Rail Accident Investigation Branch

Rail Accident Report

Derailment of a freight train at Shrewsbury station, 7 July 2012

Report 08/2013
July 2013

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

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Summary

On 7 July 2012, at around 14:13 hrs, the leading bogie of the 16th wagon of a freight train derailed all wheels to the left as it passed over a set of points at the north end of Shrewsbury station whilst travelling at 14 mph (22 km/h). The bogie ran derailed for 65 metres causing significant track damage in the process before the train was brought to a stop. There were no injuries as a result of the derailment but the wagon suffered damage.

The immediate cause of the derailment was that the points were unsafe to negotiate because of wear and damage. The degradation of the points since the last detailed inspection had not been prevented by the maintenance regime nor had it been identified by the inspection regime.

The inspection regime in place at Shrewsbury at the time of the derailment was inconsistent with the risk-based approach intended by Network Rail's standard aimed at preventing derailment on points. Shrewsbury maintenance delivery unit misinterpreted the intent of this standard, when it was modified in 2008, and ceased regular detailed inspections of the points (this misinterpretation may not have been limited to the Shrewsbury delivery unit). Instead, the inspection regime at Shrewsbury relied solely on a weekly visual inspection by a patroller and a 13-weekly visual inspection by a supervisor. Neither of these inspections triggered the need for a detailed inspection which could have revealed the degradation and the need for remedial actions.

The RAIB has made four recommendations and identified a learning point. The first recommendation is for Network Rail to ensure that the risk-based approach intended by the standard covering the risk of derailment on points is re-briefed to all delivery units including Shrewsbury. The second recommendation is for Network Rail to incorporate the findings from this investigation into its review of the standard covering the risk of derailment on points. This review started following the accident at Princes Street Gardens in Edinburgh in July 2011 and the publication of the RAIB report in August 2012. The third recommendation is for Network Rail to consider whether it needs to mandate the removal of grease and residue on points during the visual inspection by supervisors. The fourth recommendation is for Freightliner to ensure that it has arrangements in place to assess the risk of continued operation when it has identified deficiencies in its maintenance operations.

The learning point is about the importance of providing training and assessment modules when requiring specific competences in standards covering safety critical activities.

Introduction

Preface

1 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.

2 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.

3 The RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of all other investigations, including those carried out by the safety authority, police or railway industry.

Key definitions

4 The report contains technical terms (shown in *italics* the first time they appear in the report). These are explained in appendix A.

5 'Left' and 'right' are referred to in the context of facing the direction of travel.

The accident

6 At 14:13 hrs on Saturday 7 July 2012, the leading bogie of the 16th wagon on train number 6M61 derailed all wheels to the left as it passed over No. 75 *points* at the north end of Shrewsbury station (figure 1). The train was the 07:25 hrs Portbury Dock to Fiddlers Ferry freight service operated by Freightliner and it was travelling at 14 mph (22 km/h) at the time of the derailment. The derailed wagon (370510) was an HXA type and was loaded with coal (figure 2).

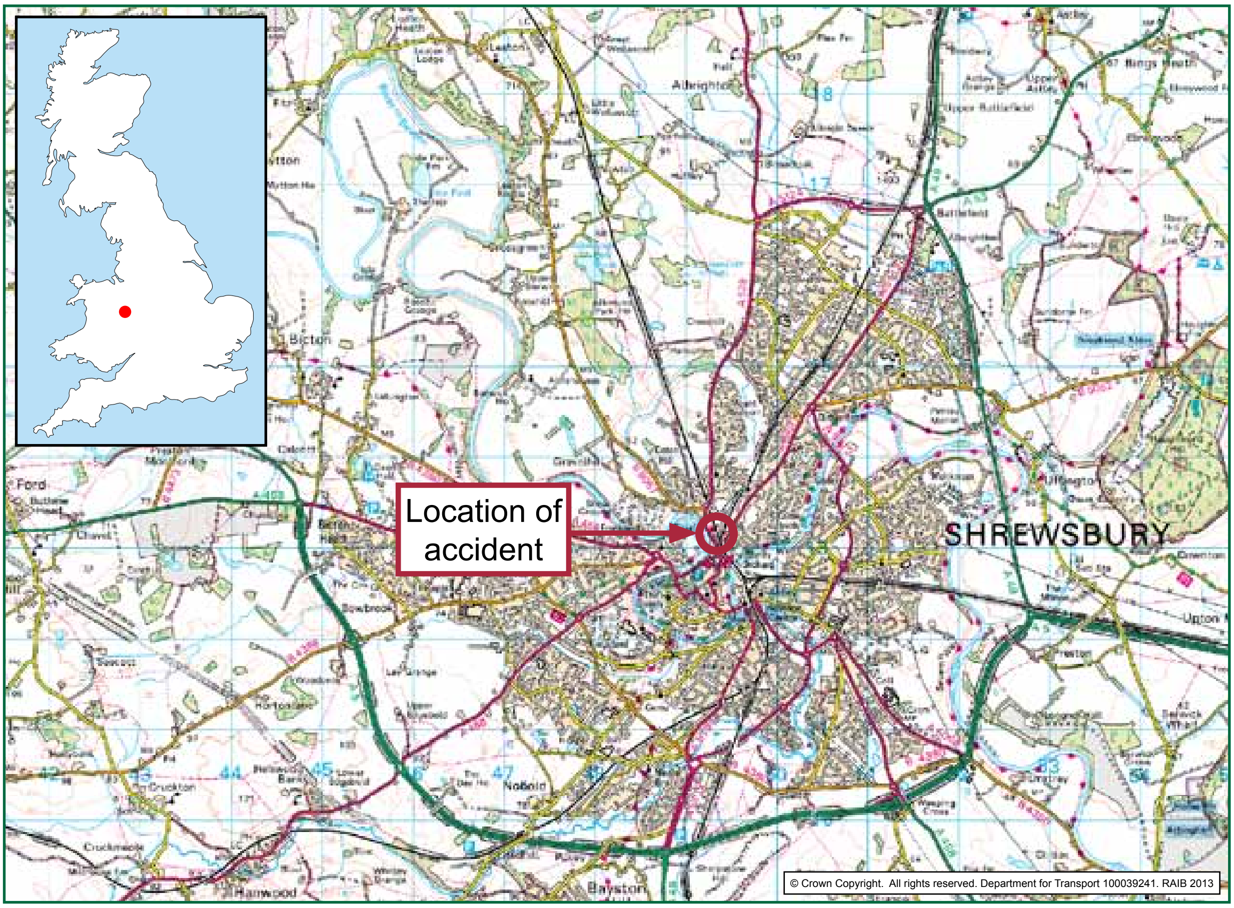

Figure 1: Extract from Ordnance Survey map showing location of accident

7 The leading bogie of wagon 370510 ran derailed for approximately 65 metres causing significant track damage in the process. The train was eventually stopped by a brake application initiated by the parting of the brake pipe between the 15th and 16th wagons. The *screw coupling* between these wagons remained intact.

