RAIB

Rail Accident Investigation Branch

Rail Accident Report

Derailment at Washwood Heath West Junction, Birmingham
23 March 2015

Report 01/2016
January 2016

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. However, where the RAIB is less confident about the existence of a factor, or its role in the causation of the accident, the RAIB will qualify its findings by use of the words '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 but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, the words '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 event 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.

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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Derailment at Washwood Heath West Junction, Birmingham, 23 March 2015

Contents

Summary

At 08:03 hrs on Monday 23 March 2015, one bogie of a wagon in a container train derailed on a set of points as it crossed between lines at Washwood Heath West Junction, in Birmingham. The bogie ran derailed for 121 metres before rerailing itself as it ran through another set of points. The train driver was not aware that a derailment had occurred. The signaller noticed irregular indications on his display panel, stopped the train and asked the driver to examine it. The driver found that the tenth wagon in the train showed signs of having run derailed.

The train consisted of a class 66 locomotive pulling 24 container wagons and had been travelling at 15 mph (24 km/h) while negotiating the series of crossovers. The wagon that derailed was a 'Megafret' IKA wagon which consisted of two flat platforms permanently coupled together. The derailment caused significant damage to track and signalling equipment. No-one was injured.

The track where the wagon derailed was curved and found to contain a twist fault of a magnitude which Network Rail's track maintenance standard specified should be rectified within 36 hours. Network Rail was not aware of the existence of this fault at the time.

Wagons should be capable of negotiating a track twist of a magnitude which the track standard allows to remain in a line open to traffic. When tested, the wagon which derailed was found not to meet the requirements of the relevant Railway Group Standard for resistance to derailment due to track twist.

When examined after the derailment, the liner on the centre pivot of the bogie was found to be worn beyond its maintenance limit. The centre pivot liner is made from a plastic material and is provided to allow relative movement between the body centre pivot and the bogie. The worn liner had restricted the freedom of the bogie to rotate, increasing its rotational stiffness. Furthermore, it resulted in reduced side bearer clearances, increasing wheel unloading in track twist conditions. Both the increased rotational stiffness and the increased wheel unloading reduced the wagon's resistance to derailment, causing it to derail when it encountered the track twist on the curved track.

The worn centre pivot liner had not been identified during maintenance of the wagon as the maintenance instructions were unclear about when it should be inspected.

Following another derailment, at Doncaster on 11 April 2015, the wagon owner instigated a check of part of its UK fleet which revealed that a number of other wagons of the same type had experienced a similar degree of centre pivot liner wear.

The RAIB has made three recommendations and four learning points. Two of the recommendations are made to the wagon owners and cover the maintenance procedures for Megafret wagons and the process for dealing with any problems found with the wagons. One recommendation is made to Network Rail and covers the training and briefing of staff on the maintenance of points of the type used at Washwood Heath West Junction. One of the learning points concerns wagon maintenance and three are related to track maintenance.

Introduction

Key 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 terms left and right are used in this report with respect to the direction of travel of the train.

2 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. Sources of evidence used in the investigation are listed in appendix C.

The accident

Summary of the accident

3 At 08:03 hrs on Monday 23 March 2015, one bogie of a wagon in a container train became derailed on a set of points as it crossed between lines at Washwood Heath West Junction, in Birmingham (figure 1). The bogie ran derailed for a short distance before rerailing itself as it ran through another set of points.

4 The train driver was not aware that a derailment had occurred. The signaller noticed that the signalling equipment behind the train was showing irregular indications after the train had passed, stopped the train at Landor Street Junction and asked the driver to examine his train. The driver found that the tenth wagon in the train showed signs of having run derailed.

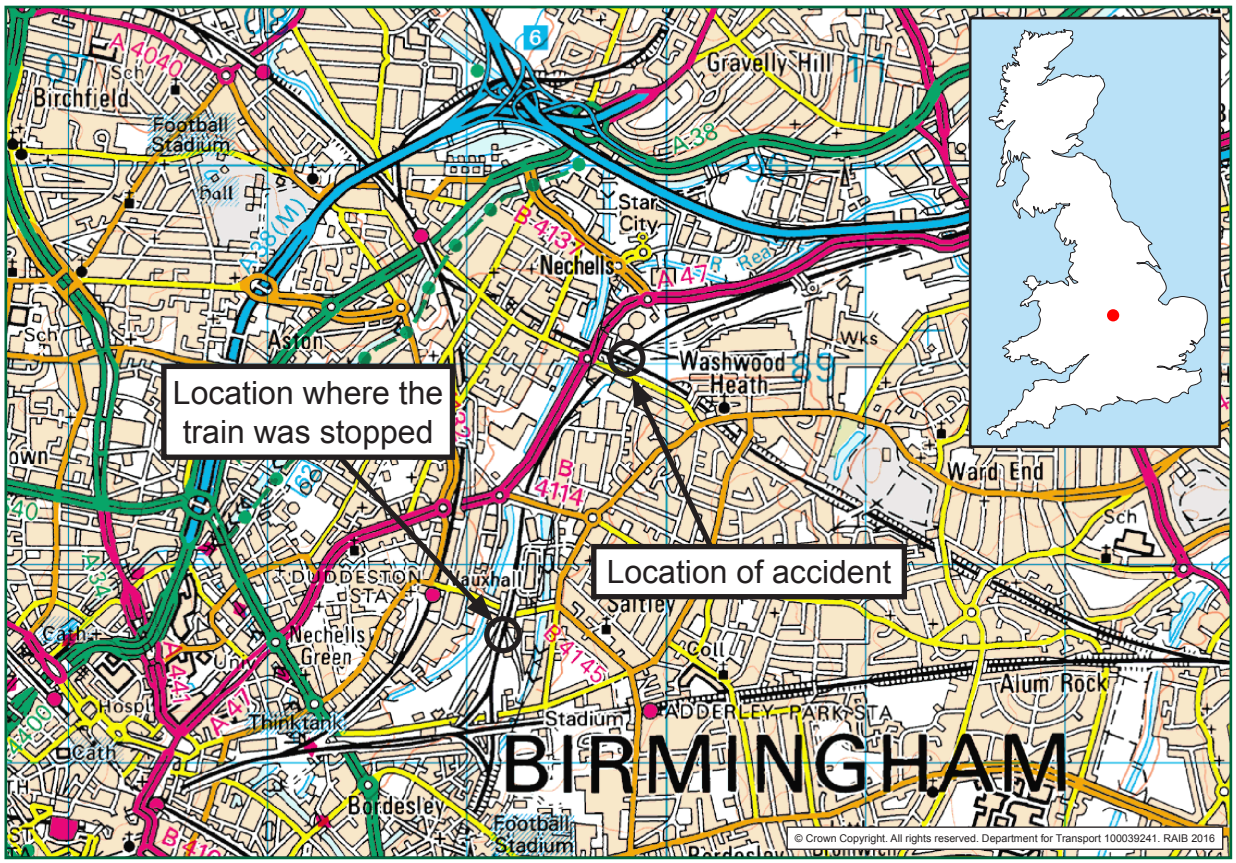

Figure 1: Extract from Ordnance Survey map showing location of derailment and location where train was stopped

5 The train was the 05:58 hrs Basford Hall (Crewe) to Southampton container service, reporting number 4O14. It consisted of a class 66 locomotive pulling 24 container wagons of various types.

6 The derailment caused extensive damage to three sets of points and the *plain line* track between them (figure 2). The derailed wheels severed several signalling cables, causing *track circuits* and points to show a failed status to the signaller. The line was closed until 04:40 hrs on 24 March for repairs.

7 No one was injured in the derailment.

Figure 2: Site of the derailment, looking in the direction that the train was travelling

Context

Location

8 Washwood Heath West Junction is on the Birmingham to Derby main line which consists of four running lines at this location (figure 3). The *up* direction is towards Derby and the *down* direction is towards Birmingham. The train was travelling towards Birmingham on the Up Derby Slow line, which is signalled for trains in either direction at this point.

9 The train was crossing to the Down Derby Goods line via a series of crossovers, made up of points 802, 805 and 807, when the derailment occurred. Each of these crossovers consists of two points which operate together and have a suffix A or B to distinguish each end (figure 3). The derailment occurred as the wagon was running through 802B points.

10 The permitted speed on the Up Derby Fast line through the area is 75 mph (120 km/h), the permitted speed on the Up Derby slow is 40 mph (64 km/h) and the maximum speed through the crossovers is 15 mph (24 km/h). The Up Derby Fast line was designed to have 50 mm of *cant* whereas the Up Derby Slow line has zero cant, hence the crossover made up of 802A and 802B points was designed such that the cant on the crossover route varied from zero at the 802A end to 50 mm at the 802B end.

11 As is normal for a crossover between two parallel tracks, crossover 802 included a *reverse curve*. The manufacturer's drawing showed that the minimum radius was 227 metres on the left-hand curve through 802A points and 286 metres on the right-hand curve through 802B points.

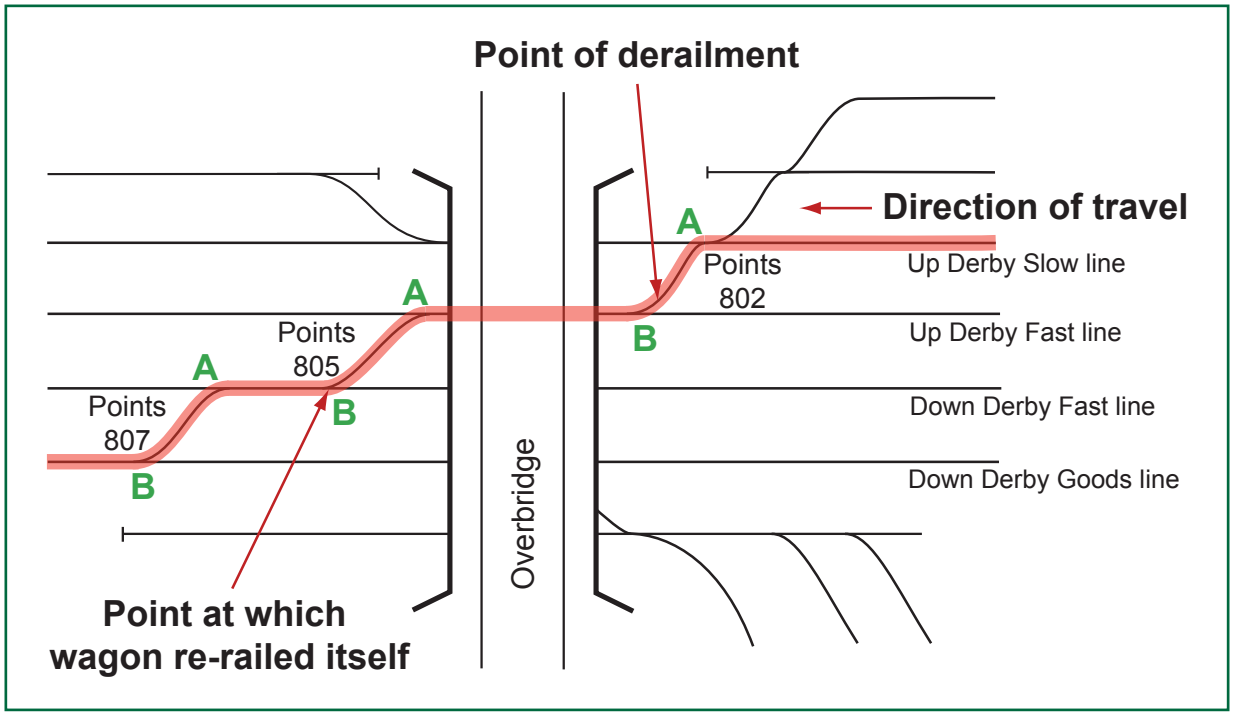

Figure 3: Track layout at Washwood Heath West

Organisations involved

12 The track is owned by Network Rail and is part of its London North Western (South) Route. It is maintained by Network Rail's Birmingham (Saltley) maintenance delivery unit.

