RAIB

Rail Accident Investigation Branch

Rail Accident Report

Wagon derailment at York station
18 January 2006

Department for Transport

Report 21/2006
November 2006

This investigation was carried out in accordance with:

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

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Contents

Introduction

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

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

3 This report contains the findings of the RAIB investigation into the wagon derailment at York station, 18 January 2006.

4 Access was freely given to English Welsh & Scottish Railway (EWS), GE Rail Services (GE) and Network Rail staff, data and records for the purposes of this investigation.

5 Appendices at the rear of this report contain Glossaries explaining the following:

- acronyms and abbreviations are explained in the Glossary at Appendix A; and
- certain technical terms (shown in *italics* the first time they appear in this report) are explained in the Glossary at Appendix B.

Summary

Key facts about the incident

6 Freight train 6V49, the 22:03 hrs service from Tees Yard to Newport, was travelling through York station on 18 January 2006 at 23:22 hrs when one wheelset on *KIB* wagon 7008990380 became derailed. The wheelset re-railed at the first set of *points* south of the station - see Figure 1.

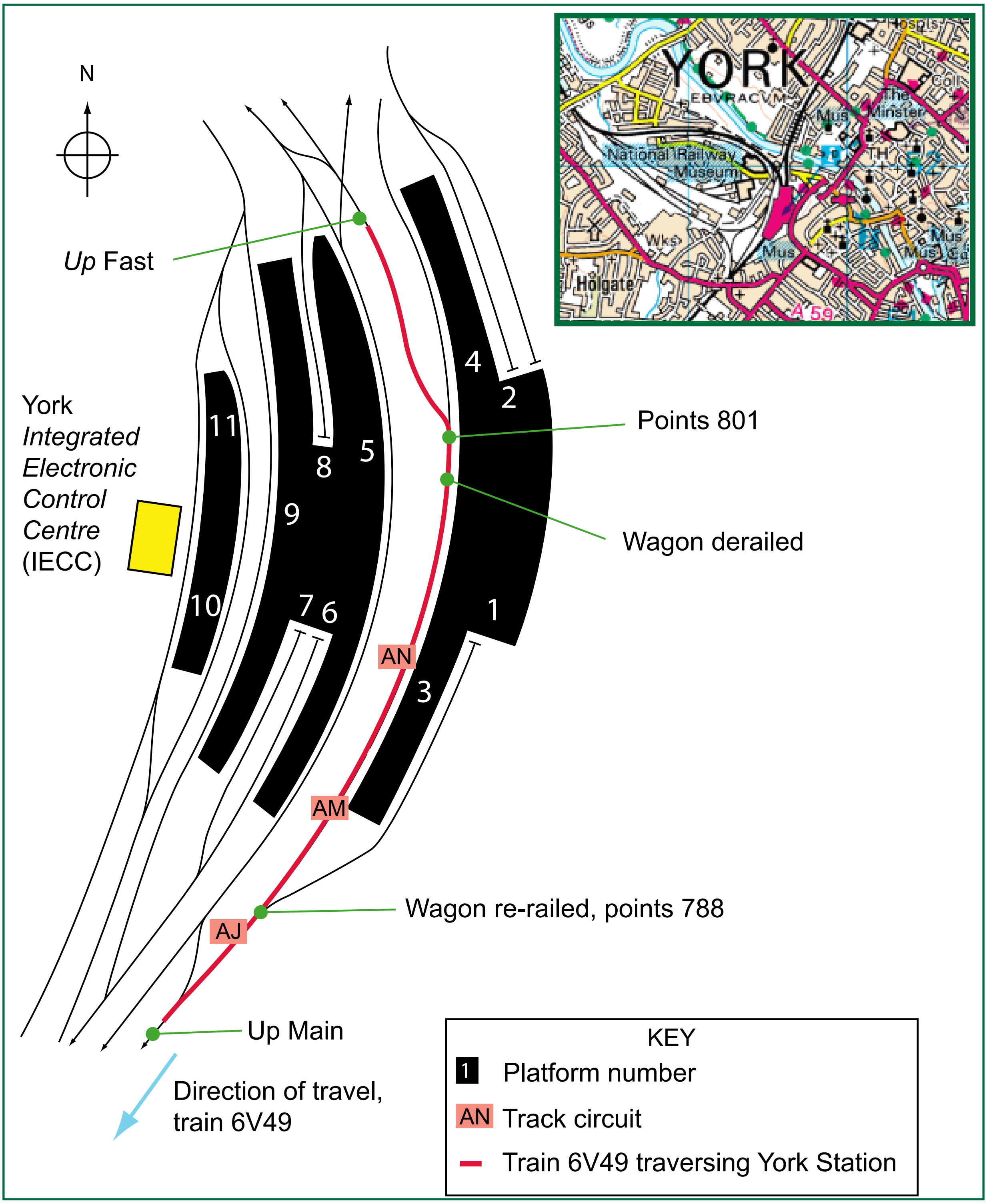

Figure 1: Map showing location of the incident

Immediate cause, contributory factors, underlying causes

7 The immediate cause of the incident was *flange climb* of an unloaded wheel onto the railhead. The displaced *wheelset* then fell outside the railhead and in the direction of the adjacent platform.

8 The causal factor was the loss of a suspension spring link pin. The subsequent collapse of the suspension at one wheel caused the diagonally opposite wheel to become significantly unloaded and thus susceptible to flange climb.

9 The contributory factors that promoted flange climb at the particular location were (i) high adhesion at the wheel-rail interface and (ii) right hand horizontal track curvature. Both were normal conditions that, when combined with wheel four's significantly reduced vertical wheel load, increased its susceptibility to flange climb.

10 The likely underlying causes were: (i) the loss of the link pin due to degradation, fatigue cracking and rapid overload and (ii) the inability of the maintenance and inspection regime to detect link pin degradation and fatigue cracking sufficiently early in its inception to avoid failure between scheduled examinations. However, the likely underlying causes could not be proved conclusively as the missing link pin was not located.