8 There were no injuries as a result of the derailment. The derailed bogie of wagon 370510 was damaged. The leading right-hand *buffer* detached and became lodged between the trailing left-hand wheel of the derailed bogie and the wagon underframe (figure 2).

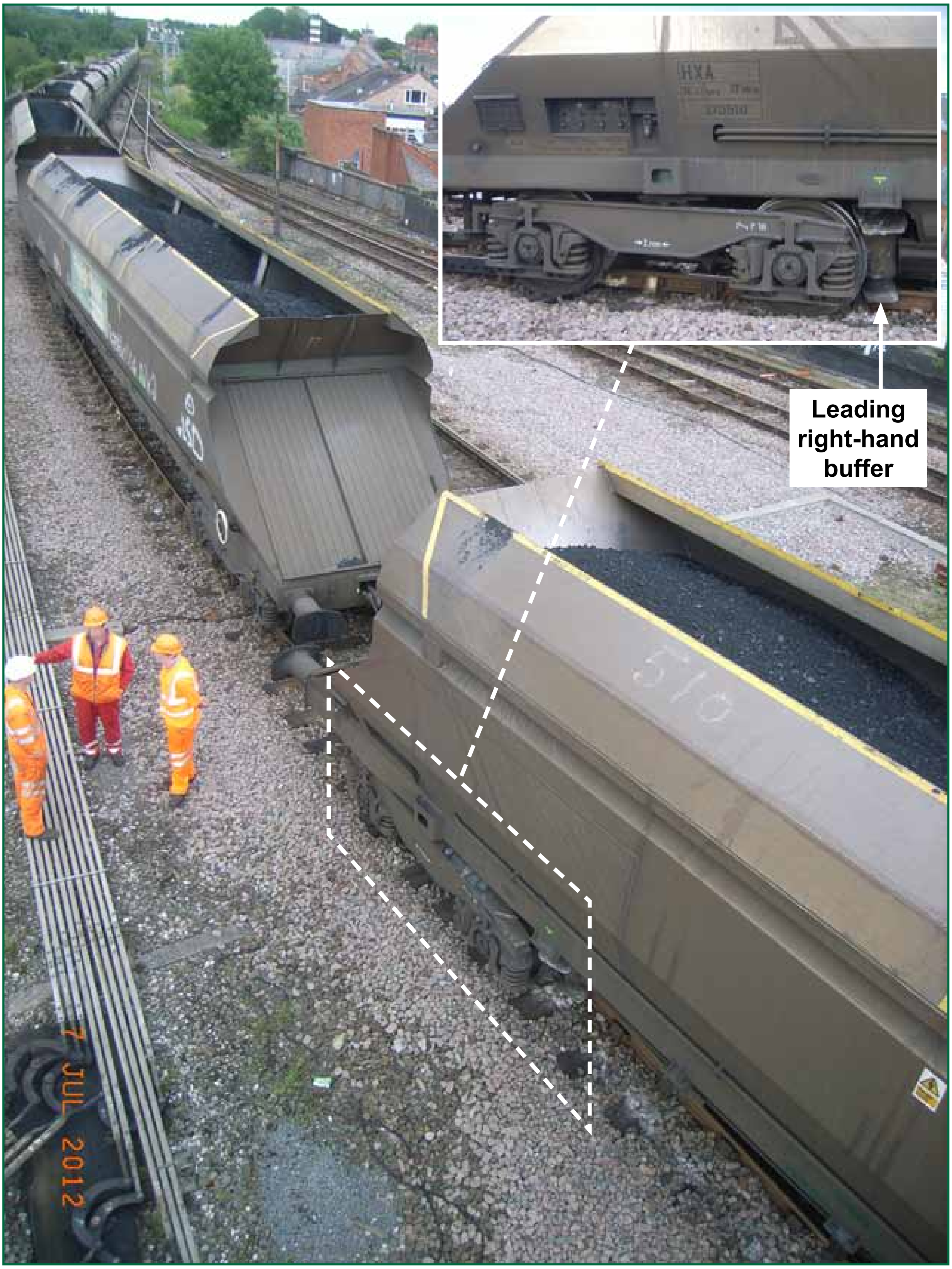

Figure 2: Wagon 370510 after the derailment

Background

Location

9 Shrewsbury station is located at 171 miles and 46 *chains* from Paddington via Oxford and Birmingham Snow Hill. The train derailed on No. 75 points at 171 miles 53 chains located at the north end of the station at a place known as Crewe Junction (figure 3). These points enable the traffic travelling along the *down main* line to be directed either towards Chester or towards Crewe. Train 6M61 was heading towards Crewe. The maximum permitted speed on the down main line and through the junction is 15 mph (24 km/h).

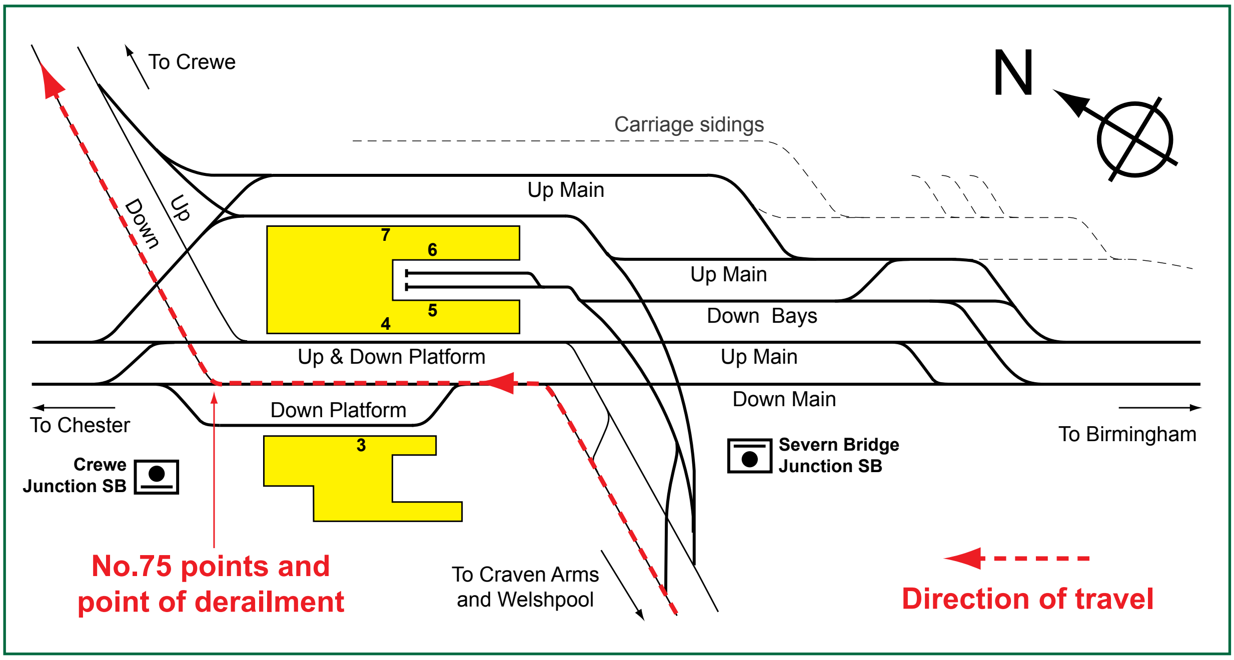

Figure 3: Schematic diagram showing location of accident

10 Train movements within the area are controlled by the Network Rail signal box at Crewe Junction (171 miles 57 chains). Signals in the area are a mixture of *semaphore* and *colour light signals*. The signal protecting No. 75 points is signal number CJ106 which is a 3-aspect colour light signal with a *theatre indicator*. No. 75 points are equipped with a *facing point lock* controlled by lever 76 within the signal box.