13 The train was operated by Freightliner Intermodal which also employs the driver.

14 Freightliner hired the wagon which derailed from Ahaus Alstätter Eisenbahn AG (AAE), a wagon hire company based in Switzerland. AAE was acquired by VTG AG, a German company, on 6 Jan 2015. Freightliner started its hire of the wagon on 8 August 2014.

15 Davis Wagon Services (DWS) maintained the wagon on behalf of AAE while it was on hire to Freightliner.

16 From 24 April 2012 to 7 August 2014 the wagon was hired to Direct Rail Services (DRS). As part of the arrangements for this hire, DRS carried out the maintenance on the wagon for AAE.

17 The last major maintenance event (termed *revision*) was carried out in March 2012 by Lormafer in Creutzwald, France.

18 DRS, DWS, Freightliner, Lormafer, Network Rail and VTG AG freely co-operated with the investigation. The RAIB noted that AAE was not so pro-active or helpful in providing relevant information in a timely manner to assist the investigation (paragraphs 123 to 127).

Train involved

19 Train 4O14 was made up of a class 66 locomotive and 24 wagons, 23 of which were loaded with containers. Most of the containers were empty but the wagon which derailed was carrying one empty and one loaded container.

20 The wagon which derailed was number 37 80 4909 147-3, a 'Megafret' type (*TOPS* code IKA, UIC code Sffggmrrss). This was the tenth wagon in the train. The ninth wagon was also a Megafret, and these were the only Megafret wagons on the train.

21 A Megafret wagon consists of two semi-permanently coupled *platforms*, each of which has two bogies. The combination of the two platforms is regarded as a single wagon for operational purposes and is given one wagon number. Each platform of a Megafret can carry a container up to 45 ft[1] long. At the time of the derailment, wagon 37 80 4909 147-3 conveyed an empty 40 ft container on the leading platform and a 40 ft container loaded with scrap plastic chips on the trailing platform. The bogie which derailed was the leading bogie of the trailing platform (figure 4).

Figure 4: Wagon 37 80 4909 147-3 after the incident

External circumstances

22 The weather at the time of the derailment, as recorded at Birmingham airport, 9 km from Washwood Heath, was clear and dry with an air temperature of 4°C and a dew point of 1°C. The rail conditions at the time of the derailment were not recorded, but the rail was likely to have been dry.

[1] Container sizes are quoted in imperial dimensions (feet) in accordance with international shipping practice.

The sequence of events

Events preceding the accident

23 The containers were loaded onto the wagon at Garston container terminal in Liverpool and the train ran to Crewe on 21 March. The train was stabled at Basford Hall sidings in Crewe until its scheduled departure at 05:58 hrs on 23 March.

24 The journey from Basford Hall to Washwood Heath was uneventful.

Events during the accident

25 The train was routed from the Up Derby slow to the Down Derby Goods lines via the series of crossovers at Washwood Heath West Junction. The locomotive's on-train data recorder indicated that the speed through the crossovers was 15 mph (24 km/h), which was compliant with the 15 mph speed limit for this route.

26 Shortly before 08:03 hrs, as the tenth wagon traversed crossover 802, the leading bogie of the trailing platform derailed soon after passing the place within the crossover where the curve changed from being left to right-handed. The leading left-side wheels of the bogie climbed onto the head of the *closure* rail of 802B points, then all wheels of that bogie dropped off to the left.

27 The bogie ran derailed through the *switches* of 802B points, the plain line between them and 805A points and through those points (figure 5). Significant damage was caused to 802B and 805A points and the track between them (figure 6).

28 The derailed wheels were guided back onto the track by the converging rails of 805B points.

Events following the accident

29 The damage to the track and signalling equipment caused the signaller's control panel to show that this equipment was in a failed state and locked the route through the crossovers. The signaller stopped the train at a signal at Landor Street at 08:10 hrs and asked the driver to examine the train.

30 The signaller reported the problem to the Network Rail control office as the damage to the equipment prevented the signaller from setting any routes for trains through Washwood Heath.

31 Network Rail sent a mobile operations manager to look at the crossovers and he reported, at 08:30 hrs, that there was damage consistent with a derailment having occurred. Network Rail informed the RAIB of this at 08:41 hrs and an investigation team was despatched to site.

32 Having examined the train, the driver confirmed that wagon 37 80 4909 147-3 had damage on its wheels consistent with it having run derailed.

33 The RAIB examined the train at Landor Street then authorised Freightliner to remove wagon 37 80 4909 147-3 from the train and place it in quarantine at Lawley Street Freightliner terminal pending further investigation. The rest of the train was then released to continue its journey to Southampton.

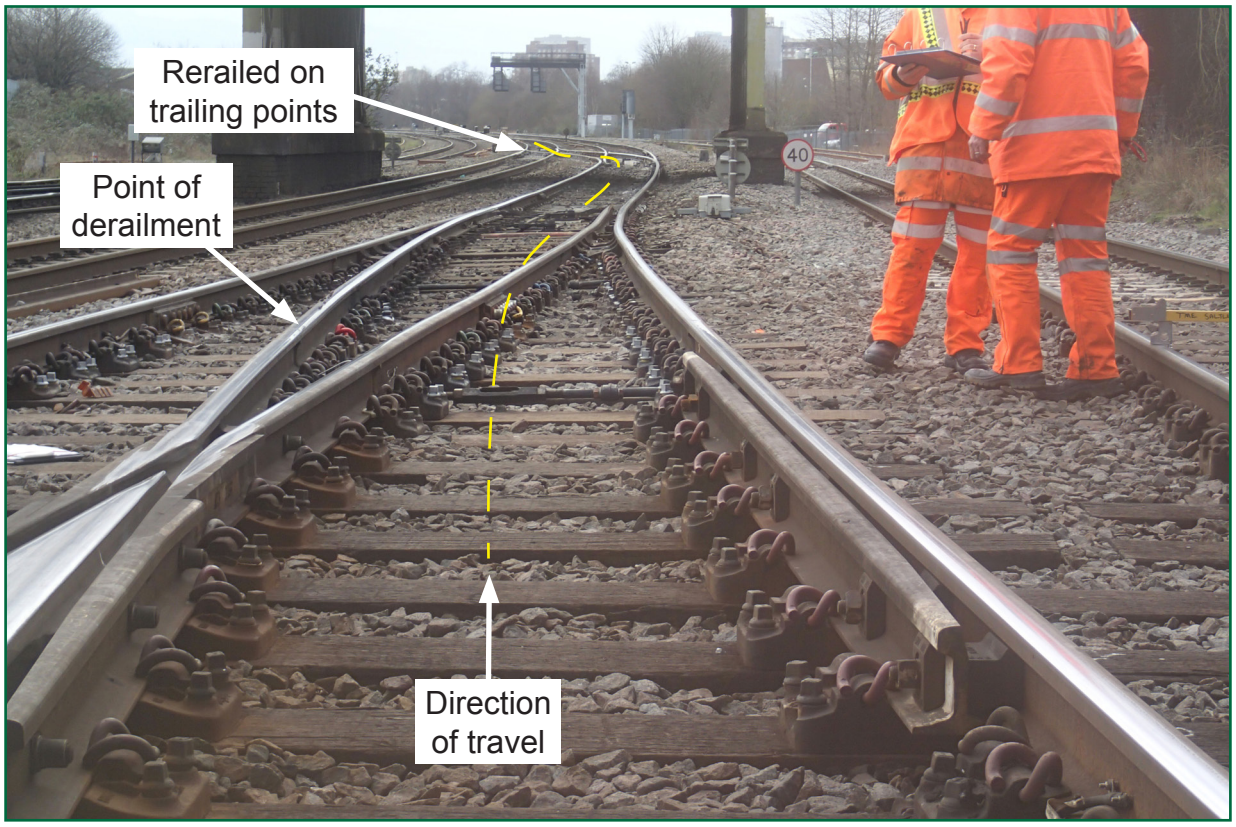

Figure 5: Path of the derailed bogie

Figure 6: Damage caused to track by the derailed bogie

Key facts and analysis

Background information relating to the wagon

Megafret wagons

34 The 'Megafret' wagon design was intended for the conveyance of containers and other *intermodal boxes*. It features a low floor to enable 9' 6" 'high cube' containers to be carried on routes from which they would otherwise be barred due to height restrictions. Megafret wagons were originally built by Remafer in France until that company ceased trading. Following this, Megafret wagons were built by Arbel Fauvet Rail in France and by Thrall Europa in the UK. The three designs of Megafret differ slightly in appearance, but all are fitted with Y33-type bogies.

35 AAE owned a fleet of approximately 650 Megafrets, all but 63 of which were built by Arbel Fauvet Rail. These were hired to freight operators throughout Europe, including the UK.

36 The Megafret wagons built by Thrall Europa were built for English Welsh and Scottish (EWS) Railway (now DB Schenker) and were given the designation FKA. DB Schenker also operated some IKA Megafrets hired from AAE.

37 The AAE IKA Megafret wagons were designed and certified for international traffic in accordance with the Regolamento Internazionale Veicoli (RIV) regulations of the International Union of Railways (UIC). The design of the wagons was scrutinised for compliance with UIC codes (standards) rather than Railway Group Standards.

38 The French national railway, Société nationale de chemins de fer français (SNCF), approved the Megafret design as meeting all the requirements of the RIV and also confirmed to Railfreight Distribution (part of EWS at the time) in July 1998 that it had carried out a clause by clause assessment of the wagon against the requirements of UIC 503 'Continental wagons running in Great Britain', and that it met those requirements.

39 The AAE IKA Megafrets were registered in the UK rolling stock library computer system on 10 July 2000. This registration was on the basis of route acceptance certification only as no engineering acceptance certificate was required because the wagons were certified under the RIV regime (paragraph 37).

40 The FKA Megafrets were built in the UK to Railway Group Standards, which included GM/RT2141 'Resistance of Railway Vehicles to Derailment and Roll-Over'. One of the FKA wagons was tested for compliance with this standard in 1999 and was found to meet the requirements for bogie rotation and wheel unloading in that standard. An engineering acceptance certificate was issued for these wagons by Railway Approvals Ltd in 2002.

Wagon 37 80 4909 147-3

41 Wagon 37 80 4909 147-3 was built by Arbel Fauvet Rail in Douai, France, and entered service in October 1999. It was hired to various operators in mainland Europe between 1999 and January 2012. It then went to Lormafer's works at Creutzwald, France, for overhaul. The wagon was overhauled according to AAE's 'Technical Specification for Overhaul' (TSO). This specified three levels of overhaul (referred to as 'revisions'). The wagon was subject to a G4.0 revision, the most extensive of the revisions, which was completed on 8 March 2012.

42 The wagon was brought to the UK and hired to DRS from 24 April 2012 to 7 August 2014. DRS also carried out maintenance on the wagon during the time that it hired the wagon. The last maintenance action by DRS on this wagon was a vehicle inspection and brake test (VIBT) carried out at Motherwell on 13 August 2014.

43 Freightliner commenced its hire of the wagon on 8 August 2014. The hire agreement included maintenance. AAE contracted DWS to carry out all maintenance on the wagons that were hired to Freightliner.