Recommendations

11 Recommendations can be found in paragraph 71. They relate to the following areas:

- wagon maintenance and inspection; and
- the measurement of in-service link pin loads compared with their load carrying capability.

The Incident

Background

12 The infrastructure at York is owned and maintained by Network Rail.

13 The train was operated by EWS and comprised locomotive number 66205 and 29 wagons.

Figure 2: Wagon 7008990380

14 Wagon 7008990380, empty at the time of the incident, was the fifteenth wagon from the locomotive. A photograph of the wagon is shown in Figure 2.

15 The wagons were designed and certified for international traffic in accordance with the *Regolamento Internazionale Veicoli* (RIV) regulations of the *Union Internationale des Chemins de Fer* (UIC). The design of the wagons was scrutinised for compliance with UIC codes (standards) rather than Railway Group Standards. By this process, compliant wagons are considered to have satisfied the requirements of Railway Group Standard GM/RT2000, Engineering Acceptance, and are approved for use on Network Rail Infrastructure.

16 The wagon is fitted with bogies and has a maximum load per axle of 22.5 tonnes. The suspension is attached to the bogie frame via an assembly of links, link pins and bearings - see Figure 3. This type of bogie suspension is fitted to hundreds of wagons in the UK and is used extensively in other parts of Europe.

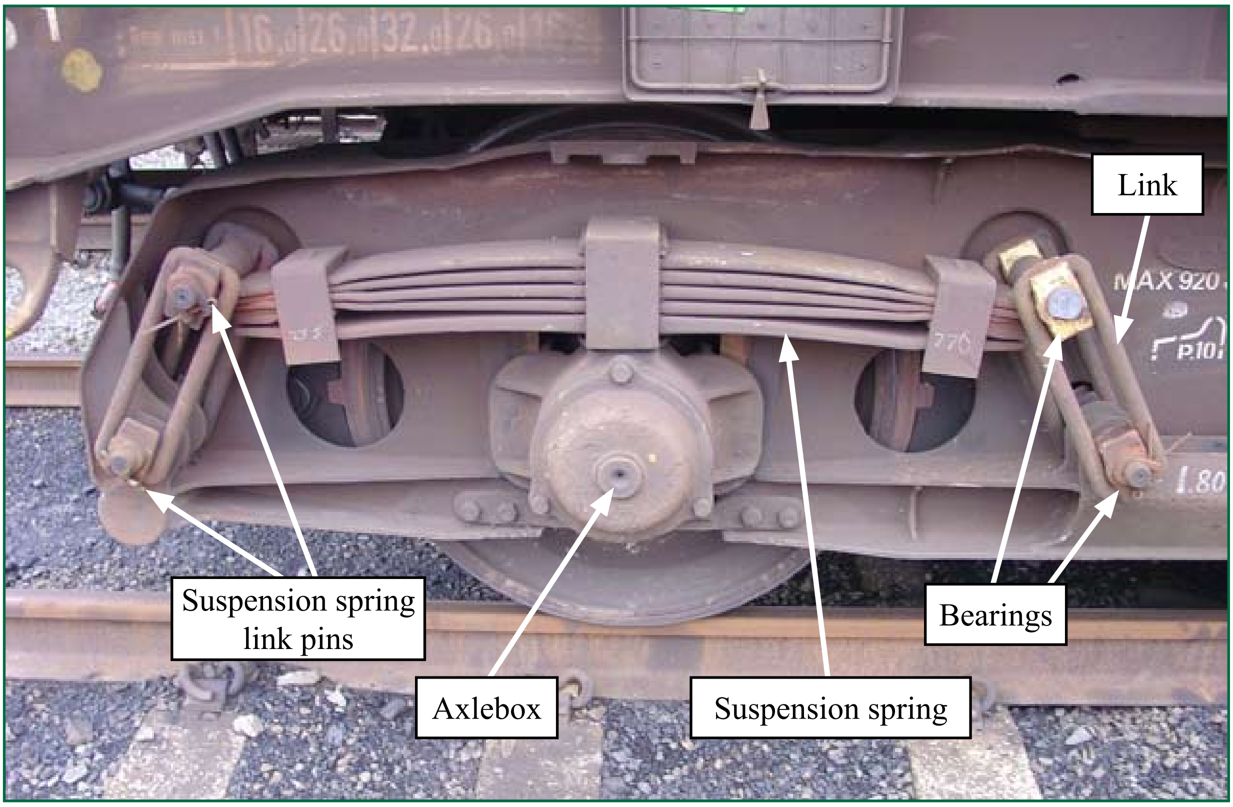

Figure 3: Bogie suspension

17 The wagon, previously owned by Tiphook, is one of a fleet of 151 KIB wagons owned by GE. The wagon was leased by GE to Corus and had been maintained by Marcroft Engineering (Marcroft) and Wabtec Rail (Wabtec) under contract to GE. Marcroft was purchased by EWS Holdings (EWSH) on 1 February 2006 but continues to operate as a free standing, independent business.

18 EWS is responsible for determining and applying the necessary pre-departure technical examinations on the vehicles that they haul, in order to ensure that they are fit to operate on Network Rail controlled infrastructure in accordance with Railway Group Standard GO/RT3056 section B5.1 and GM/RT2455.

19 Maintenance is prescribed in GE specification GE-M-SPEC-64. This specification was developed from Tiphook specification TIPH/REV/6/33/34/1. The GE maintenance schedule is as follows:

- Traffic Inspection (TI) at trip or daily intervals where possible. Every wagon should be seen at least once per week;
- Planned Preventative Maintenance (PPM) and Vehicle Inspection and Brake Test (VIBT), each at alternate six month intervals;
- General Repair (GR) at six year intervals.