11 The down main line on the approach to No. 75 points is laid on a curve (130 metres radius at its tightest) on top of a bridge. Along the curve, the inner rail is fitted with a *check rail* which terminates 2.8 metres before the *toe* of the points. The track in the area is *jointed track* with the closest rail joint located approximately 1.7 metres before the toe of the points. Figures 4 and 5 show the track layout in this area. The rails on the approach to No. 75 points are laid on *vertical baseplates* except for the section of track between the end of the check rail and the toe of the points which were on *inclined baseplates*. No. 75 points are of the *B-type* with two *permanent way stretcher bars* and one *lock stretcher bar*. The *flat-bottomed rails* in No. 75 points are laid on vertical baseplates and the switch rails are *full depth*. There is no *supplementary drive*.

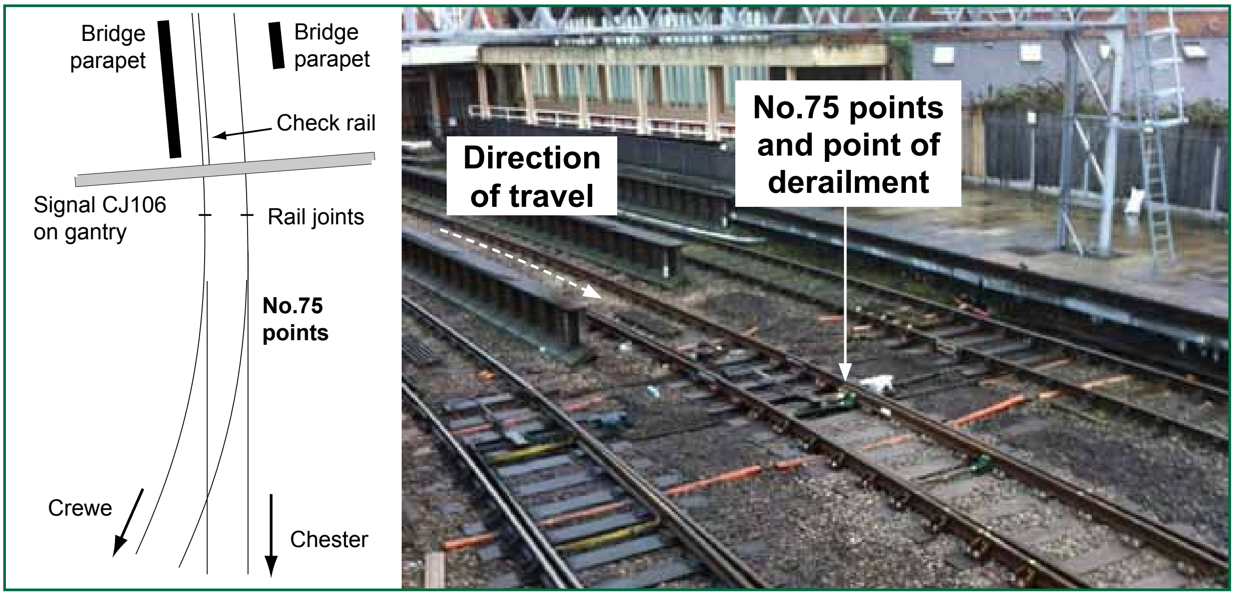

Figure 4: Layout of the area

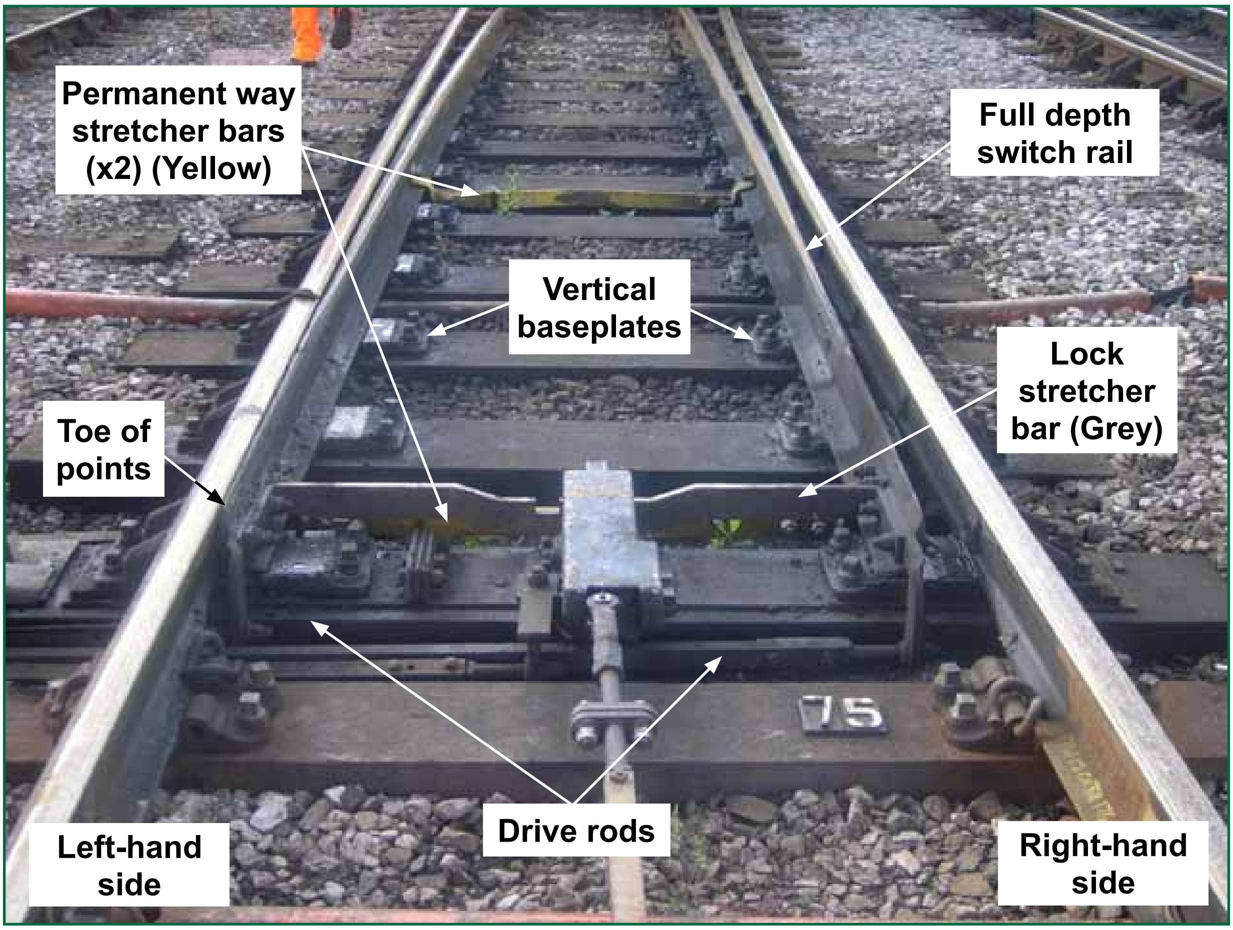

Figure 5: No. 75 Points

Parties involved

12 Train 6M61 was made up of locomotive 66549, 3 HHA wagons and 16 HXA wagons. It was operated by Freightliner, who also employed the driver. The track and infrastructure are owned, operated and maintained by Network Rail. All parties freely co-operated with the RAIB and provided assistance during the course of this investigation.

Track maintenance and inspection

13 At the time of the derailment, the requirements for the inspection and maintenance of points were mainly contained in two Network Rail standards: NR/L2/TRK/001 issue 4 and NR/L2/TRK/053 issue 5 (referred to as TRK/001 and TRK/053 in the rest of this report).

14 Standard TRK/001 is the overarching standard covering the maintenance and inspection of all track assets. The inspection requirements depend on the category of the track being inspected. The track category is a function of the speed of traffic and of the *equivalent tonnage* using the line. No. 75 points, because of the low speed (15 mph) and fairly low usage, are classified as category 6 (the least onerous category in TRK/001).

15 For track category 6, the inspection regime to ensure safety of the line defined in TRK/001 is based on a 2-weekly 'basic visual inspection' by a *patroller* combined with a 13-weekly 'supervisor's visual inspection' by the Section Manager – Track (SM(T)) or his delegate.

16 The basic visual inspection is a regular track inspection with the objective of identifying any immediate or short term actions required. There is no requirement for any measurements of the track. There is no specific instruction in TRK/053 about the basic visual inspections of points, over and above the requirements in TRK/001.