44 DWS changed the wheelsets on the wagon at Doncaster on 12 November 2014 as they had *wheel flats* on them. DWS also carried out a VIBT on 30 December 2014, which was the last maintenance action prior to the derailment.

Entities in charge of maintenance

45 European Commission Regulation EU/445/2011 requires the appointment of an Entity in Charge of Maintenance (ECM) for every vehicle used on the national railway network of a member state.

46 The ECM is responsible for ensuring that its wagons are maintained in a safe condition. The ECM does not have to carry out the maintenance itself; it can use a contractor, but the safety responsibility remains with the ECM.

47 Each member state must maintain a national vehicle register to record who is the ECM for each wagon. In the UK, the Secretary of State for Transport has appointed a registration entity, Network Rail Infrastructure Ltd, to maintain the UK national vehicle register.

48 The individual national vehicle registers are made more widely available through the European Virtual Vehicle Register, which is administered by the European Rail Agency. The European Virtual Vehicle Register showed that the ECM details of wagon 37 80 4909 147-3 were recorded on the German national vehicle register and recorded AAE as the ECM.

49 The European Commission Regulation requires that ECMs hold an ECM certificate and, at the time of the derailment, AAE held ECM certificate no. CH/31/0212/9074, issued by Sconrail AG and valid from 31 August 2012 to 30 August 2017.

Background information relating to the track

Track inspection and recording

50 Network Rail has a standard for track inspection defined in document NR/L2/TRK/001. The document is divided into several modules which are referred to in the following paragraphs.

51 Visual inspection is covered by NR/L2/TRK/001/mod02 and has several levels. The first of these is a basic visual inspection which is usually carried out by manual inspection by a patroller walking the line. The frequency of the inspections is driven by the track category of the line, which is derived from the speed and tonnage of traffic using it, and the type of track. Track categories range from 1A, for high speed, high tonnage lines, to 6, for low speed, low tonnage routes. The Up Derby Fast line at Washwood Heath West was categorised by Network Rail as track category 1. As a result a basic visual inspection was required every week for 802 points.

52 In addition to the basic visual inspection, the section manager (track) and track maintenance engineer were also required to conduct visual inspections of the track. For track category 1, section manager (track) inspections of the *switches and crossings* (S&C) were required at 8 week intervals and track maintenance engineer inspections at 2 year intervals.

53 Network Rail's inspection records showed that the track had been inspected in accordance with these intervals. The most recent basic visual inspection at the time of the derailment was carried out on 19 March 2015. The inspection report stated that there were 'no actionable defects'. The most recent supervisor's inspection was on 2 February 2015 and the report stated that there were no defects. The most recent track maintenance engineer's inspection was on 19 February 2015 and the report stated that there were no issues with 802 and 805 points.

54 Track geometry recording is specified in standard NR/L2/TRK/001mod11. For category 1 track the nominal interval between track recording vehicle runs is 8 weeks and the maximum interval is 18 weeks. Network Rail's new measurement train ran over the Up Derby Fast line every 4 weeks and the most recent recording, at the time of the derailment, was made on 6 March 2015. The Up Derby Slow line is track category 2 and the nominal interval between track recording vehicle runs is 12 weeks and the maximum interval is 26 weeks. Network Rail's track recording unit ran over this line three times in 2014 and the most recent recording at the time of the derailment was on 20 December 2014.

55 The crossover route between the Up Derby Fast line and the slow line is track category 6. Standard NR/L2/TRK/001mod11 states that the nominal interval between track recording runs for this category is 24 weeks and the maximum is 52 weeks. The standard specifies that track through crossovers between lines with different amounts of cant (as was the case with crossover 802) should be recorded by a track recording vehicle, where practicable. Where this is not practicable, it specifies manual measurement using hand propelled track recording devices, such as the Giesmar 'Amber' recording trolley. As manual measurement methods can only measure the unloaded profile of the track, the standard calls for these measurements to be supplemented by the use of void measurements and dynamic track spread gauges. Network Rail recorded the route through the crossovers using an Amber trolley and took void measurements at 6 month intervals. The most recent set of measurements at the time of the derailment was made on 5 October 2014. The interval between recordings was compliant with the standard.

Two-levelling of S&C

56 A simple *turnout* (point) consists of two diverging routes which only become completely separate after the *crossing*. As the two tracks diverge, the sleepers which support the two tracks become longer, but do not become separate sleepers until the distance between the diverging tracks is great enough to allow space for two sleeper ends. These long sleepers are known as *bearers* and both of the tracks supported by them normally have the same cant.

57 Where the two routes through a turnout need to have different amounts of cant, as was the case with crossover 802, some of the rails within the turnout are raised by using thicker baseplates beneath them. This practice is known as *two-levelling* and the thicker baseplates are identified by having markings cast on them to show how much thicker they are than standard baseplates (figure 7).

Figure 7: Two-levelled baseplate with marking (circled) to show it is 25 mm thicker than the standard baseplate

Identification of the immediate cause

58 **Wagon 37 80 4909 147-3 was unable to negotiate track with the amount of curvature and *twist* that was present in 802B points at Washwood Heath West Junction.**

Identification of causal factors

59 The accident occurred due to a combination of the following causal factors:

a. The bogie which derailed was unable to rotate freely, and the amount by which the vertical load on the wheels of wagon 37 80 4909 147-3 reduced when the wagon encountered a track twist was excessive (paragraph 60).

b. The track contained a twist fault that, once detected, Network Rail's standard stated should be rectified within 36 hours (paragraph 101).

Each of these factors is now considered in turn.

The condition of the wagon

60 **The leading bogie of the trailing platform of wagon 37 80 4909 147-3 was unable to rotate freely, and the amount by which the vertical load on the wheels reduced when the wagon encountered a track twist was excessive.**

61 The RAIB carried out a visual examination of the wagon at Lawley Street Freightliner depot shortly after the derailment. There were no visible signs of suspension defects and the wheel profiles were within the wear limits allowed for UK-registered vehicles in Railway Group Standard GM/RT2466 'Railway Wheelsets'.

62 The container on the wagon was opened under RAIB supervision and its contents appeared to be reasonably evenly loaded (figure 8).

63 The RAIB arranged for the wagon to be tested on site, to measure the amount of wheel unloading on twisted track. The test method followed that specified in Railway Group Standard GM/RT2141 'Resistance of vehicles to derailment and rollover'. The two platforms of the wagon were separated and the trailing platform was tested with the loaded container in place. The loads on the leading wheels of the bogie which derailed were found to be reduced by 79% of their original value when the other wheels on the platform were jacked up by the amount specified in the standard. Standard GM/RT2141 specifies a maximum of 60% wheel unloading to minimise the risk of flange climb derailment on twisted track.

Figure 8: Contents of the container that was loaded on the trailing platform of wagon 37 80 4909 147-3

64 Further wheel unloading tests were then carried out to investigate the effect of the container on the wagon's performance. These involved testing the platform in tare (unladen) condition and with an empty 40 ft container loaded on it. The RAIB noted that the minimum wheel load was the same regardless of the load on the platform, and that the centre pivot on the bogie came out of contact with the vehicle body at the maximum amount of applied twist (70 mm over the length of the platform), meaning that all of the body weight at that end of the platform was being carried by one of the *sidebearers* (figure 9). It was found that the presence of the container on the wagon had no effect on the minimum wheel load when this twist was applied, apart from causing the wheel load without the twist to be higher than the tare case. This higher load meant that, when the twist was applied, the percentage reduction in wheel load was greater in the laden case than the tare. This meant that the laden cases failed to meet the unloading limits in the standard, whereas the tare case was compliant.

65 When the wagon was lifted from its bogies to examine it further (paragraph 68), the RAIB found evidence that the bogie had not been able to rotate properly. There were marks on the centre pivot, where the steel surfaces had been in contact, which showed signs of abrasion. The flanges of the wheels on the bogie that derailed were thinner than on the other wheels of the wagon and there were marks high up on the wheel flanges indicating that they had been in hard contact with the rails. These are all signs of a bogie that was not sufficiently free to rotate.

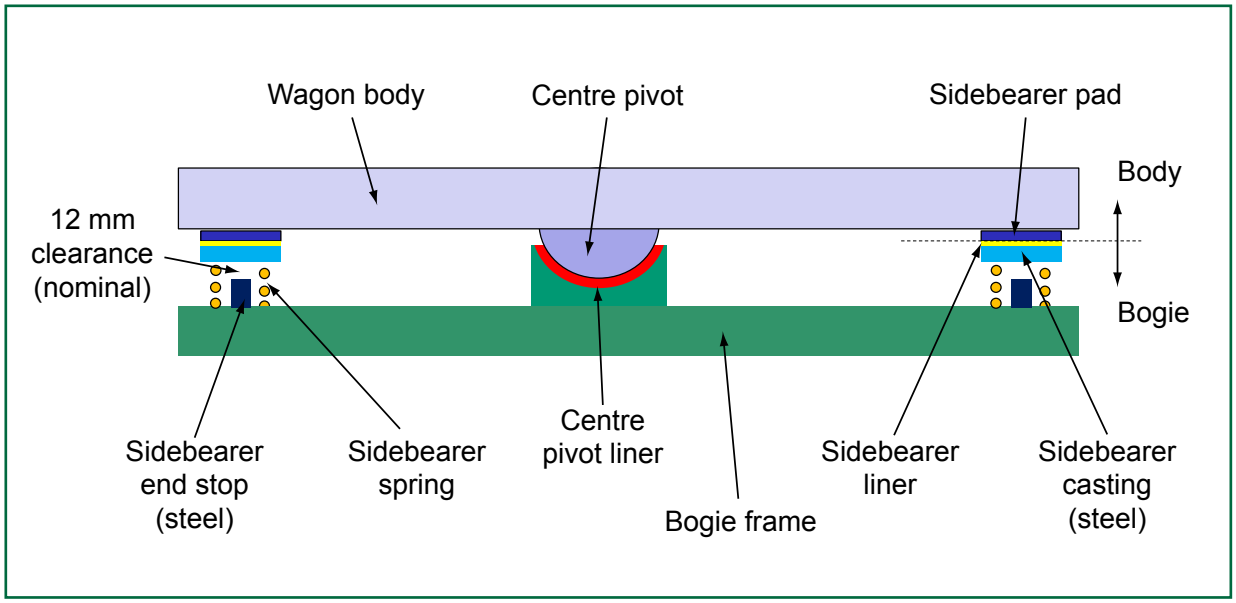

Figure 9: Diagram showing arrangement of sidebearers and centre pivot

66 This causal factor (paragraph 60) arose due to a combination of the following:

a. The bogie centre pivot liners of the wagon were worn well beyond their maintenance limits (paragraph 67).

b. The worn liners had not been identified and replaced during maintenance (paragraph 77).

Each of these factors is now considered in turn.

Bogie centre pivot liner wear

67 **The bogie centre pivot liners were found to be worn well beyond their maintenance limits.**

68 The wagon body was lifted from its bogies under RAIB supervision at Lawley Street Freightliner terminal. The centre pivot liners of all four bogies of the wagon were found to be worn to the extent that the steel centre pivot on the wagon body was in contact with the steel casting on the bogie. These plastic centre pivot liners are intended to prevent direct contact between the centre pivot on the body and the casting on the bogie. This is because the friction involved in direct steel to steel contact is much higher than the intended level of friction between the polished steel surface and the plastic liner. This increased frictional resistance would have prevented the bogies from rotating freely in curves. Figure 10 shows the centre pivot of another Megafret wagon whose liners had not worn so as to cause steel to steel contact. Figure 11 shows the centre pivot of the bogie which derailed.