20 PPM and VIBT require visual inspection and measurement to determine the operating condition of the wagon suspension. GR requires complete strip down of the bogie and the measurement of all suspension components.

21 At GR all link pins are measured over their bearing surfaces for reduced cross section through wear. UIC code 517 permits 3 mm of wear on a section nominally 34.5 to 35 mm in diameter. A link pin should therefore be replaced if its cross section ranges from less than 31.5 mm to 32 mm. The GE GR document requires link pin replacement if the cross section is less than 33.5 mm, which is a more conservative dimension than that in the UIC code.

22 The most recent GR prior to the incident was undertaken by Wabtec at its Doncaster works on 2 September 2002.

23 The most recent PPMs prior to the incident were undertaken by Marcroft on 7 June and 25 October 2004 at Llanwern. The most recent VIBT prior to the incident was undertaken by Marcroft on 9 August 2005 at Port Talbot.

24 PPM and VIBT events are planned by Marcroft staff based at Stoke on Trent. If a wagon's PPM or VIBT is not carried out within 28 days of its due date then that wagon is '*H' or 'O' carded*' in the *Total Operations Processing System* (TOPS) and may not be loaded.

25 The two most recent TIs prior to the incident were undertaken by Marcroft on 2 June 2005 at Llanwern and 8 November 2005 at Port Talbot. GE and EWS stated that TIs were not conducted to the required frequency due to difficulty of access to the wagons while in-service.

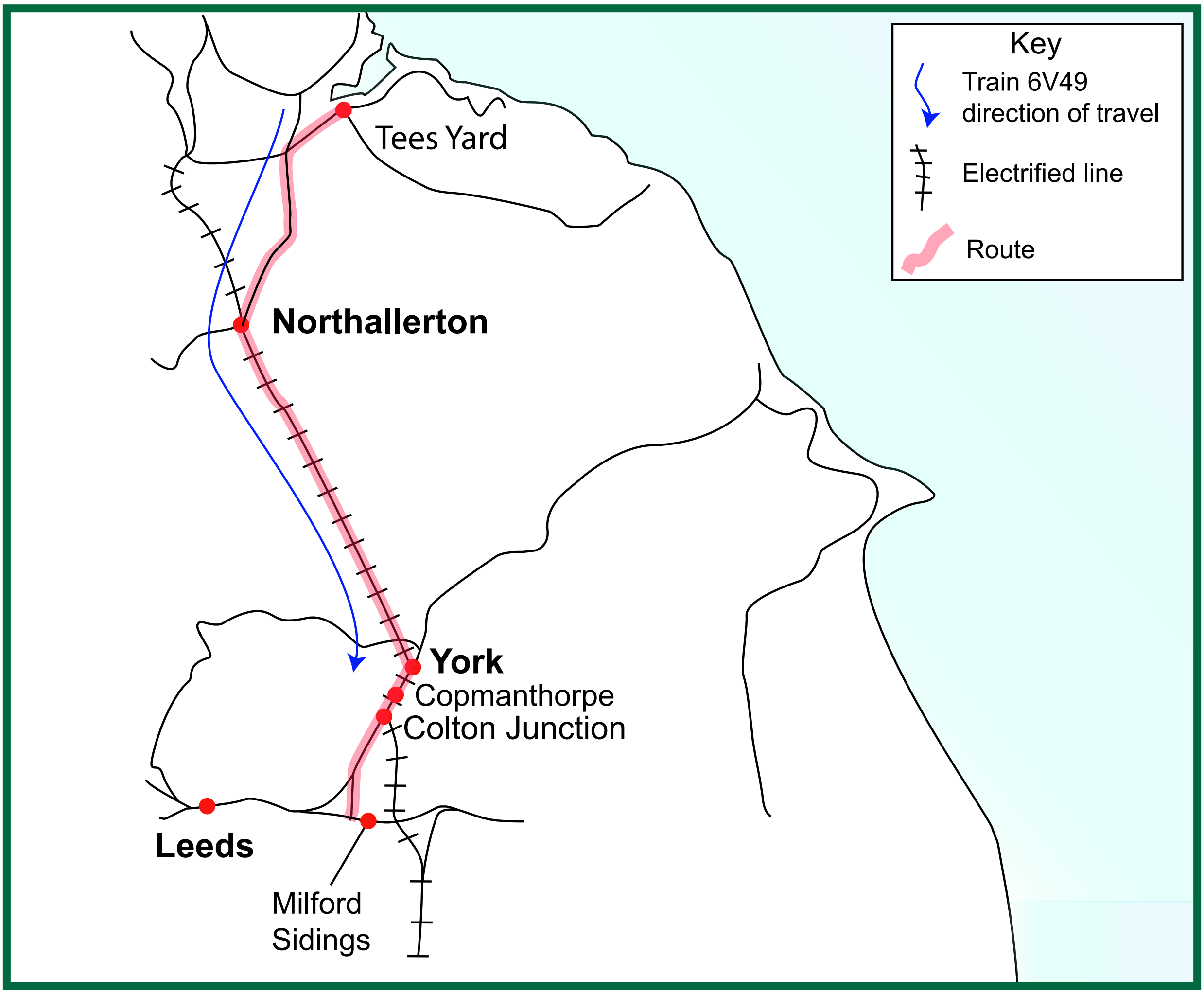

Figure 4: Route taken by 6V49 on 18 January 2006

26 The planned route for the train from Tees Yard to York is shown in Figure 4, along with the location at which the train was stopped - Copmanthorpe - and the location at which the wagon was detained for examination and test - Milford sidings. The route is straight for several miles to the north of York then turns through an ‘S’ curve to reach York station. The route speed is progressively reduced from 125 mph (200 km/h) on the straight, to a minimum of 30 mph (48 km/h) at the north end of York station, platform three.