17 The supervisor's visual inspection is a regular track inspection carried out on foot. This is supplemented by a 6-monthly journey in the cab of a train, by the SM(T), who checks the condition of the track and determines the actions necessary to respond to reports of the basic visual inspections and other inspections. TRK/001 requires measurements of *track twist* and *track gauge* to be undertaken. There are specific instructions on how to inspect points in TRK/053 when undertaking a supervisor's visual inspection.

18 Standard TRK/053 describes the inspection and maintenance regime to be undertaken at points to reduce the risk of derailment. It draws a clear distinction between the supervisor's visual inspections and the detailed inspections of points. A detailed inspection in accordance with TRK/053 assesses the points against four (or five depending on the grade of rail steel) derailment hazards using various gauges. Appendix B describes the five derailment hazards. Measurements are made with the gauges and recorded on Track Engineering Form TEF/3029. The detailed inspection can only be carried out by someone who holds the full competence to TRK/053.

The sequence of events

19 On the day of the accident, train 6M61 left Portbury Dock late at 08:56 hrs and after an uneventful journey arrived at Shrewsbury station at 14:10 hrs for a scheduled change of driver. Train 6M61 stopped 30 metres on the approach to signal CJ106. This signal protects Crewe Junction. The Network Rail signaller in Crewe Junction signal box had set No. 75 points to direct train 6M61 towards Crewe. When the points were *detected* and *locked*, the signaller cleared signal CJ106 to authorise the train to proceed.

20 After the change of drivers, train 6M61 departed signal CJ106 at 14:12 hrs. The driver applied power and reached a speed of 8 mph (13 km/h) as the locomotive traversed No. 75 points. As the rest of the train was traversing the points, the speed gradually increased to 14 mph (22 km/h) which was the speed at which wagon 370510 entered the points. The marks left on the switch rail suggest that the *flange* of the leading left-hand wheel of wagon 370510 is likely to have started climbing the switch rail close to the toe of the points (figure 6).

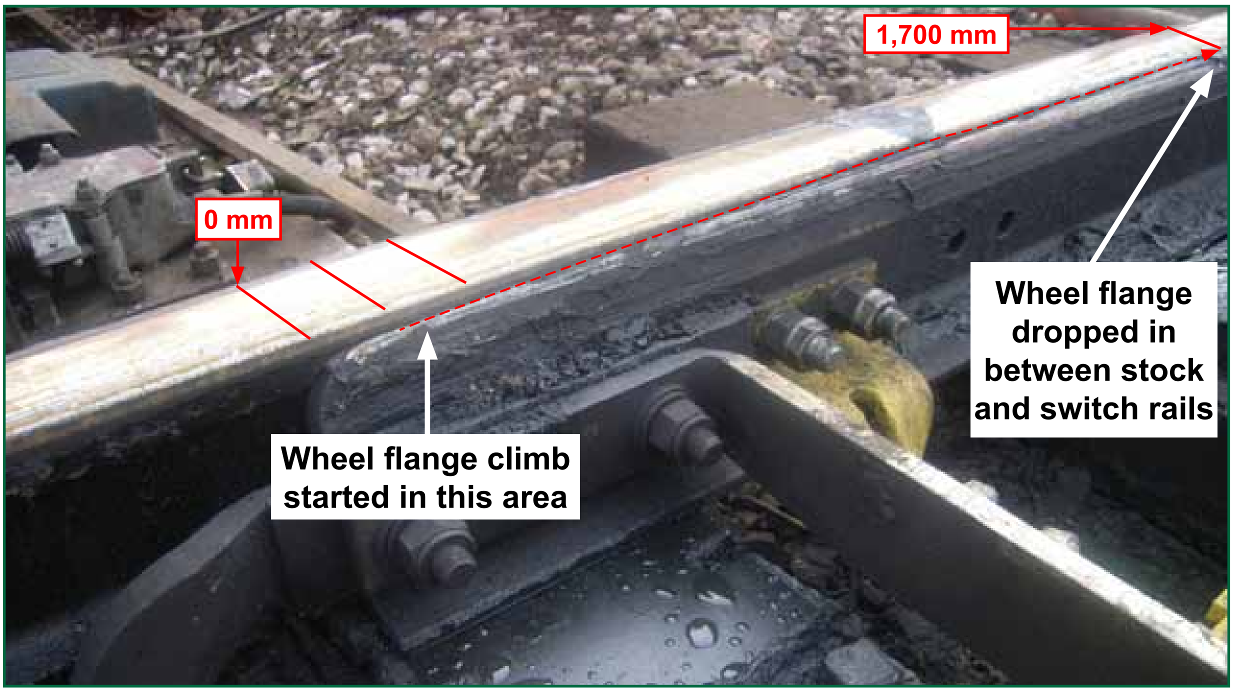

Figure 6: Toe of No. 75 points showing left-hand stock/switch rails and path of derailment

21 It took approximately 1.7 metres before the wheel flange, having completely climbed over the switch rail, dropped between the stock and switch rails. After the train had travelled another 13 metres, the *On-Train Data Recorder* (OTDR) detected a drop in brake pressure which suggests that the brake pipe had parted leading to an automatic brake application[1]. The train stopped 50 metres after this event with the trailing end of the locomotive in line with signal CB25 further along the line towards Crewe.