69 The AAE TSO specified that the wear of the liner be assessed by measuring its thickness using a special gauge placed across the centre pivot bowl. AAE stated, however, that other methods of checking the wear were acceptable provided that the liner projected above the steel bowl by a minimum of 2 mm at the bottom of the bowl and 1 mm at the top.

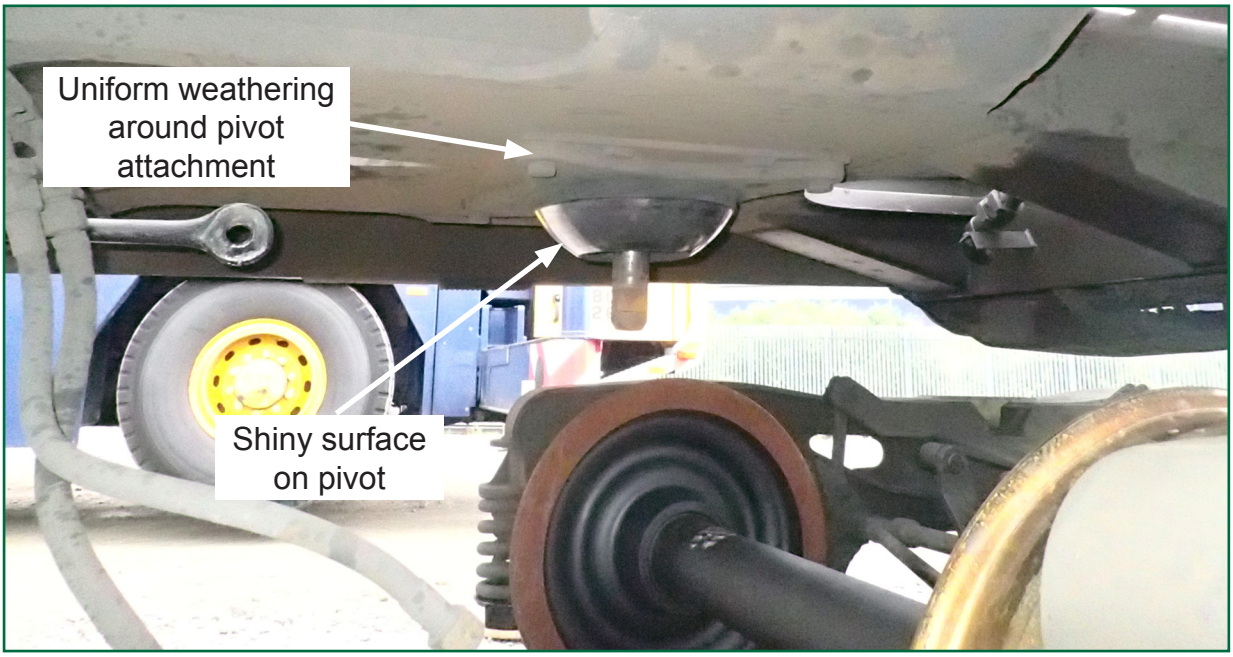

Figure 10: Centre pivot of another Megafret wagon

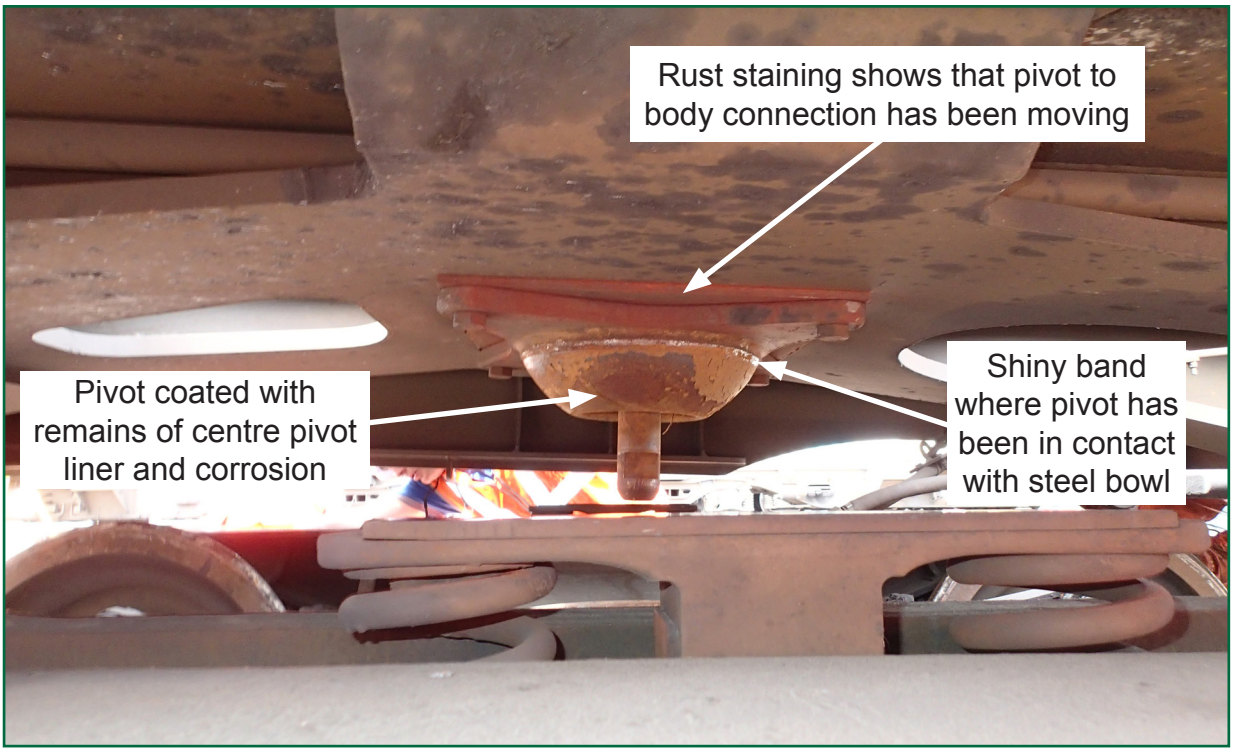

Figure 11: Centre pivot of the bogie which derailed

70 DWS used a small step gauge, shaped to the curvature of the liner, to assess the wear at the top and bottom of the liner. This gauge was specified in the maintenance instructions for other Y-series bogies with the same centre pivot arrangement. It measures whether the projection of the liner above the bowl is 1.5 mm. The RAIB does not consider that the use of different measurement gauges would have affected the assessment of the wear on the liners of this wagon as the liners had worn to the extent that their surfaces were below the steel rim of the bowl (figure 12).

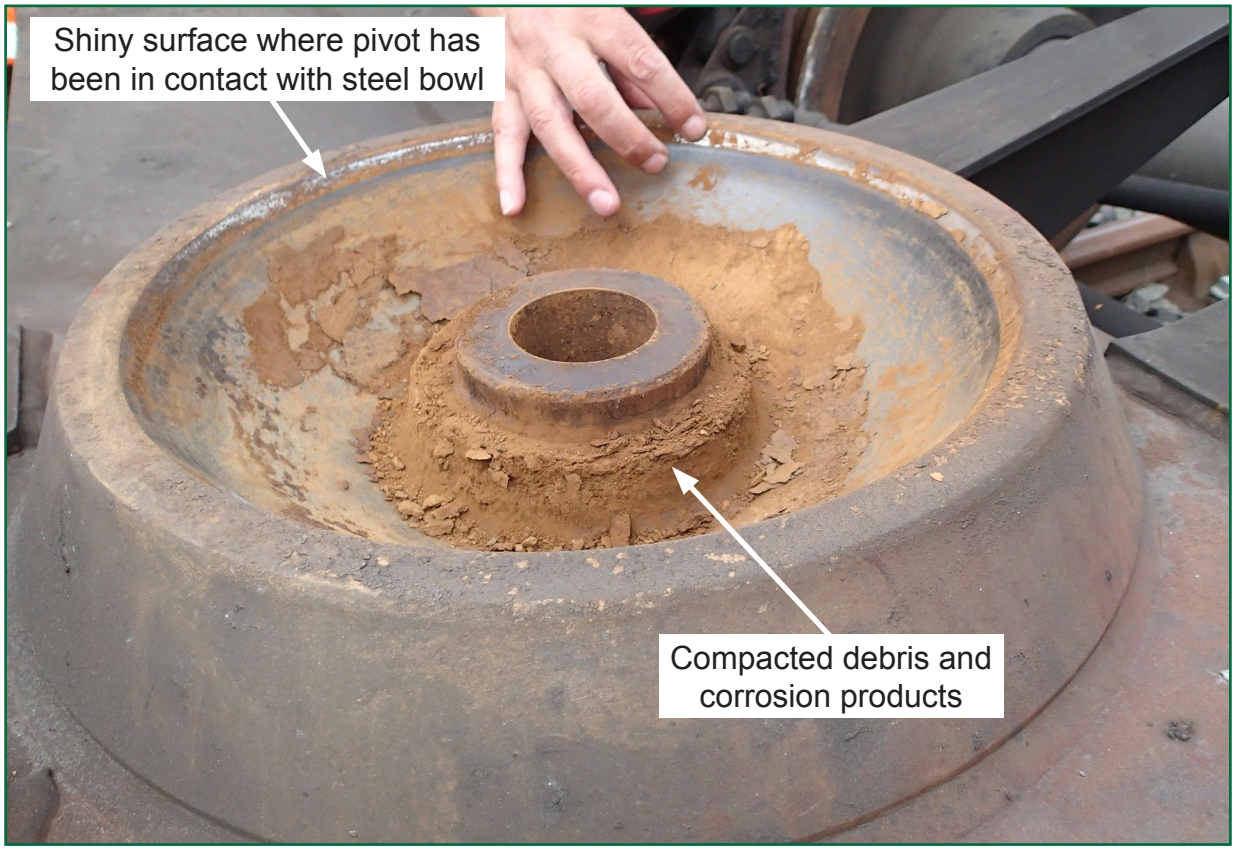

Figure 12: Worn centre pivot liner on the bogie which derailed

71 The AAE TSO did not specify the type of liner to be fitted. AAE supplied liners to its maintenance contractors for fitting to its wagons, but in the case of revisions carried out in workshops, the contractor responsible for the revision supplied the liners. AAE supplied the RAIB with a list of liners that it would allow revision contractors to use. This included thermoplastic liners made by a number of companies and also liners made from thermoset plastic material. The thermoplastic liners fitted to the incident wagon were included in this list.

72 VTG AG reported that evidence it had gathered from mainland Europe indicated that the centre pivot liners, which include those of the type fitted to the incident wagon, would remain within the wear limit for at least 400,000 km (250,000 miles). AAE's Megafret wagons running in the UK, on average, achieved this distance run in 3.1 years. Furthermore, another operator in the UK informed the RAIB that it expected thermoset plastic liners, which are more wear resistant than the thermoplastic type fitted to the incident wagon, to last for at least four years (paragraph 89). Following another derailment (paragraph 124), DWS conducted a check of the fleet of Megafret wagons that it maintained for AAE and found that a significant number of these also had liners worn beyond the maintenance limit (paragraph 127).

73 The worn centre pivot liner reduced the clearance between the steel sidebearer castings and their steel end stops (figure 9). The AAE TSO specified that this clearance should be 12 mm, with a tolerance of -1/+ 2 mm (ie an acceptable gap between 11 and 14 mm). Other maintainers' maintenance instructions for the Y33 bogie specified the same clearance but with a tolerance of -0/+2 mm. When measured during the wagon examination, this gap was found to be zero on one side of the bogie which derailed and 4 mm on the other side (figure 13).