Events preceding the incident

27 On the day of the incident, train 6V49 departed Tees Yard on time. The train travelled via Northallerton at a maximum speed, determined from the locomotive’s data recorder, of no more than 60 mph (96 km/h). The train speed was within the permitted speed for the route and the wagons throughout.

28 The train entered York station at 27 mph (43 km/h). A comparison between train speed and permitted route speed is given in Figure 5.

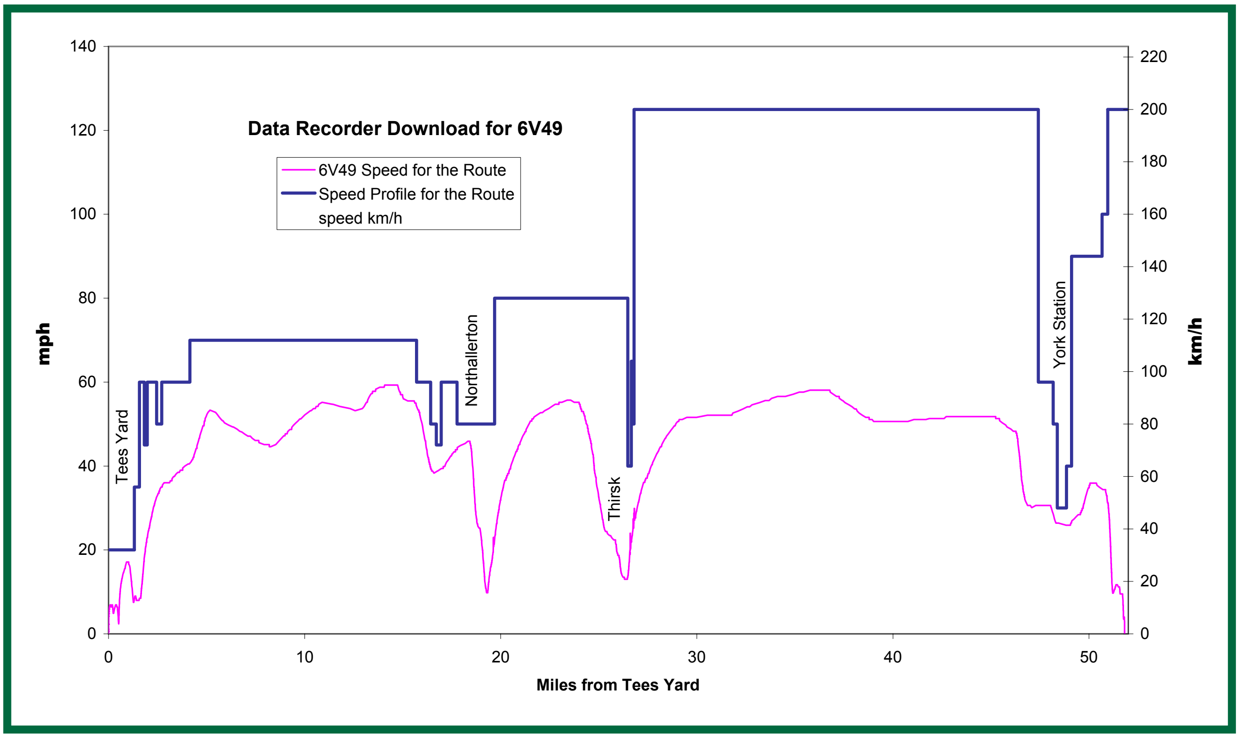

Figure 5: Train speed compared with permitted speed for the route

Events during the incident

29 Train 6V49 entered York station on the up fast line, negotiated points 801 and joined the right hand curve of the up main line as it runs south through platform three. The wheelset derailed at 188 miles 37 chains, ran derailed for approximately 250 m and then re-railed at points 788.

30 Station staff heard a loud bang as the train travelled through platform three and observed damage to the infrastructure after the train had passed. The signaller at York IECC was contacted and a request made that the train be stopped for examination.

31 The signaller noted that *track circuit*s AJ, AM and AN continued to indicate that a section of the line was occupied after train 6V49 had passed and the line was clear.

32 The signaller set the signal at Copmanthorpe, 3 miles (5 km) south of York station, to a red *aspect*. The driver stopped the train at the signal at 23:30 hrs, contacted the signaller and was advised that the train had damaged the infrastructure in York station.

33 The driver examined the train at the signaller's request. The examination, conducted from the *cess* side, found all wheels of the train on the rails and no low-hanging, train borne equipment that could have damaged the infrastructure.

34 The driver reported to the signaller that no fault could be found. The signaller advised the driver that the train may have derailed, caused damage to infrastructure and then re-railed.

35 The driver re-examined the train with the Network Rail Mobile Operations Manager (MOM) who had arrived on site. They found a collapsed suspension at wheel one and a missing brake block at wheel four on bogie serial number 89 - see Figure 6.

36 Damage to the wagon from the incident included: (i) deformation of the bogie frame due to impact by the suspension spring - see Figure 7; (ii) deformation of the bogie frame by the wagon structure due to excessive relative movement during derailed running – see Figure 8 and (iii) damage to wheel three from number 788 points check rail – see Figure 9.

37 Infrastructure equipment damage extended over approximately 250 m and included: (i) approximately 400 *sleeper*s; (ii) 20 *Pandrol* clips; (iii) 18 *bearer*s; (iv) 8 track circuit cables; (v) *Train Protection and Warning System* (TPWS) equipment mounting bars and (vi) check rail and *fish plate*s at number 788 points. The coping stone at platform three was misaligned and scored by impact with the bogie as shown in Figure 10.

38 After the incident, EWS staff used a hydraulic jack between the bogie frame and suspension spring to return the suspension to its correct orientation. The train was then moved at walking pace to the up Normanton line adjacent to Colton Junction to allow the resumption of service on the up main line.