[1] The control of the braking system on most trains is ensured via a continuous brake pipe which runs the length of the train. Any change in the pressure in the brake pipe is detected by the braking equipment installed on each vehicle and an appropriate response activated (brake applied if the pressure in the brake pipe drops or brake released if the pressure increases). In order to make the braking system fail-safe, the brake pipe is continuously pressurised so that any unintentional drop in pressure leads to an automatic brake application.

22 The signaller at Crewe Junction signal box had witnessed the derailment. He replaced the signal ahead of train 6M61 to danger. He checked that the correct indications were still showing for the route for the train and that No. 75 points were still being detected by the signalling system in the *reverse* position. He checked that all the other signals within his control were at danger to protect the derailed train. In the meantime, the driver contacted the signaller and asked if the signaller had heard or had seen something wrong with the rear of his train. The signaller informed the driver that the leading bogie of the fourth wagon from the rear had derailed; he then proceeded to report the accident to Network Rail's Control and to the station staff.

Identification of the immediate cause[2]

23 Wagon 370510 derailed on No. 75 points because the points were unsafe to negotiate due to wear and damage.

24 After the derailment at Shrewsbury and before any further rail traffic passed over them, the RAIB examined No. 75 points and found signs of wear and damage which are believed to have been there before the derailment. After removal of the grease and residue, the examination revealed that the left-hand switch rail was worn and damaged close to the toe of the points (figure 7). The switch rail damage started 120 mm from the toe of the points and continued for an additional 110 mm. The switch rail wear started close to the toe of the points (approximately 50 mm from the toe) and extended beyond the damage. The presence of grease obscuring the damage on the switch rail indicates that the damage is unlikely to be a consequence of the accident. The RAIB carried out a detailed inspection of No. 75 points against the requirements of TRK/053. The detailed inspection revealed that No. 75 points failed three out of the four checks for derailment hazards identified within the standard for this type of points. No. 75 points were therefore at risk of creating a derailment (see appendix B for more details about the results of this detailed inspection). Measurements carried out by the RAIB indicated that the first section of the switch rail, between 50 mm and 120 mm from the toe, in front of the damage, was compliant with TRK/053 despite the presence of wear.

25 A simulation of the derailment by computer modelling was undertaken by Network Rail in consultation with the RAIB. The simulation used a wagon model which was validated against static test results during the original approvals of the wagon type. The wagon model is a mathematical representation of the wagon based on its suspension characteristics and mass including a representative wheel load distribution. The simulation also uses a track model which is a mathematical representation of the geometry of the track. Apart from friction which has been estimated, the simulation was based on actual track and vehicle measurements gathered on site after the derailment. The RAIB independently validated the incident-specific input data to both models.

[2] The condition, event or behaviour that directly resulted in the occurrence.

Figure 7: Left-hand switch rail damage

26 The individual wheel loads of the derailed wagon were measured after the accident and showed that the left-hand wheel of the leading axle of wagon 370510 was less heavily loaded than the right-hand wheel. This would increase the propensity for the left-hand wheel to climb over the rails and hence increase the derailment risk. However, the extent to which this uneven loading was as a result of the derailment was unclear. Train 6M61 had run over the *Wheelchex* site at Bromfield between Ludlow and Shrewsbury on the day of the derailment. The Wheelchex data showed that the leading axle was indeed unevenly loaded but that the extent of this unevenness was less than measured after the derailment. Using the Wheelchex data, it was calculated that 47% of the total axleload for the leading axle was carried by the left-hand wheel and 53% by the right-hand wheel before the derailment.

27 The coefficient of friction considered in the analysis at the flange to switch rail contact ranged from 0.1 (lubricated conditions) to 0.3 (dry conditions). The simulation demonstrated that, for a coefficient of friction between 0.2 to 0.3, wagon 370510 was predicted to derail. The simulation indicated that the derailment was likely to initiate close to the toe of the points (50 – 120 mm from the toe) before the wheel reached the switch rail damage. In that area, the angle of contact between the flange and the worn switch rail was low enough to create conditions which would have increased the tendency for the flange to start climbing the face of the switch rail. However, the simulation also indicated that the damage was necessary to maintain the conditions over a distance sufficient to lead to a derailment. This suggested that the damage and wear were important factors in the derailment at Shrewsbury.

Sensitivity analysis

28 The following track and wagon parameters as measured on site were found to be within maintenance limits when compared with existing standards. Nevertheless, the sensitivity of the derailment prediction to these parameters was assessed using the model and found to have no tangible effects on the propensity to derailment:

a. track gauge on the approach to No. 75 points;

b. track twist throughout the area;

c. rail inclination between the end of the check rail and the toe of the points;

d. track *vertical alignment* throughout the area; and

e. wheel profiles.

29 The simulation was re-run with a modified wheel load distribution assuming a uniform distribution of axleload. This analysis did not predict a derailment for the friction conditions that were considered (coefficient of friction varying between 0.1 and 0.3).

30 As there is no requirement in the standards for a limit on the uneven loading of wagons, the RAIB compared the actual wheel load distribution against data from the other wagons in the train as well as with other freight wagons (HHA coal hopper wagons). The RAIB calculated that it was not unusual to have a side-to-side loading difference of ±10% (ie 40% - 60% split of axleload) for freight wagons. The RAIB therefore concluded that despite the clear effect that the wheel load distribution had on the propensity of the wagon to derail, the degree of uneven wheel load distribution was typical of loaded freight wagons and should not on its own have led to a derailment.

31 As a consequence of the rail joint located directly before the toe of No. 75 points, the lateral track alignment within the area was poor when assessed against the limits in TRK/001 (figure 8). The alignment on the approach to the toe of No. 75 points was measured[3] at 24 mm which is above the *alert limit* of 21 mm in TRK/001 but below the *intervention limit* of 27 mm. This factor was demonstrated by computer modelling to have no tangible influence on the propensity to derail.

32 The RAIB found no evidence that the buffer operation was a factor in the cause of the derailment.

Identification of causal factors

33 The left-hand stock and switch rails of No. 75 points had been renewed in July 2011 after having been in service for four years during which it had been subjected to two weld repairs following damage to the switch rail. In March 2012, eight months after having been renewed, the left-hand switch rail of No. 75 points was again in need of weld repair as the switch rail was damaged (the top of switch rail was *chipped*). In accordance with Network Rail's processes defined in TRK/053, the points were subjected to detailed inspections to TRK/053 before and after the weld repair. The records of these detailed inspections suggest that No. 75 points had been left in a safe condition following the repair.