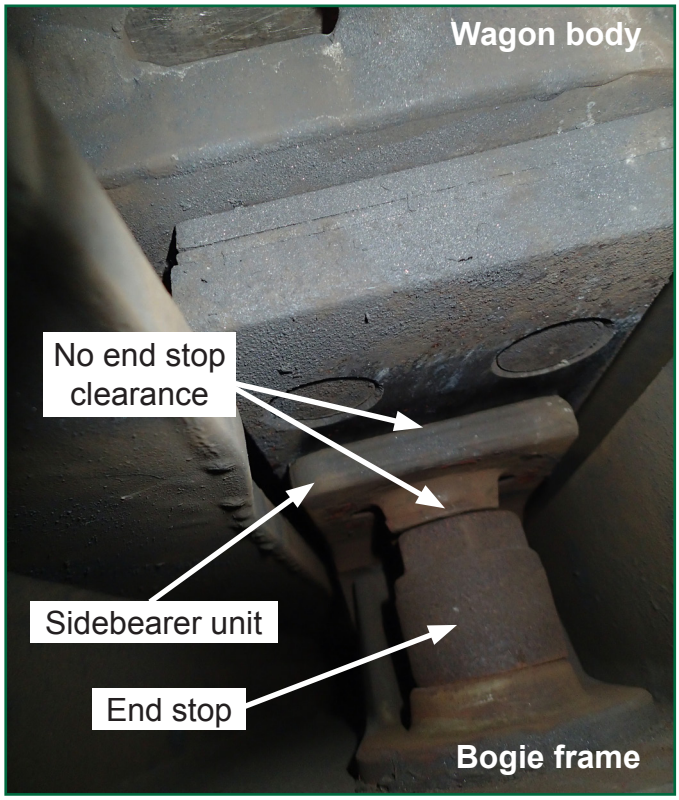

Figure 13: Sidebearer on the left side of the bogie which derailed, showing no clearance between sidebearer casting and end stop (arrowed)

74 The reduction in end stop clearance had caused the sidebearer castings to come into contact with the end stops much more frequently than they were designed for. This caused wear of the castings and damage to the castings and the saddles in which they slide (figure 14).

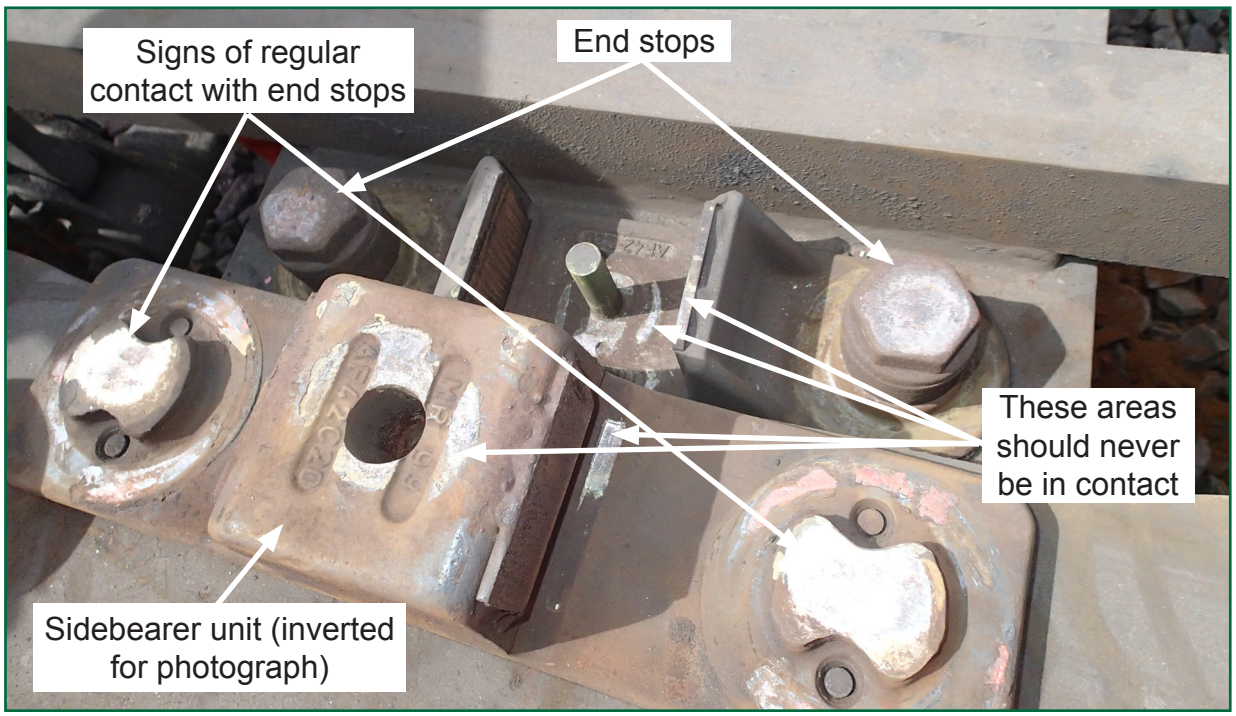

Figure 14: Sidebearer on the left side of the bogie which derailed, showing where contact has occurred with the saddle (arrowed)

75 The reduced sidebearer end stop clearance meant that when the wagon body was tilted, as it would be during the wheel unloading test or during passage over a track twist, the sidebearer came into contact with the end stops. Since the end stops are rigid, this meant that as the twist increased, the load was transferred from the centre pivot, where the majority of the vertical load is designed to be taken, onto the sidebearer. The sidebearer is positioned outside the plane of the wheel treads, so this repositioning of the load caused all the weight of the body to be shifted to one rail, leading to the high level of unloading measured on the other rail in the tests. Once the centre pivot has been lifted out of contact, the load remaining on the wheels on the opposite side to the sidebearer that is in end stop contact is only that due to the self-weight of the bogie and wheelsets. This phenomenon would explain why the load on those wheels in the tests reduced to the same value, regardless of the wagon load (paragraph 64).

76 The combination of increased resistance to rotation of the bogie as it negotiated the reverse curve through the crossover, and the reduced load on the left-side wheels as the wagon negotiated the track twist, caused the leading left-side wheels of the wagon to derail by flange climbing[2].

Identification of worn centre pivot liners

77 **The worn centre pivot liners had not been identified and replaced during maintenance.**

78 This arose due to a combination of the following:

a. AAE's maintenance specification did not mandate inspection or replacement of the centre pivot liners any more frequently than every 6 years when the likely lifespan of the type of liner fitted was considerably less (paragraph 79).

b. Centre pivot liners were not examined when the wagon underwent VIBT or wheelset changes (paragraphs 91 and 92).

Each of these factors is now considered in turn.

[2] A situation where the flange of a rail wheel rides up the inside (gauge) face of the rail head. If the wheel flange reaches the top of the rail head, the wheelset is no longer laterally constrained and this usually leads to derailment.

Inspection of the centre pivot liners

79 AAE specified the maintenance requirements of its Megafret wagons in its TSO document. The version of this document that was current at the time of overhaul of the wagon in 2012, and at the time of the derailment, was version 02. This was arranged into modules, with module 1 'Maintenance Planning' specifying details of various maintenance events and the intervals between them. Planned maintenance was split into two types, defined as revision and servicing. Revision events were divided into three levels, with reducing levels of work content in each:

- G4.0 – revision to restore full work capacity
- G4.2 – simplified revision
- G4.3 – intermediate revision

The intervals between revisions were specified in the TSO in a series of tables according to the annual distance that the wagon runs. The distance run was divided into bands, with the minimum being an annual distance run of less than 50,000 km, for which revisions were specified on a 6 year cycle, and the highest an annual distance run of 125,000 km or over, for which the interval between revisions was 3 years. However, the pattern of revision types in each table was not the same. The revision pattern for a vehicle that was planned to operate over 125,000 km/year (paragraph 84) is shown in figure 15.

New build	G4.3	G4.2	G4.3	G4.0	G4.3	G4.2	G4.3	G4.0
Time	3	3	3	3	3	3	3	3
Years	3	6	9	12	15	18	21	24

Table 2: IP02 - 3 REV: Distance run >125 000 km/year or wagon with SS brakes

Figure 15: Pattern of revisions for wagon scheduled to run over 125,000 km/yr (extracted from AAE TSO module 1, table 2)

80 Module 5 of the TSO, 'Revision planning', contained a series of tables giving details of the work required at each revision, according to the type of wagon. For container wagons, the bogie centre pivot liner was specified for replacement at revisions G4.0 and G4.2 only.

81 Module 22 covered the wagon body and stated that the bogies should be removed at each revision G4.0 or after 12 years, whichever was the sooner.

82 Bogies were dealt with in module 21 which detailed three levels of maintenance called IS D1, IS D2 and IS D3. These were matched to the wagon revision levels: IS D1 for revision G4.3, IS D2 for revision G4.2 and IS D3 for revision G4.0. It stated that during bogie revision IS D1 'the inspection of bogies is mainly carried out in the installed state'. The other two maintenance levels specified that the bogies be removed.

83 The TSO did not call for inspection of the centre pivot liners between revisions, and revision G4.3 did not call for the body to be lifted from the bogies. The centre pivot liners cannot be seen unless the vehicle body is lifted from its bogies.

84 DWS carried out maintenance on 108 Megafret wagons operating in the UK. AAE did not ask DWS to monitor the distance run by this fleet of wagons and neither AAE nor DWS did so. The hire contract between Freightliner and AAE was on the basis of an annual distance run of 80,000 km, for which the TSO specified a revision which would renew the centre pivot every 6 years. The RAIB examined the information recorded in TOPS for these wagons, analysing the dates of the last maintenance (revision) and the distance run since then. The average for the fleet was found to be approximately 80,000 miles per year (128,000 km), placing them in the highest distance run band in table 2 of AAE TSO module 1. Although this table specified a revision every 3 years, every alternate revision was a G4.3 revision, which did not entail lifting the wagon off its bogies. The centre pivot liners of this fleet of wagons were therefore only planned for replacement every 6 years, with no intermediate inspection.

85 The maintenance instructions for AAE Megafret wagons running in the UK were supplemented by the instructions for VIBT. These were contained in a document called 'Maint 0292' drawn up for AAE by Marcroft Ltd in May 2002. This stated that VIBTs should be carried out annually on the basis that each vehicle covered 70,000 miles (112,000 km) per year. The instructions contained in Maint 0292 stated 'examine without lifting bogie top centre castings' and 'if vehicle is lifted for any reason and bogie is removed … examine bearing surface'. The maintenance instructions for the bogie similarly stated 'when stripped for any reason, all components should be examined against relevant limits'. There was no requirement in the document for the centre pivot liner to be inspected unless the bogie was removed for another reason.

86 In summary, the TSO stated that centre pivot liners should be replaced every 6 years but did not call for any interim inspection; a position that was only tenable if the life of the centre pivot liner for the duty had been demonstrated to be in excess of 6 years. However, as paragraph 72 explains, the likely life was much less.

87 The RAIB has not seen any evidence that AAE undertook any work to understand the expected life of a centre pivot liner, nor specified any specific centre pivot liner material. The life of a liner is in part dependent on the material it is made from, and a number of alternative materials with different wear rates are on the market.

88 AAE stated that, on the basis of its experience in Europe, it assumed that wagon bodies would be lifted off bogies on an annual basis (though this is not called for in the TSO), therefore allowing for an annual inspection of the centre pivot liner.

89 The RAIB looked at the maintenance instructions used by four other operators of wagons with Y-series bogies in the UK which have the same centre pivot arrangement. Three of these mandated an annual inspection of the centre pivot liner, with replacement if it was worn such that there was less than 1.5 mm projecting above the steel rim. However, one operator had carried out a study of wear rates and concluded that, if a certain brand of thermoset plastic liner was used, the liners need not be inspected but must be replaced every 4 years.