39 Marcroft staff fitted a replacement link pin and the train was then moved to Milford sidings at a speed no greater than 35 mph (56 km/h). The wagon was detained at Milford sidings while examinations and tests were undertaken by GE and the RAIB.

Previous occurrences of a similar character

40 GE recorded five KIB wagon derailments from 2005 through to August 2006. The derailment considered in this report and a derailment on steel works infrastructure on 14 January 2006 were directly attributed to link pin failure.

41 Link pin failure to a wagon other than a KIB was the subject of National Incident Report (NIR) 1232 dated 15 November 2001. The action required was to replace all link pins fitted to the affected fleet.

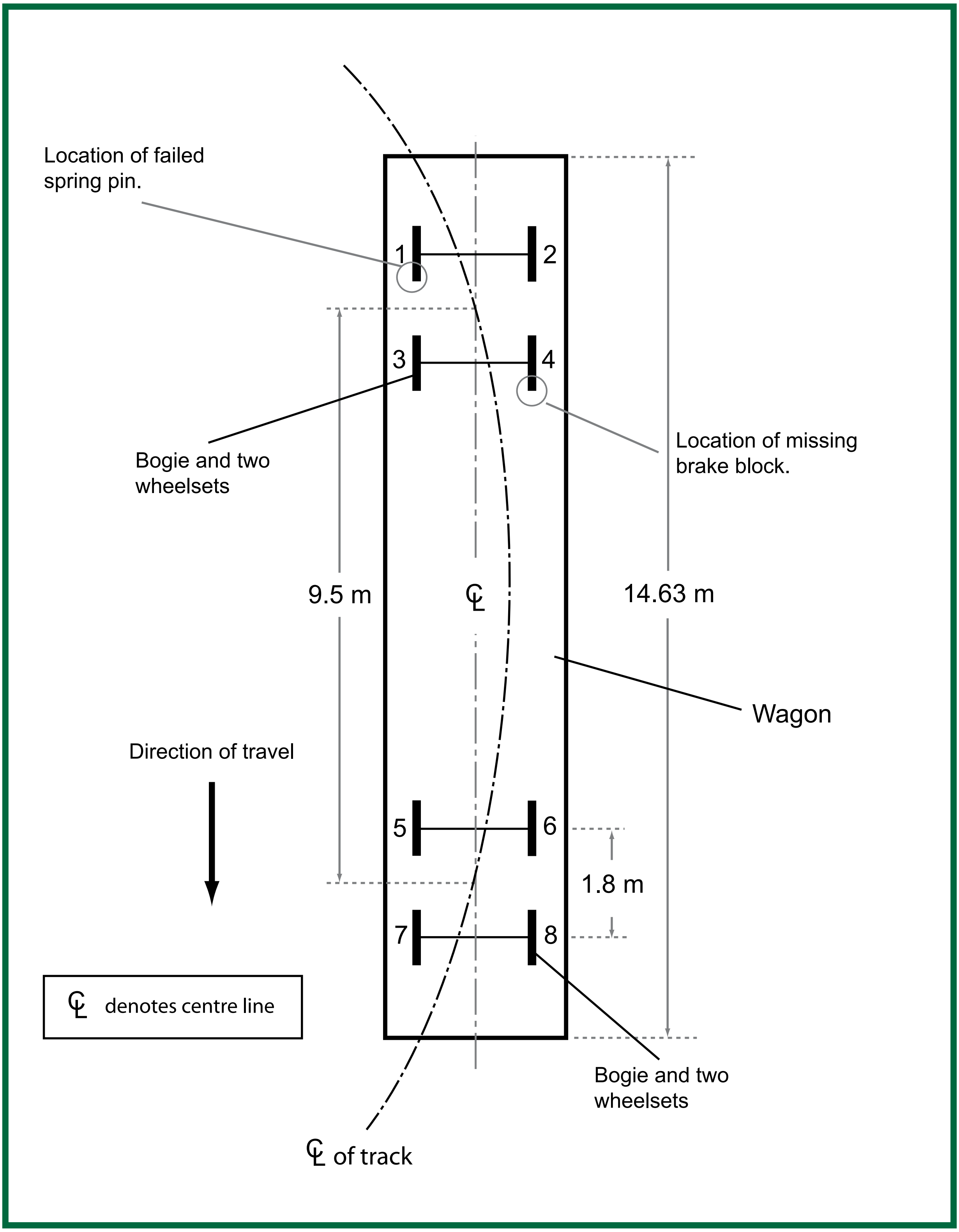

Figure 6: Plan view of wagon 7008990380 and the derailed wheelset

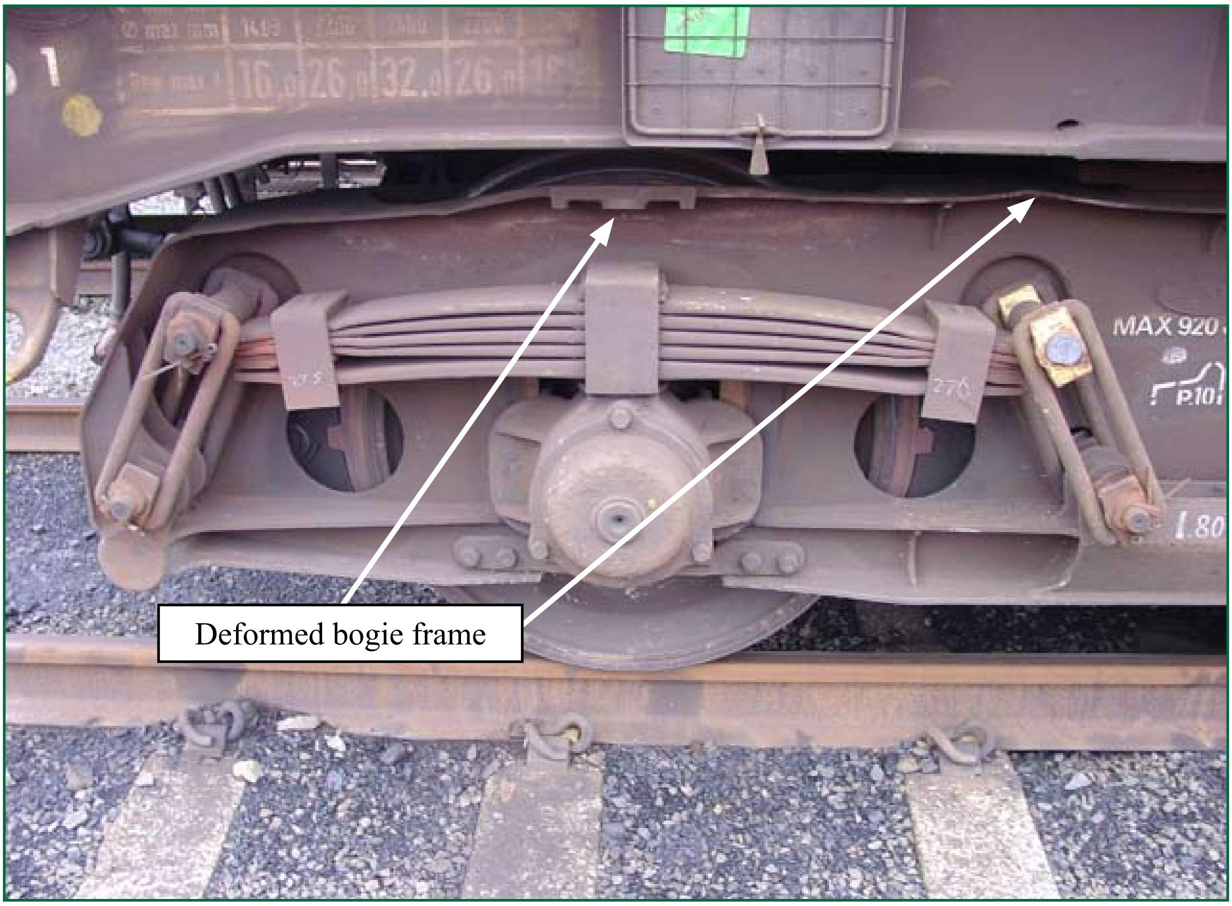

Figure 7: Photograph of deformation of the bogie frame due to impact by suspension spring

Figure 8: Photograph of deformation of the bogie frame by the wagon structure due to excessive relative movement during the incident

Figure 9: Damage to wheel three from number 788 points check rail

Figure 10 Platform three coping stone misaligned by impact with bogie

Analysis

42 The incident was analysed to determine the immediate cause, causal factors, contributory factors and underlying causes - see Figure 11.