[3] By Network Rail using one of their track recording vehicles (measurements in February 2012).

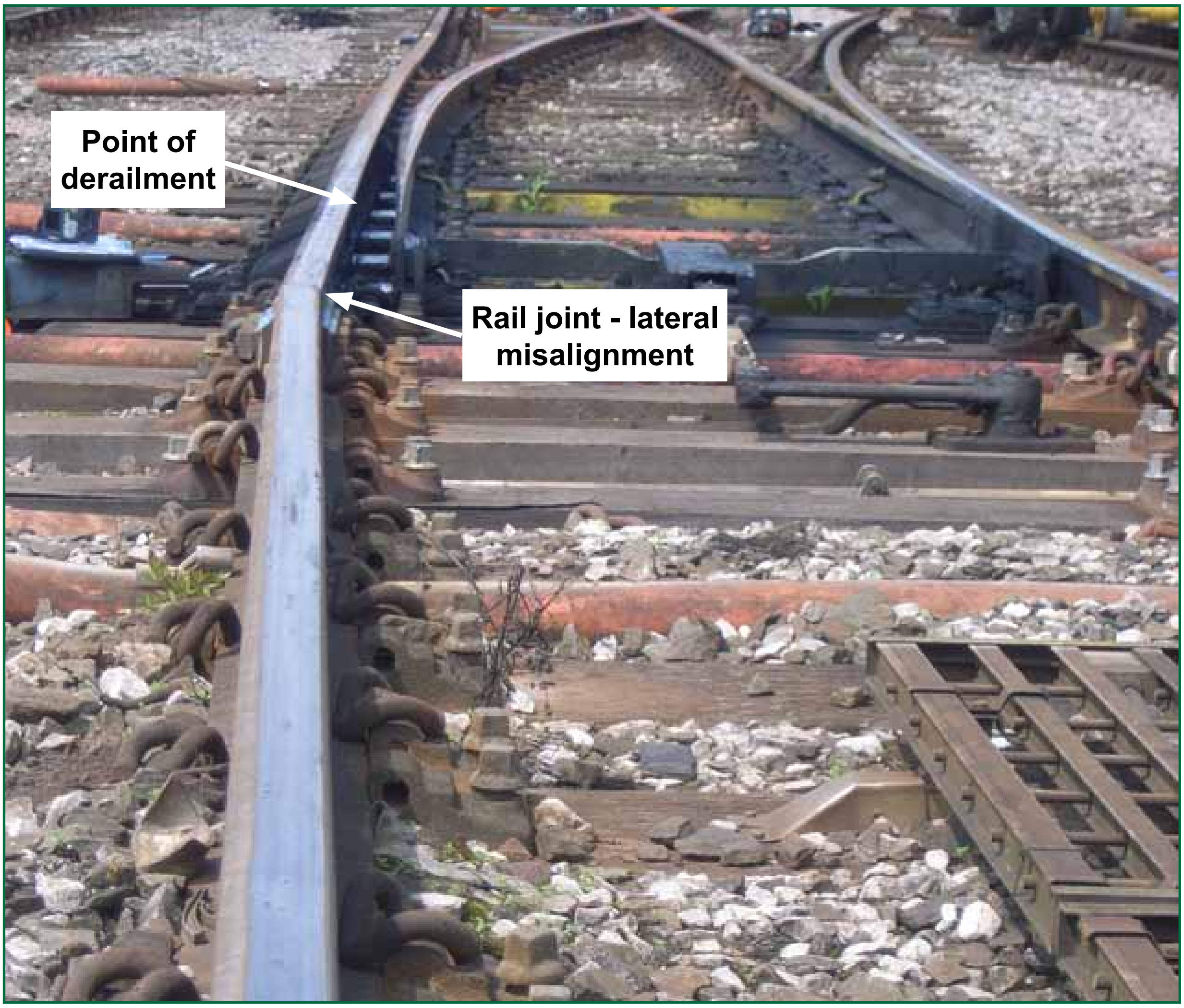

Figure 8: Track lateral alignment approaching No. 75 points

34 Since the weld repair in March 2012, No. 75 points had been in regular use for freight traffic in the *facing direction* with an increasing number of freight trains taking the route towards Crewe (paragraph 39). As a result, No. 75 points had degraded since March 2012. The degradation recorded during the detailed inspection after the derailment included wear as well as the physical damage to the switch rail (figure 7).

35 The simulation referred to in paragraph 25 indicated that the wear and damage to the points were important factors in the derailment at Shrewsbury on 7 July 2012. The extent of this wear and damage was due to:

a. the maintenance regime not adequately controlling the risks associated with the degradation; and

b. the inspection regime in place at Shrewsbury not detecting the degradation.

These causal factors are now considered in turn.

Maintenance regime

36 The maintenance regime in place on No. 75 points did not control the risk associated with the degradation of the points. This was a causal factor.

37 Up to the summer of 2011, the lubrication[4] in the area was solely reliant on an automatic lubricator located within the station on the down main line approximately 65 metres before the toe of No. 75 points.

38 Following the renewal of the left-hand stock and switch rails in July 2011, and based on the understanding that the wear rate on No. 75 points and others in the vicinity was high, the Track Maintenance Engineer (TME) and the SM(T) decided to implement an enhanced lubrication regime for the points as specified in TRK/053 for points subject to high wear. This consists of manually applying an approved lubricant at three locations: 1.2 metres in front of the toe, at the toe and 1.2 metres beyond the toe. This activity was undertaken as part of the regular baseplate oiling activity which has a 2-week periodicity. The last baseplate oiling and switch lubrication took place on 1 July 2012. Examination of the points by RAIB personnel after the accident suggests that this activity had been taking place. Nevertheless, this enhanced lubrication regime in place on No. 75 points did not prevent the wear and damage that resulted in the derailment.

39 It is possible that the degree of wear and damage arose because of the increase in freight traffic taking the route towards Crewe. The RAIB has gathered data showing the number of freight trains planned to go over No. 75 points between December 2011 and July 2012. This showed a planned increase from approximately 40 - 45 freight trains per week in December 2011 to 70 - 75 freight trains per week in July 2012.

Inspection regime

40 The inspection regime in place on No. 75 points did not detect the degradation of the points. This was a causal factor.

41 The inspection regime did not detect the degradation of the points because:

a. it did not apply the risk-based approach intended by TRK/053 for high-risk points because the intent of TRK/053 was misinterpreted; and

b. it did not detect that the points had degraded to an unsafe condition and therefore did not trigger a detailed examination to TRK/053.

These factors are now considered in turn.

Inspection regime did not apply the risk-based approach intended by TRK/053 for high-risk points

42 The intent of TRK/053 was misinterpreted and did not result in high-risk points like No. 75 points being subjected to regular detailed inspections.