Examination of centre pivot liners

90 The most recent revision of the wagon was that carried out by Lormafer in March 2012. This was a revision G4.0, the most comprehensive of the three levels of revision. Revision G4.0 calls for the replacement of the centre pivot liners and Lormafer stated that it did this, fitting thermoplastic liners manufactured by Polytron GmBH. These liners were included on the list of liners which AAE stated were acceptable (paragraph 71).

91 Between April 2012 and August 2014 wagon 37 80 4909 147-3 was on hire to DRS and it carried out the maintenance on the wagon during this time. DRS followed the maintenance instructions in the AAE TSO and also applied the instructions in Maint 0292. DRS carried out VIBTs on the wagon in September 2012, July 2013 and July 2014. The check sheets for these VIBTs indicated that the wagon body was not lifted from its bogies on any of these occasions.

92 After the wagon transferred from DRS to Freightliner, the organisation undertaking the maintenance changed from DRS to DWS. DWS carried out a wheelset change in November 2014 following the discovery of wheel flats on all wheels of the wagon. DWS stated that it did this wheelset change by lifting the wagon with the bogies still attached (the AAE TSO did not specify how the wheelsets were to be changed). DWS carried out a VIBT of the wagon in December 2014 and this did not include lifting it from its bogies.

93 There is no evidence that the wagon was lifted from its bogies at any time between the revision in March 2012 and the derailment, during which time the thermoplastic liners fitted to it were able to wear out completely and not be detected. As stated in paragraphs 79 to 89 above, the maintenance instructions did not call for the wagon to be lifted.

Underlying factor

94 **AAE's processes for management of maintenance were not robust and allowed the centre pivot liners of its Megafret wagons in the UK to deteriorate to an unsafe state.**

95 The AAE maintenance instructions in the TSO document did not mandate inspection of the centre pivot liners (paragraphs 79 to 83). Although these instructions were supplemented, in the UK, by the VIBT instructions (paragraph 85), these too did not mandate inspection of the liner. AAE could provide the RAIB with no evidence that it had assessed the service life of the liners in terms of distance run and neither AAE nor DWS were monitoring the distance that the wagons actually ran (paragraph 84).

96 The ECM regulation (paragraph 45) requires the ECM to comply with a number of requirements and assessment criteria. These are listed in an annex to the regulation. The regulation allows many of the tasks associated with maintenance to be outsourced, but the overall responsibility for maintenance must remain with the ECM.

97 Where maintenance execution (ie the physical maintenance work done on the vehicle) is outsourced by the ECM, article 8 of the regulation provides for the body carrying out the maintenance to voluntarily obtain certification from the ECM certification body (the ORR, in the case of the UK). DWS held such a certificate, issued by the ORR on 21 November 2012.

98 The ECM regulation requires the outsourced maintenance contractors to have an internal auditing system. The European Rail Agency publishes guidance on the ECM process which states that the ECM must apply the EU Common Safety Method (CSM) on monitoring. The CSM on monitoring is defined in EU Regulation 1078/2012. This states that the ECM is responsible for conducting monitoring and must define a strategy for maintenance such that it '… shall identify as early as possible instances of non-compliance in the application of the management system that might result in accidents, incidents, near-misses or other dangerous occurrences'.

99 AAE carried out an audit of DWS on 8 May 2013. The audit report noted that there was no process of document control for updates to the TSO and that the maintenance system handbook was not available to the staff. The report approved DWS and noted that there were requirements to be fulfilled, but did not give a timescale for this.

100 AAE was unaware that none of the UK maintainers were lifting the wagons to examine the centre pivot liners. Since AAE had not defined a maintenance strategy that required inspection of the centre pivot liners at a frequency related to the wear rate of the fitted liner material (paragraph 95), any audit which only checked that the maintenance contractor was following the TSO would be unlikely to identify the lack of inspection of the liners.

Factors relating to the track

101 **The track contained a twist fault of such a magnitude that, once detected, Network Rail's standard stated that it should be repaired within 36 hours.**

102 Track twist is the variation in cross-level over a given distance, where cross-level is a measure of the height that one rail of a track is above the other. Ideally, the cross-level is measured when the track is under load from a train, so the dynamic track twist can be determined. Network Rail's standards and processes for track inspection and maintenance call for track twist to be measured over a base distance of 3 metres and all limits for track twist are based on this.

103 The RAIB surveyed the track after the derailment using an Amber trolley (paragraph 55). The data from this survey was supplemented by void measurements made using a class 66 locomotive. It was not possible to obtain a full set of void measurements as damage to the track caused by the derailment prevented the locomotive from travelling completely through the crossover. The survey showed that the track contained a static twist of 1 in 121 over 3 metres. The location of the twist was at the point of derailment (figure 16). The sense of the twist was such that the leading left-side wheel of a vehicle would see a reduction in load. Network Rail's standard NR/L2/TRK/001mod 'Track geometry - Inspections and minimum actions' states that a twist between 1 in 91 and 1 in 125 requires remedial action within 36 hours of its discovery.

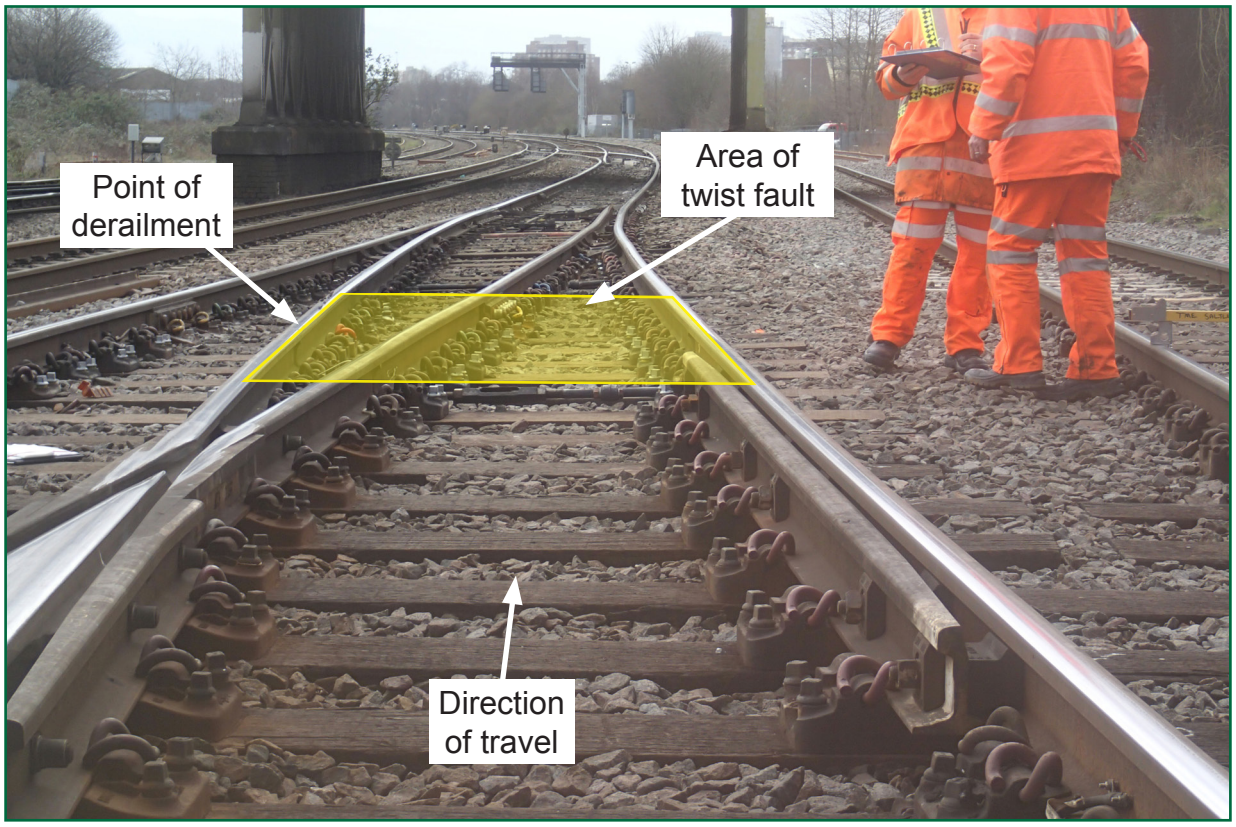

Figure 16: Location of track twist at the point of derailment

104 This causal factor arose due to a combination of the following:

a. The track through crossover 802 contained a designed twist due to the cant difference between the slow and fast lines (paragraph 105).

b. Some of the two-levelled baseplates within the crossover were not in the correct places (paragraph 109).

c. The twist fault in the track had not been identified by maintenance staff (paragraph 119).

Each of these factors is now considered in turn.

The design of the track

105 **The track through crossover 802 contained a designed twist due to the cant difference between the slow and fast lines.**

106 Crossover 802 joined the slow line, with zero cant, to the fast line, with 50 mm cant, and therefore it was necessary for it to accommodate the difference through the crossover. This was done by use of two-levelled baseplates (paragraph 57). The crossover was installed in December 1998 and was manufactured by Edgar Allen Engineering. Edgar Allen Engineering provided a copy of the drawing of the crossover to the RAIB. The drawing of the crossover showed that the two-levelled baseplates varied in additional thickness from 1 mm to 37 mm.

107 The textbook of the Permanent Way Institution 'British Railway Track, volume 5, switch and crossing maintenance' states that where two-levelled baseplates are fitted, the maintenance staff should have access to the design drawings. The provision of an as-built drawing of a renewed asset, such as crossover 802, is part of the handover package that Network Rail requires its contractors to provide. Network Rail stated that the track technical team at Saltley kept a set of record drawings of some of their S&C, but it could not locate a copy of the drawing for this S&C in the records of the route asset manager (track) or the Saltley maintenance delivery unit.

108 The RAIB analysed the twist in the crossover route through crossover 802 assuming that the cant was exactly 50 mm on the fast line and zero on the goods line and that the two-levelled baseplates were all in the correct places. This showed that the maximum design twist was 5 mm over 3 metres (1 in 600).

Installation of the two-levelled baseplates

109 **The two-levelled baseplates beneath the rails of the crossover were not installed in accordance with the design drawing.**

110 As the thickness of two-levelled baseplates varies, it is important that they are installed in the correct location shown on the design drawing. If a two-levelled baseplate is put in the wrong place, the rail will either be unsupported, if the baseplate is thinner than designed for that location, or will be raised too high, possibly leading to a twist fault. Some of the baseplates on point 802B were in the wrong locations.

111 This had occurred because the local maintenance staff were not fully aware of the significance of the two-levelling (paragraph 112). It is also possible that the guidance on replacement of timber bearers given in Network Rail's track work instructions was not followed when replacing bearers in 802B points (paragraph 116).

Awareness of the significance of two-levelling

112 Witness evidence indicated that not all of the local maintenance staff were aware that the crossover was two-levelled and none of the staff knew the correct locations of the two-levelled baseplates as they did not have access to a drawing showing the correct positions.

113 Network Rail provided the RAIB with details of its S&C training courses for maintenance staff. The objectives of the courses did not specifically mention two-levelling and although it was included in the briefing for the trainer, witness evidence suggested that it was not widely known about. Two-levelling was not covered in the track work instructions (paragraph 116).

114 When examined after the derailment, the RAIB found that of 30 baseplates in the area of the derailment, 21 were not of the type shown on the drawing for that position.

