any related responsibility on the MPC. RAIB has drawn this to ORR's attention.

[Derailment of two locomotives at East Somerset Junction, 10 November 2008, RAIB Report 28/2009, published 10/11/09](#)

Recommendation 8:

'Network Rail, Western Route should arrange for signallers to practise a range of infrequently encountered situations (such as the introduction of pilot working) on a simulator at regular intervals within the three-year competence cycle.'

Network Rail's response to the recommendation:

'Each signaller is subject to an annual review. At this review, their line manager shall identify any areas of concern where the signaller would benefit from a session on the simulator. This provides a yearly opportunity to identify shortfalls in the three-year cycle, and also to act on issues arising on a case by case basis. It should also be noted that the assessment process is changing, both as regards frequency of assessment of 'high risk' items, and also how and what can be simulated, and this approach is currently being trialled (September 2009 to April 2010) in the Wessex and Scotland routes within Network Rail. Success of this approach will see the roll out of this new framework nationally from June 2010.' Roll out of a revised assessment process is expected to commence in June 2010 and be completed by 30 April 2011.

Office of Rail Regulation (ORR) response to Network Rail's actions:

'ORR ... has concluded that ... Network Rail:

- has taken the recommendation into consideration; and
- is taking action to implement it.'

The proposed implementation timescale is June 2010 to April 2011. ORR is not proposing to take any further action at this stage.

Recommendations

101 The following recommendations are made:¹⁷

Recommendations to address causal, contributory, and underlying factors

- 1 *The purpose of this recommendation is for Network Rail to be able to identify third party land upon which trees present the greatest risk to the railway.*

Network Rail should review and enhance its processes for gathering intelligence about neighbouring land where there may be a higher risk of tree fall affecting the railway. This might be achieved by modifying the remit for the national tree survey, before this is repeated, and/or by providing suitable guidance to local off-track teams (paragraph 95).

- 2 *The purpose of this recommendation is for Network Rail to raise the awareness of its neighbours to the risk their trees may present to the operational railway.*

Network Rail should develop and implement a plan, or adapt and enhance existing plans, to communicate with those of its neighbours whose land is considered to present a high risk of tree fall affecting the railway. The objective should be to inform them about their responsibilities and the threat their trees may present to the railway (paragraph 94).

Recommendations to address other matters observed during the investigation

- 3 *The purpose of this recommendation is to reduce the potential for confusion about the location of an accident, incident or any event requiring safety-critical communication to take place.*

Network Rail should brief its signallers about the importance of reaching a clear understanding about the location of the incident/accident when taking any safety-critical call. Such understanding should make reference to signal numbers and/or mileposts unless it is impractical for this information to be provided (paragraph 96a).

continued

¹⁷ 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 Regulation to enable it to carry out its duties under regulation 12(2) to:

- (a) ensure that recommendations are duly considered and where appropriate acted upon; and
- (b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 167 to 171) can be found on RAIB's website www.raib.gov.uk.

- 4 *The purpose of this recommendation is for First Great Western to improve the effectiveness of the use of mobile telephones in an emergency situation.*

First Great Western should review its policy for the use of mobile telephones to take account of *Rail Industry Standard on the Use of Mobile Telephonic Equipment in Driving Cabs*, RIS-3776-TOM. This review should include consideration of how to make current emergency contact numbers available to traincrew (paragraph 96b).

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCF	Control Centre of the Future
DMU / EMU	Diesel Multiple Unit / Electric Multiple Unit
FGW	First Great Western
g	Acceleration due to gravity (9.81 m/s ²)
GRP	Glass Reinforced Plastic
GSM-R	Global System for Mobile Communications – Railways
HST	High Speed Train (InterCity 125)
NRN	National Radio Network
ORR	Office of Rail Regulation
OTDR	On Train Data Recorder
RAIB	Rail Accident Investigation Branch
RSSB	Rail Safety & Standards Board
SRM	Safety Risk Model
TVSC	Thames Valley Signalling Centre
WON	Weekly Operating Notice
WSP	Wheel Slide Prevention / Wheel Slip Prevention