43 Up to December 2008, regular detailed inspections to TRK/053 were undertaken on all points controlled by the Shrewsbury delivery unit once every 13 weeks. As there are more than 150 points within the area controlled by the delivery unit, this resulted in a very large number of detailed inspections taking place. These inspections were carried out regardless of the usage of the points, so that heavily used and heavily worn points were inspected with the same periodicity as lightly used points. This situation was not confined to the Shrewsbury area but was common across the network.

[4] Lubrication is provided on curves and points to reduce friction at the wheel flange to rail interface so as to reduce wear and hence increase the life of the assets. Lubrication also reduces the risk of derailment by flange climbing.

44 Aware of this practice and keen to re-focus the inspection regime of points in areas of highest risk, Network Rail re-issued TRK/053 in October 2007 and again in August 2008. This also coincided with the introduction of some new gauges (including the *TGP8 gauge*) designed to provide a measured assessment of the points against a set of criteria and identify any necessary remedial action.

45 The intent of the re-issued standard was to introduce a risk-based approach, in which high-risk points would be subjected to detailed inspections to TRK/053 more often than low-risk points. The risk was to be ranked by the SM(T) and TME based on, amongst other factors, the length of the points (with shorter points being more at risk), the historical wear rate and the area in which the points are laid (with generally poor track geometry being more at risk). No. 75 points and other points in the vicinity were of the short type, prone to damage, known to be subjected to high wear rates and in an area of poor geometry and hence should have been considered to be high-risk according to the risk criteria in TRK/053.

46 The introduction of the revised TRK/053 was accompanied by a briefing campaign that took place in September and October 2007, during which more than 950 Network Rail personnel around the country were informed of the changes to the standard. The TME and SM(T) at Shrewsbury maintenance delivery unit were briefed in October 2007 in Cardiff. The briefings were followed up with a set of clarification notes issued in November 2007 which aimed to answer some of the questions raised during the briefings. The notes also came with a risk assessment form designed to help TMEs determine the appropriate frequency of detailed inspections for each individual set of points.

47 However, the Shrewsbury delivery unit misinterpreted the intent of the revised standard and the practice of undertaking regular detailed inspections of points to TRK/053 ceased in December 2008. It was replaced by a new inspection regime where detailed inspections of points to TRK/053 were only undertaken when triggered by a visual inspection (mainly a supervisor's visual inspection). The risk-based approach intended by the standard was not applied and all points were treated in accordance with the same inspection regime. High-risk points such as No. 75 points were not put on a programme of regular detailed inspections.

48 The RAIB concludes that the following factors contributed to the misinterpretation of the intent of the standard in terms of inspection regime:

a. the wording of the section in TRK/053 dealing with periodicity of detailed inspection is open to misinterpretation; and

b. the misinterpretation was not picked up by any follow-up checks or subsequent internal compliance monitoring activities carried out by Network Rail.

These factors are now considered in turn.

TRK/053 frequency of inspections

49 Section 10.1 of TRK/053 describes the required frequency of inspections as follows:

"*When required by the Supervisor's visual inspection detailed inspections shall be carried out at a frequency commensurate with risk and documented wear rates. The interval for these inspections will be a maximum of 13 weeks unless supported by a risk assessment signed off by the Supervisor and approved by the Track Maintenance Engineer (TME).*"

50 This wording has been interpreted differently by individual maintenance delivery units around the country. For example, the RAIB investigation of the accident at Princes Street Gardens in Edinburgh (paragraph 79) showed that the delivery unit there had interpreted this requirement as meaning that it could fix the frequency of the detailed inspections of all its high-risk points within the area to every 24 weeks (in addition to the regular basic and supervisor's visual inspection regimes). The Shrewsbury delivery unit interpreted this requirement as meaning that it could solely rely on the supervisor's visual inspections to trigger detailed inspections and did not need a regime of regular detailed inspections of its high-risk points.

Misinterpretation not identified by any follow-up checks or subsequent audits

51 Since the introduction of the revised standard in 2007 and 2008 and since the initial briefing campaign, there had been no systematic check that the requirements of TRK/053 in terms of inspection regime have been understood and adhered to.

52 Network Rail runs an audit programme approximately every two years where a Network Rail qualified team of auditors from one route audits another route in accordance with standard NR/SP/ASR/036 – 'Network Rail Assurance Framework'. This is known as the National Core Audit Programme (NCAP)[5]. The last time that the Shrewsbury delivery unit was subjected to a NCAP audit before the accident was in September 2010, when a team from Birmingham carried out the audit. The audit was a detailed exercise which lasted several weeks and included a section on TRK/053 and its implementation. The 2010 audit report accurately describes the inspection regime in place at the time at Shrewsbury without raising any concerns about it. This indicates that the auditor did not perceive anything wrong with Shrewsbury delivery unit's interpretation of the requirements in terms of inspection regime and implies that the same approach may have been adopted elsewhere across the network.

The regular visual inspections did not detect that the points had degraded to an unsafe condition and did not trigger a detailed examination to TRK/053

53 Despite not undertaking regular detailed inspections on No. 75 points to TRK/053, the inspection regime that was in place could have detected the degradation of the points to an unsafe condition but did not.

54 The inspection regime in place at Shrewsbury was based on a weekly basic visual inspection combined with a 13-weekly supervisor's visual inspection. For No. 75 points which have a track category 6 (paragraph 14), this is actually more onerous than is required by TRK/001 (the basic visual inspection could be done every 2 weeks – paragraph 15). Supervisor's visual inspections were the trigger for detailed inspections to TRK/053.

55 This inspection regime had been in place at Shrewsbury since December 2008 when the regular detailed inspection of points to TRK/053 ceased (paragraph 43). Since December 2008, the inspection regime had identified three instances of No. 75 points needing repair (August 2009, April 2011 and March 2012). The perception by the TME and SM(T) was therefore that the inspection regime in place at Shrewsbury was working and detecting problems before they could lead to a derailment.

[5] This has now been replaced with the Functional Audit Programme.

56 The last basic visual inspection before the derailment was carried out on 2 July 2012 (5 days before the accident) and the records show that no concerns were raised about No. 75 points. The last supervisor's visual inspection was carried out on 19 June 2012 (18 days before the accident) and the records again show no concerns about No. 75 points. The records also show that no detailed inspection to TRK/053 had been triggered by either of these inspections.

57 It is possible that the damage to the switch rail occurred after the last basic visual inspection. The inspection of the points immediately after the accident identified fresh shards of metal, presumably from the switch rail, embedded within the grease at the base of the rail (figure 9). The size and appearance of these shards suggests that the creation of the damage could have been a fairly rapid process which could have taken place shortly before the accident (the presence of grease obscuring the damage on the switch rail indicates that the damage is unlikely to be a consequence of the accident). However, the more gradual nature of the wearing process suggests that the wear on the rails was already present at the time of the last supervisor's visual inspection and the last basic visual inspection.