115 After it had obtained a copy of the drawing of the crossover, Network Rail moved the baseplates to the positions shown on the drawing. Network Rail reported that the wrongly-positioned baseplates were not confined to the five bearers that had been replaced during maintenance work on 7/8 March (paragraph 118).

Network Rail's track maintenance guidance on bearer replacement

116 Network Rail has guidance for track maintenance staff which it published in 'Track Work Instruction' (TWI) sheets. These stated that the information is for guidance only, but represents best practice. Track Work Instruction 2S013 'How to change a crossing timber' version 1, dated March 2005, described the method for replacing a timber bearer. The same method was also described in another Network Rail document, NR/L3/TRK/002/G06 'S&C Change Timber Bearer', version 2.0 dated August 2007.

117 The method described in both documents consists of unscrewing the baseplates from the bearer to be replaced, leaving them attached to the rails. The old bearer is then slid out from beneath the baseplates and the new one inserted. The baseplates are then screwed back down to the new bearer, using a track gauge to ensure the gauge is correct.

118 Network Rail replaced five of the timber bearers in 802B points during an overnight possession on 7/8 March 2015. Witness evidence stated that the method used involved removing the baseplates from both the bearers and the rails. This was not the same as the method described in the guidance documents, and introduced the possibility of them being returned to incorrect locations.

Track twist in 802B points

119 **The twist that was present in 802B points at the time of the derailment had not been identified by Network Rail maintenance staff.**

120 Network Rail's standard NR/L2/TRK/001mod13 'Confirming track is safe for selected line speed after work' requires that a 'competent authorised person shall undertake inspections on completion of engineering work to… confirm the track is safe for existing line speed...'. Network Rail confirmed to the RAIB that the supervisor of the work on 7/8 March 2015 had been assessed through the *assessment in the line* process as meeting this requirement.

121 On completion of the retimbering work, the supervisor did not measure the cant or calculate the track twist because he considered that the retimbering work would not have affected the cant. The method given in the track work guidance documents (paragraph 116) included measuring cant and checking twist.

122 The next occasion when the twist would have been measured was during the 6-monthly monitoring of the crossover using the Amber trolley. This was not due until April 2015.

Observations

123 **The actions taken by AAE following discovery of a problem with the centre pivot liners on its UK Megafret wagons did not fully address the risk posed by wagons with worn liners remaining in service.**

124 On 11 April 2015, three weeks after the Washwood Heath derailment, a Megafret wagon owned by AAE and hired to Freightliner derailed while being shunted into a siding at Doncaster. This derailment occurred by flange climbing as the wagon was traversing a curve. The team sent to rerail the wagon found difficulty in rotating the bogie during the rerailing process and the wagon was subsequently lifted from its bogies for inspection. The centre pivot liners were found to be worn well beyond their maintenance limit such that metal to metal contact was occurring between the body-mounted pivot and the bogie-mounted pivot bowl.

125 AAE asked DWS to carry out checks of the centre pivot liners of the wagons it maintained. As a special check, AAE asked that the wagon body be lifted and the liners be checked whenever a planned preventative maintenance, VIBT or wheelset change was done. Wagons were checked during normal scheduled maintenance activities and they were not prioritised according to time since last revision. AAE did not make the RAIB aware that this fleet check was taking place and did not immediately ask the maintainers of its other Megafret wagons in the UK to undertake this check, neither did it issue a *National Incident Report* (NIR). Duty holders can issue an NIR to advise the rest of the UK railway industry of a safety-related problem they have found. AAE advised DRS, who operated and maintained a fleet of 100 AAE Megafret wagons, to inspect the liners in a letter of 21 July 2015, three months after asking DWS to check the wagons it maintained, but AAE did not advise other maintainers.

126 When the RAIB became aware, on 3 August 2015, of the fleet check being undertaken by DWS, it obtained a copy of the spreadsheet tracking the results of these checks and analysed the data. The information included photographs of the wagon centre pivots taken as the wagons were lifted, but did not record the type of liner that was fitted.

127 At the time the results were analysed, 75 of the fleet of 108 wagons maintained by DWS had been checked. Of these 75, 29 were found to have centre pivot liners worn beyond the maintenance limit and the photographs showed that 19 wagons had one or more centre pivots where metal to metal contact was occurring. The RAIB issued urgent safety advice to the industry on 9 September 2015 (appendix D) warning of the problem of worn centre pivot liners and suggesting that vehicle operators ensure that the maintenance plan includes checking the wear of these items.

128 The results of the checks of centre pivot liners undertaken by DRS on the AAE Megafret wagons that it operates were provided to the RAIB by VTG AG on 19 November 2015. They indicated that, to date, nine out of a fleet of 100 wagons had been checked and none were found to have liners worn beyond the maintenance limit.

Previous occurrences of a similar character

At the same location

129 A container wagon of type FAA derailed on the same points while making the same move through them on 8 September 2006. The RAIB investigated this derailment ('The derailment of a freight train at Washwood Heath', RAIB report 39/2007) and found that the derailment was caused by the design and condition of the sidebearers of the wagon producing high levels of bogie rotational resistance and wheel unloading. There was also a track twist of 1 in 108 at the point of derailment.

130 A container wagon of type FAA derailed on these points on 23 February 2004. The leading bogie derailed by flange climbing. The RSSB[3] safety management information system (SMIS) record for this incident stated that the track contained a twist of 1:101 and the wagon involved '…was a type with a known intolerance of reverse curvature'.

131 A freight train derailed on this crossover while departing from Washwood Heath sidings on 2 February 2000. The SMIS record indicated that the derailment was due to buffer locking between two wagons.

Involving a similar mechanism of derailment

132 A bogie tank wagon fitted with Y-series bogies and loaded with propane gas derailed at Orthez in France on 24 November 2009. The accident was investigated by the French national investigation body, the Bureau d'Enquêtes sur les Accidents de Transport Terrestre (BEA-TT) (report BEATT-2009-011).

133 The BEA-TT report stated that the derailment was caused by flange climbing as the wagon traversed a reverse curve. The investigation found that the bogie rotation was restricted when the sidebearer load reached 5 tonnes and that the sidebearers appeared to have worn out very quickly. The wagon was fitted with sidebearers which did not have springs in them, so the relative distribution of load between the centre pivot and sidebearers was indeterminate. The sidebearers were completely worn out but the centre pivot appeared to be intact in the photographs (the report did not mention the extent of centre pivot wear). BEA-TT suggested that this was probably due to the sidebearers being excessively loaded in some circumstances. Maintenance records showed that the sidebearers had been replaced when the wagon underwent revision at Lormafer's works in Creutzwald on 17 October 2008.

[3] A not-for-profit company owned and funded by major stakeholders in the railway industry, and which provides support and facilitation for a wide range of cross-industry actvities. The company is registered as 'Rail Safety and Standards Board' but trades as 'RSSB'.

Summary of conclusions

Immediate cause

134 Wagon 37 80 4909 147-3 was unable to negotiate track with the amount of curvature and twist that was present in 802B points at Washwood Heath West Junction (**paragraph 58**).

Causal factors

135 The causal factors were:

a. The leading bogie of the trailing platform of wagon 37 80 4909 147-3 was unable to rotate freely, and the amount by which the vertical load on the wheels reduced when the wagon encountered a track twist was excessive (**paragraph 60**). This causal factor arose due to a combination of the following:

i. The bogie centre pivot liners of the wagon were worn well beyond their maintenance limits (**paragraph 67 and Recommendation 1**).

ii. The worn centre pivot liners had not been identified and replaced during maintenance (**paragraph 77 and Recommendation 1**).

b. The track contained a twist fault that, once detected, Network Rail's standard stated should be repaired within 36 hours (**paragraph 101**). This causal factor arose due to a combination of the following:

i. The track through crossover 802 contained a designed twist due to the cant difference between the slow and fast lines (**paragraph 105**).

ii. The two-levelled baseplates beneath the rails of the crossover were not installed in accordance with the design drawing (**paragraph 109 and Recommendation 3**).

iii. The twist that was present in 802B points at the time of the derailment had not been identified by Network Rail maintenance staff (**paragraph 119 and Recommendation 3**).

Underlying factor

136 AAE's processes for management of maintenance were not robust and allowed the centre pivot liners of its Megafret wagons in the UK to deteriorate to an unsafe state (**paragraphs 94 and 144**).

Observation

137 The actions taken by AAE following discovery of a problem with the centre pivot liners on its UK Megafret wagons did not address the risk posed by wagons with worn liners remaining in service (**paragraph 123 and Recommendation 2**).

Previous recommendations relevant to this investigation

138 The following recommendations, which were made by BEA-TT as a result of its investigation, have relevance to this investigation.

Accident at Orthez, France, 28 November 2009, BEA-TT report 2009-11, Recommendations R2 and R4

139 The RAIB considers that the following recommendations were relevant to this derailment, although they were not directly applicable to the Megafret wagon. They were not advised to the UK national safety authority (the ORR) and were not applied in the UK.

140 The recommendations read as follows (RAIB translation):

Recommendation R2 (to VTG France and AFWP, the private wagon owners association in France)

To arrange for the ECMs to check the appropriateness of maintenance rules relative to the interface between body and bogie of long wheelbase tank wagons and reinforce the requirements relative to the traceability of maintenance work on these components.

141 The French national safety authority, EPSF, reported in its 2014 annual report that VTG France had implemented this recommendation and that implementation by AFWP was ongoing.

142 Recommendation R4 reads as follows (RAIB translation):

Consider whether to circulate to all national safety authorities, recommendations R2 and R3[4] with a view to implementation in their member states.

143 EPSF reported in its 2013 annual report that it considered that recommendation R2 did not need to be circulated.

[4] Recommendation R3 was not relevant to the Washwood Heath West derailment.

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

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

144 ECM responsibility for the AAE wagons has been transferred from AAE in Switzerland to VTG AG in Hamburg. VTG AG has reported to the RAIB that it plans to change the maintenance scheme from the AAE TSO to the system used for its other wagons, which was issued by the Vereinigung der Privatgüterwagen-Interessenten (an association of German private wagon owners). The RAIB has not made a recommendation related to the previous system, because it will no longer be relevant to the UK fleet of Megafret wagons. Neither has it investigated the Vereinigung der Privatgüterwagen-Interessenten system because it did not apply to the accident wagon at the time of the derailment.

Other reported actions

145 AAE issued version 3.0 of TSO module 22 'Wagon body and vehicle superstructure' on 1 June 2015. The changes from version 2.0 included allowing the vehicle to be lifted one end at a time for 'mobile maintenance' (ie maintenance carried out away from a workshop) and the addition of a highlighted note which stated 'Important: Before mounting the bogies the centre pivot bearings... must be inspected and replaced if necessary.' The revised module did not, however, mandate removal of the bogies for inspection of the centre pivot liners.

146 AAE asked DWS to carry out a special inspection of the centre pivot liners of the Megafret wagons it maintains for AAE following the derailment at Doncaster (paragraph 124). AAE also wrote to DRS on 21 July 2015 to ask that it checks the wear of the centre pivot liners during maintenance.

147 Network Rail reported to the RAIB that it has moved the baseplates in point 802B to their correct places, as shown on the drawing (paragraph 115).

Learning points

148 The RAIB has identified the following key Learning points[5]:

1 Centre pivot liners made of differing materials have different wear rates. This illustrates the importance of ECMs ensuring that their maintenance plans for wearing components mandate an inspection interval which is compatible with the rate of wear of the components (paragraphs 86 to 89).

2 The derailment may have been avoided had the track twist been measured following the maintenance work on 7/8 March 2015. This highlights the importance of staff who are responsible for certifying that track is safe for traffic after maintenance work confirming, by measurement, that the track geometry has not been adversely affected by the work (paragraphs 119 to 122).