Appendix B - Glossary of terms

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

Access point	A designated point along a railway at which entry to railway property may be made safely. Most are pedestrian only, often with steps to track level.* Some include vehicular access.
Bogie	A metal frame equipped with two or three wheelsets and able to rotate freely in plan, used in pairs under rail vehicles to improve ride quality and better distribute forces to the track.*
Beyond	Describing a position or object which appears after another, from the train driver's point of view.*
Controlling signal box	The signal box that has control over a particular signal or points, or controls the signal protecting a particular section of line.*
Dangerous tree	A tree which has been inspected by a competent person and which, through defect, is found to be able to reach a target of value (safety, financial, etc) for either railway or third party.
Detonator	A small disc shaped explosive warning device designed to be placed on the railhead for protection and emergency purposes. It explodes when a train passes over thus alerting the driver.*
Fatalities and weighted injuries (FWI)	An index used by the Rail Safety and Standards Board (RSSB) to indicate the relative values of risks. For a set of events resulting in harm, the numbers of major and minor injuries are weighted in recognition of their relatively less serious outcome in relation to a fatality. The current weighting is 0.1 of a fatality for each major injury and 0.005 for each minor injury. The weighted values are added together to produce the FWI figure.
Full protection distance	The distance on the approach to an obstruction at which the Rule Book (Module M1, <i>Train stopped by train accident, fire or accidental diversion</i>) states that a driver should place detonators on the line.
Global System for Communications – Railways (GSM-R)	A national radio system which will provide secure voice Mobile communications between trains and signallers, relaying calls via radio base stations built alongside the railway or on suitable vantage points.
National Radio Network (NRN)	A dedicated National Radio Network operated and maintained by Network Rail that allows direct communication between driver and network controller.*
On train data recorder (OTDR)	A data recorder fitted to trains, collecting information about the performance of the train, including speed, distance travelled, traction and brake control positions, activations of horn, automatic warning system signals and drivers safety device. There is one for each power car on an HST.

Protection duties	The duties carried out by the driver and guard in accordance with the Rule Book (Module M1, <i>Train stopped by train accident, fire, or accidental diversion</i>) to protect trains from other traffic in the event of an accident.*
Railway emergency group call	The highest priority call carried by GSM-R. It may be initiated by a driver from a cab mobile, or by a signaller or route controller from a fixed terminal.
Safety Risk Model	A computerised model, managed by the Rail Safety and (SRM) Standards Board (RSSB), which is a quantitative representation of the potential accidents resulting from the operation and maintenance of the national railway network.*
Signal overlap	The distance beyond a signal that is proved clear prior to the signal on the approach to it being cleared.*
Signal post telephone	A telephone located on or near a signal that allows a driver or other member of staff to communicate only with the controlling signal box.*
Target	Person or property at risk from a falling tree.
Track circuit operating clip	A pair of spring clips connected by a wire, used to short out track circuits (TC) by connection across the rails in times of emergency.*
Weekly operating notice (WON)	A document published by Network Rail on a route by route basis, providing information about engineering work, speed restrictions, alterations to the network and other relevant information to train drivers.*
Wheel flat	A form of wheel damage caused by the wheel sliding on the rail instead of rotating.
Wheel slide prevention (WSP)	(Sometimes referred to as wheel slip prevention) A control system fitted to modern locomotives and multiple unit trains that prevents the driving wheels spinning out of control or locking up during times of reduced adhesion.*
Wrong direction	In a direction opposite to that which trains normally run on the line concerned.*
Wrong side failure (WSF)	A failure that causes a piece of equipment to cease functioning in such a way as to cause danger to the safety of the line.*

Appendix C - Key standards current at the time

NR/L2/TRK/5201 (Issue 3)	<i>Management of lineside vegetation – Network Rail standard (September 2009)</i>
SM01208 (Issue 1 draft)	<i>Train Evacuation Plan – FGW procedure (March 2009)</i>
SM0105 (Issue 2)	<i>Use of Mobile Phones and Pagers – FGW procedure (November 2006)</i>
GE/RT8000 Modules G1 (Issue 4), M1 (Issue 1) & M2 (Issue 2)	<i>The Rule Book – RSSB Railway Group Standard www.rgsonline.co.uk</i>
GM/RT2100 Issue 3	<i>Structural Requirements for Railway Vehicles – RSSB Railway Group Standard (October 2000)</i>
RIS-3776-TOM (Issue 1)	<i>Rail Industry Standard on the Use of Mobile Telephonic Equipment in Driving Cabs – RSSB (December 2009)</i>
RSSB-GSM-R-OC (Issue 1)	<i>UK Application of GSM-R: The Operational Concept – RSSB (December 2006)</i>

Appendix D - Extract from Network Rail's tree survey remit

Appendix – Extract from NR's tree survey remit

Schedule 1: The Project and Services

Outputs of the survey

- 3.1. Visual tree assessment of all trees greater than 150mm Diameter at Breast height (dbh) ...
- 3.2. Individual hazard assessment, recording and tagging of all trees greater than 150mm dbh where those trees pose a risk to safety of the railway or its neighbours
- 3.3. Individual hazard assessment recording and tagging of all trees greater than 500mm dbh
- 3.4. Identification of third party owned trees that potential pose a risk to the operational railway

Survey Method

- 8.1.4 Third party tree of concern when observed during visual assessment shall be;
 - i. photographed,
 - ii. assigned location tag (ELR, mileage, side of line, GPS reference) and have as many identification and defect details as possible recorded,
 - iii. subjected to any necessary risk mitigation to protect the railway in the short term.

This report is published by the Rail Accident Investigation Branch,
Department for Transport.

© Crown copyright 2011

Any enquiries about this publication should be sent to:

RAIB	Telephone: 01332 253300
The Wharf	Fax: 01332 253301
Stores Road	Email: enquiries@raib.gov.uk
Derby UK	Website: www.raib.gov.uk
DE21 4BA	