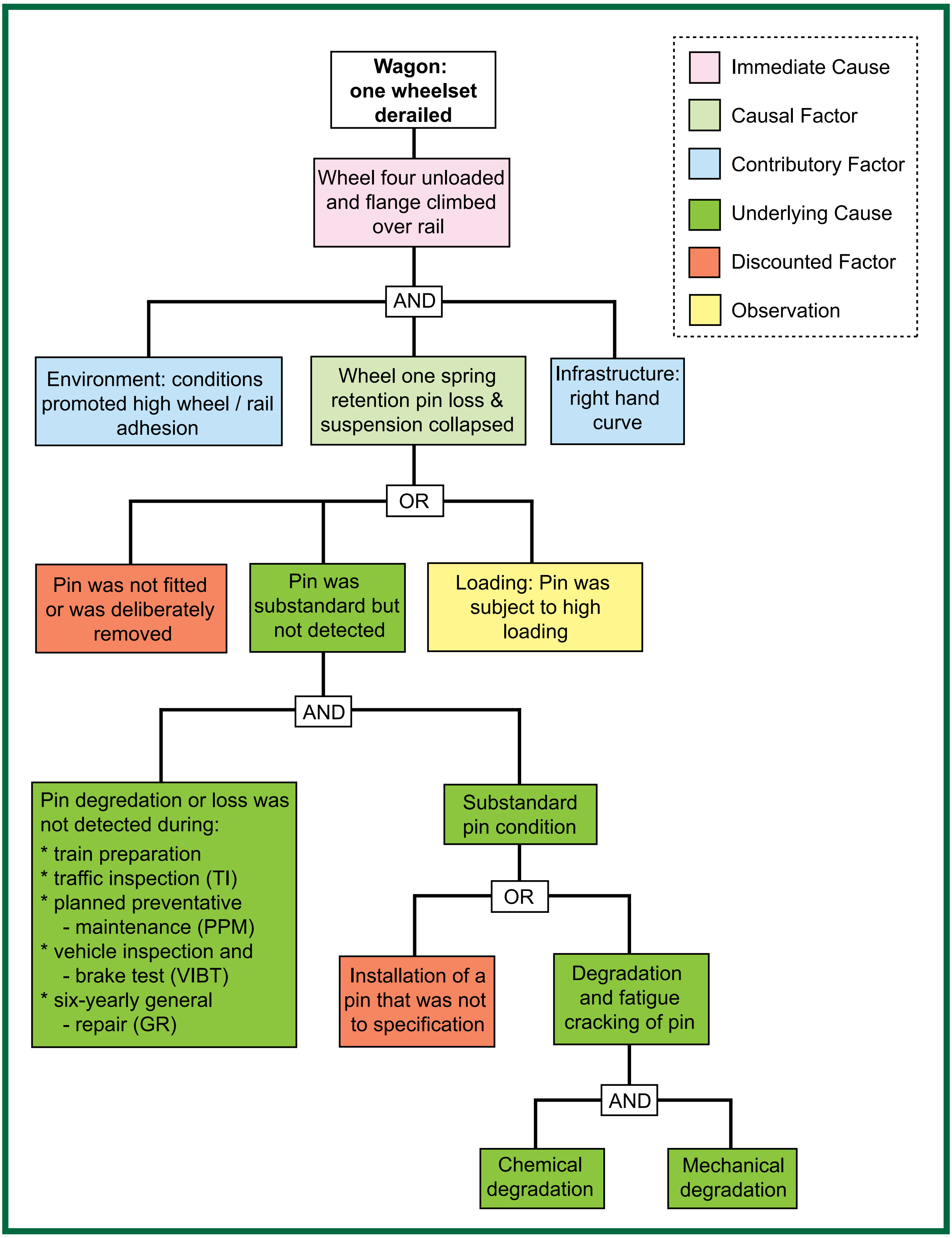

Figure 11: Causal Analysis

Identification of the immediate cause and causal factor

43 It was apparent early in the investigation that there was suspension collapse at wheel number one of wagon 7008990380 due to the loss of the link pin.

44 Suspension collapse resulted in a significant redistribution of vertical wheel loads on the damaged bogie. Wheels two and three became more highly loaded while wheels one and four became significantly unloaded.

45 Vertical wheel loads were measured with the link pin fitted and then removed by moving the wagon slowly over a weighing device placed in the *four foot* - see Figure 12.

Wheel load in tonnes				
With link pin fitted			**Without link pin fitted**	
Wheel 4 3.58	Wheel 3 3.32		Wheel 4 **0.12**	Wheel 3 6.62
Wheel 2 3.26	Wheel 1 3.50		Wheel 2 6.82	Wheel 1 **0.00**

Figure 12: Wheel loads in tonnes with and without link pin fitted

46 Derailment occurred after the susceptibility to flange climb overcame the significantly reduced vertical load exerted by wheel four. Other factors that promote flange climb include: reduced clearance between wheel flange and rail; high adhesion between wheel and rail, horizontal track curvature and centre pivot liner wear. None were factors in this incident.

47 Track geometry on the approach to the point of derailment was examined on the night of the incident and was also recorded on 12 December 2005 by the Network Rail New Measurement Train (NMT). The track was found to be in a satisfactory condition and was not a factor in either the suspension failure or the derailment.

48 The wheelsets of wagon 7008990380 were examined for compliance with wheel profile and wheel back to back requirements. The wheelsets were found to be in a satisfactory condition and were not a factor in either the suspension failure or the derailment.

49 The immediate cause of the derailment was the significant reduction in vertical load at wheel four which climbed the gauge face of the left hand rail, mounted the rail head and derailed in the direction of platform three. Wheel three fell into the four foot at this time.

50 The causal factor of the derailment was the loss of the link pin and the collapse of the suspension at wheel one on bogie serial number 89 of wagon 7008990380.

Identification of the contributory factors

51 At the time of the incident the weather was overcast but dry, the track through platform three was protected from environmental conditions by a canopy and the rails were clean through regular use. High adhesion prevailed at the wheel-rail interface.

52 During the period of travel when the vertical loads of wheels one and four were significantly reduced, the flange of wheel four was in contact with the *gauge face* of the left hand rail in the direction of travel as the wagon negotiated the right hand curve of the track - see Figure 6.

53 High wheel-rail interface adhesion and the right hand curve were normal conditions that, when combined with wheel four's significantly reduced vertical wheel load, increased its susceptibility to flange climb at that particular location.

Identification of the underlying causes