3 The mixing up of the two-levelled baseplates during maintenance over the years since the S&C was installed highlights the importance of Network Rail track maintenance staff being made aware of, and referring to, the relevant guidance documents when conducting track maintenance (paragraphs 109 to 115).

4 There have been four derailments in the last 15 years on this crossover. This highlights the importance of paying particular attention to the maintenance of the alignment at locations where the design of track is close to maintenance limits (as here) (paragraphs 129 to 131). The RAIB also made this point following the derailment of a freight train at King Edward Bridge, Newcastle, on 10 May 2007 (RAIB report 02/2008) and a recommendation was made to include guidance in the track standard (Network Rail reported to the ORR that it had implemented this recommendation in 2009).

[5] '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.

Recommendations

149 The following recommendations are made[6]:

1 *The intent of this recommendation is to alter the maintenance instructions for former AAE Megafret wagons running in the UK to clarify when the centre pivot liners should be checked, to reduce the likelihood of these items becoming worn to the extent that the safety of the wagon is compromised*.

VTG AG should update the maintenance instructions for its Megafret wagons operating in the UK to clarify the method to be used to check for wear of the centre pivot liner, and clearly specify the periodicity for these checks (paragraph 135a). In defining this periodicity VTG AG should take into account the wear characteristics of centre pivot liners that it permits to be installed and the distance travelled by the wagons.

This recommendation may also be applicable to VTG AG's Megafret wagons operating in other countries.

2 *The intent of this recommendation is to improve the management of risk posed by wagons operating in service after a systemic fault has been identified*.

VTG AG should review, and update as necessary, the processes that will apply if a systemic defect is identified with a former AAE wagon (paragraph 137). The processes should ensure that the risk of continued fleet operation is understood and any necessary mitigation measures put in place to reduce it to an acceptable level. It should also provide for adequate communication of safety related information to all other owners, operators and maintainers.

continued

[6] 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 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.

3 *The intent of this recommendation is to improve the standard of maintenance of two-levelled switches and crossings (S&C) by Network Rail maintenance staff by making them more aware of the presence and significance of two-levelling and by providing them with the drawing(s) showing correct design configurations*.

Network Rail should review, and update as necessary, its S&C training course(s) to confirm that there is adequate coverage of two-levelling of S&C. It should ensure that S&C maintenance staff who undertake maintenance of two-levelled S&C are competent to identify and maintain two-levelled S&C. In addition, Network Rail should introduce a system to make the necessary information available to enable correct maintenance of two-levelled S&C (paragraph 135b). The knowledge, skills and experience required to ensure that two-levelled S&C can be maintained competently should be made explicit within Network Rail's competency management system. The competency requirements should cover all staff likely to be involved in planning, executing and supervising the maintenance of two-levelled S&C.

Appendices

Appendix A - Glossary of abbreviations and acronyms

AAE	Ahaus Alstätter Eisenbahn
BEA-TT	Bureau d'Enquêtes sur les Accidents de Transport Terrestre
DRS	Direct Rail Services
DWS	Davis Wagon Services
ECM	Entity in Charge of Maintenance
EWS	English Welsh and Scottish railway (now DB Schenker)
FKA	TOPS code for a UK-registered Megafret wagon
IKA	TOPS code for an international-registered Megafret wagon
NIR	National Incident Report
ORR	Office of Rail and Road
RIV	Regolamento Internazionale Veicoli
S&C	Switches and crossings
SMIS	Safety Management Information System
SNCF	Société nationale de chemins de fer français
TOPS	Total Operations Processing System – a computer system used by the UK railways for traffic management
TSO	Technical specification for overhaul
UIC	International Union of Railways (Union Internationale des Chemins de fer)
VIBT	Vehicle Inspection and Brake Test
VTG AG	Vereinigte Tanklager und Transportmittel GmbH

Appendix B - Glossary of terms

Assessment in the line	The Network Rail process whereby the competence of its staff is assessed by line managers.
Bearer	A sleeper which is larger than normal to support the rails within switches & crossings.
Cant	The elevation of the outer rail in a curve above the level of the inner rail.
Closure (rail)	A rail within a set of points (turnout) which joins a switch to the crossing.
Crossing	The component within the track which allows two rails to cross each other.
Down (direction)	Derby to Birmingham.
Intermodal boxes	Freight containers which are designed for transfer between different modes of transport. The term includes freight containers that are designed only for rail and road use (swap bodies) as well as shipping containers designed for international traffic.
National Incident Report	A database managed on behalf of the rail industry by RSSB for the rapid sharing of safety-related information.
Plain line (track)	Track which just consists of the two rails and their supports.
Platform	The part of a container carrying vehicle which actually bears the container(s). Each platform is supported by its own wheels or bogies. Two or more platforms can be semi-permanently coupled together to form a single wagon.
Reverse curve	Curve which changes from left to right hand, or vice versa. Also known as an ‘S’ curve.
Revision	Term used in mainland Europe for an overhaul of a wagon.
Sidebearers	Supports located each side of a wagon bogie to limit the roll of the wagon body.
Switch	A pair of specially shaped rails which are bolted together and allow one rail to be moved to divert a train from one line to another.
Switches and crossings	Track designed to provide a facility for trains to move from one line to another, commonly known as points.
TOPS	Total Operations Processing System – a computer system used by the UK railways for traffic management.
Track circuit	An electrical circuit through the rails designed to detect whether a train is present.

Turnout	An assembly of two switches and one crossing which provides the means for a train to move to a different line, commonly known as a point or set of points.
Twist (of track)	The difference between cant at two places a defined distance apart along the track. Excessive twist can lead to a wheel lifting off the rail.
Two-levelling	The system of raising the rails of one route in a turnout above the other to provide a different amount of cant.
Up (direction)	Birmingham to Derby.
Wheel flat	A straight section on the perimeter of a wheel, usually caused by wear of the metal due to the wheel sliding on the rail during braking.

Appendix C - Investigation details

The RAIB used the following sources of evidence in this investigation:

- information provided by witnesses;
- information taken from the train's on-train data recorder;
- site photographs and measurements;
- track survey information;
- weather reports and observations at Birmingham Airport;
- wheel unloading test results for the wagon in loaded, tare and partly loaded conditions;
- examination of the wagon during lifting from its bogies;
- observation of maintenance on a similar wagon;
- records of maintenance of the wagon;
- maintenance instructions for this wagon and for other similar wagons;
- records of examination of centre pivot liners of AAE Megafret wagons in the UK;
- vehicle approval records for this wagon and for similar wagon designs;
- vehicle distance run records from TOPS;
- track recording data;
- a review of previous RAIB, and other, investigations relevant to this accident;
- Network Rail and other standards

Appendix D - Urgent Safety Advice

The following urgent safety advice was issued by the RAIB on 9 September 2015.

URGENT SAFETY ADVICE

1. INCIDENT DESCRIPTION			
LEAD / INSPECTOR		CONTACT TEL. NO.	
INCIDENT REPORT NO	**0776**	DATE OF INCIDENT	23 March 2015
INCIDENT NAME	Derailment at Washwood Heath West		
TYPE OF INCIDENT	Freight train derailment		
INCIDENT DESCRIPTION	At 08:03 hrs on 23 March 2015, the failure of signalling equipment in the vicinity of Washwood Heath West Junction, Birmingham, following the passage of train 4O14, alerted the Network Rail signaller to a possible problem with that train. It was subsequently discovered that the train had derailed and then re-railed when crossing from the Up Derby Slow line to the Down Derby Fast line. The train was brought to a stand at Landor Street Junction at 08:10 hrs and the driver was asked to examine the train. He found evidence that the 10th wagon on the train had run derailed. Train 4O14 was the 05:58 hrs Basford Hall (Crewe) to Southampton container service. It consisted of a Class 66 locomotive pulling a mix of 24 container wagons and had been travelling at 15 mph while negotiating a series of crossovers. The wagon that derailed was an IKA 'Megafret' wagon (8049091473), consisting of two flat wagons permanently coupled together. Examination of the track confirmed that the train had run derailed for a distance of 121 metres, before re-railing at a set of trailing points. The derailment caused significant damage to track and signalling equipment. No-one was injured.		
SUPPORTING REFERENCES	 Figure 1: The wagon involved.		

Figure 2: Centre pivot liner worn below level of steel rim, leading to contact between steel surfaces

Figure 3: Sidebearer showing signs of frequent contact with end stops

URGENT SAFETY ADVICE

2. URGENT SAFETY ADVICE	
USA DATE:	9 September 2015
TITLE:	The control of risks associated with worn centre pivot liners on freight vehicle bogies.
SYSTEM / EQUIPMENT:	Centre pivot liners on Y-series freight bogies, and other types of bogie with the same centre pivot arrangement.
SAFETY ISSUE DESCRIPTION:	The safe operation of bogie freight vehicles is dependent on: • The bogies being able to rotate freely so as to be able to negotiate curved track, especially reverse curves through crossovers between tracks; and • The sidebearers having sufficient clearance to their end stops to enable the wagon to cope with twisted track without the load on a wheel reducing to such an extent that it derails by flange climbing.
CIRCUMSTANCES:	The wagon involved in the derailment was tested for wheel unloading, in accordance with Railway Group Standard GM/RT2141, and the amount of wheel unloading significantly exceeded the permitted 60%. This would have increased the likelihood of derailing on track which was twisted. The track at the site contained a twist with a magnitude that, according to Network Rail's standard NR/L2/TRK/001, fell within the band for which the remedial action was 'Correct within 36 hours'. When lifted from its bogies to examine the wagon further, it was found that the plastic centre pivot liners had worn to such an extent that the steel centre pivots on the wagon body were in direct contact with the steel bowl attached to the bogie (figure 2). This would have led to high friction between the surfaces, compared to the intended level of friction between the steel pivot and the plastic liner. The increased friction reduces the ability of the bogies to rotate. The worn centre pivot liner also led to a reduction in the clearance between the side bearers and their end stops (figure 3). This increased the amount of unloading of vertical load on the wheels as the wagon traversed cant transitions and twisted track. The combination of reduced load on the wheels on one side, combined with the increased resistance of the bogies to rotate, led to the wagon derailing by flange climbing as it negotiated a reverse curve with a track twist.
CONSEQUENCES	Risk of wagons derailing on track which is curved or which contains a twist with a magnitude that does not require immediate closure of the line.
SAFETY ADVICE:	The life of centre pivot liners will be dependent on the material that they are made from. Where the maintenance plan for a vehicle has been devised on the basis of using a particular type of centre pivot liner with a known rate of wear, Entities in Charge of Maintenance (ECMs) should ensure that the specified liner, or one with the same (or better) rate of wear, is always fitted (regardless of whether the maintenance is done by their own staff or by contractors). The liner should not be substituted for one with different wear characteristics unless the ECM has previously revised the maintenance plan to take account of the new liner. Where the wear characteristics of a new liner are unknown, steps should be taken to understand them before installation. When it is decided to install a new liner with characteristics different to those specified, the adequacy of the existing maintenance regime should be assessed. In particular, the intervals between liner inspection and replacement should be set such that the regular maintenance activities ensure that the liner is replaced before it has worn to such an extent that it adversely affects the ability of the bogie to rotate or reduces the sidebearer clearance beyond its limit.

USA SIGN-OFF*			
INSPECTOR NAME:		**CI / DCI NAME:**	S French
INSPECTOR SIGNATURE:	ELECTRONIC COPY	**CI / DCI SIGNATURE:**	ELECTRONIC COPY
DATE:	9 September 2015	**DATE**	9 September 2015

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