54 After the incident a sample of 80 link pins removed from in-service wagons was examined. No link pin had a cross section of less than 33.5 mm through wear. All link pins were therefore compliant with maintenance document requirements for further use. However 79 link pins exhibited surface breaking defects including corrosion, pitting and scoring.

55 Link pin failures have been the subject of several investigation reports by Serco Railtest Derby. The earliest report available was dated 14 August 1980.

56 The investigation reports conclude that the mechanism of link pin failure is fatigue cracking that initiates from a surface breaking defect. The effective load bearing cross section is progressively reduced until the link pin fails through rapid overload.

57 Link pin fatigue cracking may not be evident at GR as the inspection criterion for re-use or replacement is wear and not the detection of surface breaking defects. Fatigue cracking would not be evident during train preparation, TI, PPM or VIBT examination as the suspension is not routinely dismantled to expose the link pin bearing surfaces.

58 It is therefore likely that the underlying causes of the incident were: (i) the loss of the link pin following degradation, fatigue cracking and rapid overload and (ii) the inability of the maintenance and inspection regime to detect link pin degradation and fatigue cracking sufficiently early in its inception to avoid failure between scheduled examinations. However, the underlying causes could not be proved conclusively as the missing link pin could not be located.

Discounted Factors

59 The susceptibility of a wagon to derail following the loss of a link pin is significant and immediate in its onset. Therefore the absence of the link pin before the incident journey commenced was discounted as it was not a credible factor.

60 The investigation reports into link pin failures by Serco Railtest Derby confirmed that the link pins complied with their production drawings in material and form. Therefore the installation of link pins that were not to specification was discounted as it was not a credible factor.

Conclusions

Immediate cause and causal factor

61 The immediate cause of the derailment was the significant reduction in vertical load at wheel four which then climbed the gauge face of the left hand rail, mounted the rail head and derailed in the direction of platform three. Wheel three fell into the four foot at this time.

62 The causal factor of the derailment was the loss of the link pin from the suspension spring at wheel one on bogie serial number 89 of wagon 7008990380. The subsequent collapse of the suspension at wheel one caused diagonally opposite wheel four to become significantly unloaded and thus susceptible to flange climb.

Contributory factors

63 The contributory factors that promoted flange climb at the particular location were: (i) high adhesion at the wheel-rail interface and (ii) right hand horizontal track curvature. Both were normal conditions that, when combined with wheel four's significantly reduced vertical wheel load, increased its susceptibility to flange climb.

Underlying causes

64 The likely underlying causes of the incident were: (i) the loss of the link pin due to degradation, fatigue cracking and rapid overload and (ii) the inability of the maintenance and inspection regime to detect link pin degradation and fatigue cracking sufficiently early in its inception to avoid failure between scheduled examinations (Recommendation 1).

Observations

65 From the sample of 80 link pins taken from in-service wagons, 41 were found to be bent from straight by more than 0.5 mm. The link pins were bent through the application of a load or loads that exceeded the link pin yield strength (Recommendation 2).

66 TIs were carried out far less frequently than required on wagon 7008990380 (Recommendation 3).

67 No common industry action has been taken on link pin in-service failure despite its occurrence over a period of more than 25 years (Recommendation 4).

Actions already taken or in progress that affect this report

68 PPM and VIBT, originally carried out at alternate six month intervals are currently carried out at four month and annual intervals respectively, ie month 4 PPM, month 8 PPM, month 12 VIBT and so on.

69 The GE KIB wagon fleet link pins were replaced following the incident.

70 At the time of the publication of this report a wagon had been instrumented to measure link pin strain during loading and in-service operation in an effort to identify the fitness of the link pins for their duty.

Recommendations

71 The RAIB's recommendations are directed at those parties who the RAIB believes are best placed to mitigate the identified risks (the implementers). When these parties have considered the recommendations they should establish their own priority and timescale for the necessary work, taking into account their health and safety responsibilities and the safety risk profile and safety priorities within their organisations.[1]

<u>Recommendations to address causal issues</u>

1. GE Rail Services should review their maintenance arrangements for link and pin type suspensions to ensure that degraded link pins are detected and replaced at a periodicity that minimises the risk of in-service failure (paragraph 64).

<u>Recommendations to address observations</u>

2. GE Rail Services should determine in-service link pin strain and ensure that either link pins of an appropriate specification are used or that in-service loads are reduced to within the link pin load carrying capability (paragraph 65).

3. English Welsh and Scottish Railway should revise their system of assurance to ensure that wagons are assessed and documented as fit to run before commencing in-service operation (paragraph 66).

4. Freight Operating Companies that operate wagons with link and pin type suspensions should review their maintenance arrangements to ensure that degraded link pins are detected and replaced at a periodicity that minimises the risk of in-service failure (paragraph 67).

[1] The RAIB addresses its recommendations to the ORR (HMRI), the safety authority, in accordance with Article 25(2) of the European Railway Safety Directive 2004 (the Directive) and Regulation 12(2)(a) and (b) of the Railways (Accident Investigation and Reporting) Regulations 2005) (RAIR). The RAIB does this to enable the ORR (HMRI) to discharge its responsibilities under Article 25(2) of the Directive and Regulation 12(2)(a) of the Regulations, namely that they must ensure that all RAIB recommendations addressed to it are duly taken into consideration and where appropriate acted upon by the end implementer.

The end implementer is required under Regulation 12(4)(b) of the Regulations, to provide the Safety Authority with the full details of the measures/actions they intend to take to implement the recommendation and the timescales for securing that implementation. The timeliness of this response to the Safety Authority is dictated by the Safety Authority's duty under RAIR Reg 12(2)(b) to report to the RAIB, without undue delay or within such other period as may be agreed with the Chief Inspector.

Appendices

Glossary of abbreviations and acronyms — Appendix A

EWS	English Welsh & Scottish Railway
EWSH	EWS Holdings
GE	GE Rail Services
GR	General Repair
IECC	Integrated Electronic Control Centre
MOM	Mobile Operations Manager
NIR	National Incident Report
NMT	New Measurement Train
PPM	Planned Preventative Maintenance
RIV	Regolamento Internazionale Veicoli
TI	Traffic Inspection
TOPS	Total Operations Processing System
TPWS	Train Protection and Warning System
UIC	Union Internationale des Chemins de Fer
VIBT	Vehicle Inspection and Brake Test

Glossary of terms **Appendix B**

Aspect	Visual indication of a signal as displayed to the driver.
Bearer	Timber (or concrete) transverse sleeper supporting the rails in switches and crossings.
Cess	The area either side of the railway immediately off the ballast shoulder. This usually provides a safe area for authorised workers to stand when trains approach.
Fish plate	Steel plate used to align and secure the ends of two rails together.
Flange climb	A situation where the flange of a rail wheel rides up the inside (gauge) face of the rail head while rotating. If the wheel flange reaches the top of the rail head, the wheelset is no longer constrained and this could result in derailment.
Four foot	The area between the inner running faces of a pair of rails.
Gauge face	The inner edge of each running rail (within the four foot) closest to where the wheel flanges run.
'H' or 'O' carded	A card physically attached to a wagon exhibiting the code 'H' or 'O' indicating overdue VIBT or PPM respectively.
Integrated Electronic Control Centre	A power signalbox where all data displays, safety interlocking etc are computer controlled and under normal circumstances trains are signalled automatically according to their train number.
KIB	A covered wagon used for carrying steel coils.
Pandrol	Type of clip used to secure track.
Points	The items of permanent way which may be aligned to one of two positions, according to the direction of train movement required.
Regolamento Internazionale Veicoli	International vehicle regulations.
Sleeper	Wood, concrete or steel object which holds the rails apart and supports the track on the ballast.
Total Operations Processing System	A national computer data system for management of train processing operations.
Track circuit	An electrical device using rails in an electric circuit which detects the absence of trains on a defined section of line.
Train Protection and Warning System	A system that provides train stop and overspeed protection at some signals, overspeed protection at some speed restrictions and at passenger platforms with buffer stops.
Union Internationale des Chemins de Fer	International Union of Railways. An organisation based in France which promotes co-operation amongst railways worldwide.
Up	Track with a normal direction of travel to London.
Wheelset	An assembly comprised of two wheels and an axle.

This report is published by the Rail Accident Investigation Branch,
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