Figure 9: Left-hand switch rail at No.75 points immediately after derailment

58 The following factors are considered to have contributed to the inspection regime not detecting the degradation or triggering a detailed inspection:

a. it is difficult to visually identify wear;

b. the supervisor's visual inspection on 19 June 2012 might have been carried out with the points in the *normal* position (facing Chester) and not reverse (towards Crewe);

c. the supervisor who carried out the supervisor's visual inspection on 19 June 2012 was not competent to TRK/053 and did not use the TGP8 gauge to determine whether a detailed inspection to TRK/053 was required; and

d. the switch rail damage might have been obscured by grease.

These factors are now considered in turn.

Difficulty in visually identifying wear

59 TRK/053 defines tell-tale signs that the supervisor is to look for when assessing the derailment risk of a set of points (appendix B). Some of these tell-tale signs, such as physical damage to the switch rail, are easier to identify than others unless obscured by grease or residue. In particular, rail wear is not easy to detect visually. This reinforces the need for a supervisor undertaking a visual inspection to routinely use the TGP8 gauge. The TGP8 gauge is used to visualise the wheel flange path along a switch rail and to determine if rail wear is leading to conditions that require a detailed inspection. It is therefore a valuable tool for the supervisor during his visual inspection to identify when wear becomes unacceptable.

No. 75 points may not have been in the reverse position during the supervisor's visual inspection on 19 June 2012

60 The normal position of No. 75 points is set towards Chester (as this is required by the interlocking at Crewe Junction signal box to enable other signals in the station to be cleared). It is only when trains take the same route as train 6M61 towards Crewe that the points are set in reverse. The supervisor who undertook the visual inspection on 19 June 2012 was unable to confirm the position of the points but he was able to confirm that the points were not thrown to the other position during his inspection. TRK/053 section 9 requires the points to be assessed in normal and reverse positions during a supervisor's visual inspection.

61 With the points in the normal position (towards Chester), the tell-tale signs described in TRK/053 become more difficult to identify (appendix B). Unless the points are moved into the reverse position it would have been impossible for the supervisor to use the TGP8 gauge on the left-hand side to determine whether the points were at risk of failing derailment hazard 2 (appendix B).

The supervisor who carried out the inspection on 19 June 2012 was not TRK/053 competent and did not use the TGP8 gauge

62 On 27 March 2012, ten days after the weld repair (paragraph 33), a planned supervisor's visual inspection was carried out by the SM(T). The next planned supervisor's visual inspection was on 19 June 2012. In accordance with TRK/001, the SM(T) is allowed to delegate 50% of his supervisor's visual inspections to another competent person approved by the TME. At Shrewsbury, the SM(T) had delegated 50% of his supervisor's visual inspections. As a result, the SM(T) did not carry out the inspection on 19 June 2012.

63 The supervisor who undertook the inspection on 19 June 2012 was passed out as competent by Network Rail to carry out supervisor's visual inspections in accordance with TRK/001 in 2008. His competence had been assessed by Network Rail using the process known as 'assessment in the line', which included a computer based knowledge test and an appraisal by a line manager (in this case, the SM(T)).

64 Having completed his appraisal, the SM(T) re-certificated the supervisor as competent to perform supervisor's visual inspections in September 2011.

65 In terms of competence requirements, section 11 of TRK/053 contains some additional requirements applicable to supervisors undertaking visual inspections:

> "*People carrying out routine supervisor's visual inspections shall be trained and hold a valid certificate of competency to determine whether a detailed inspection is required*."

However, no such certificate of competency existed within Network Rail that the supervisor could have obtained (other than the full TRK/053 qualification, which was not a prerequisite for undertaking supervisor's visual inspections). Network Rail, through its internal training and competence management process, had considered creating a specific training module and associated certificate for supervisors but this never came to fruition. Witness evidence suggests that this situation was allowed to continue probably because of the widely held belief that all supervisors would hold the full TRK/053 competence.

66 The supervisor who carried out the inspection on 19 June 2012 had received the full TRK/053 training approximately 2 years before the accident but had not completed the mentoring part of the training necessary to reach competence. As a result, he did not hold the full competence to TRK/053.

67 One factor which may have contributed is that in locations where all detailed inspections are carried out by someone other than the supervisors (all detailed inspections at Shrewsbury are carried out by the Welding Manager), it is difficult for supervisors to reach and retain competence to carry out detailed inspections to TRK/053. This is because an essential part of reaching and maintaining competence to TRK/053 is to practise the task of carrying out detailed inspections.

68 The supervisor stated that because he did not hold the competence to TRK/053, he did not use his TGP8 gauge to assess the condition of No. 75 points on 19 June 2012.

69 Despite carrying the TGP8 gauge with him during his inspections[6], the supervisor did not to use the TGP8 gauge to assess the condition of points. This had not been identified during the assessment of his competence or noticed by the SM(T).

70 This investigation highlighted that the TGP8 gauge is found by supervisors to be ergonomically difficult to use particularly when trying to assess where contact with the switch rail is made. This leads to pass/fail decisions which are considered to be open to interpretation. This was highlighted in RAIB's investigation report at Princes Street Gardens and is the subject of an RAIB recommendation. Witness evidence also indicates that TRK/053 is unclear about the mandatory use of the TGP8 gauge. Parts of TRK/053 appear to mandate its use but elsewhere the gauge is referred to only as a confirmatory tool (ie it is only used to confirm what the visual inspection is detecting).

[6] At Shrewsbury, the TGP8 gauge is fitted to the device carried by supervisors to check for *cant* and gauge during their visual inspections.

71 The supervisor stated that he thought that he would be able to visually detect the tell-tale signs of a derailment risk and would therefore know when to trigger a detailed inspection to TRK/053. The records for this supervisor showed that he had in the past referred points for detailed inspections on the basis of his visual inspections. The RAIB has no evidence as to whether this was due to observed wear or damage. The supervisor felt confident that he did not need to use the TGP8 gauge to confirm his assessment.

72 An examination with the TGP8 gauge should have indicated that the left-hand switch rail was worn and that contact below the 60° marker line on the TGP8 gauge was present for more than 200 mm (the pass-fail criteria). This should have triggered a detailed inspection to TRK/053.

73 One possible factor which may have influenced the supervisor to continue with his inspections without using the TGP8 gauge was the recent re-focus on the detection of damage to switch rails. Following the weld repair to No. 75 points in March 2012, the TME and SM(T) re-briefed their patrollers to ensure that switch rail damage was identified during routine visual inspections. This might have reinforced the supervisor's perception that visually detecting switch rail damage was more important than detecting switch rail wear using the TGP8 gauge.

The switch rail damage may have been obscured by grease

74 The RAIB's inspection of the points that took place immediately after the accident indicated that the switch rail damage might have been obscured by grease at the time of the visual inspections (figure 9). There is no requirement in TRK/001 or TRK/053 to remove grease from points during a basic visual inspection or a supervisor's visual inspection. The requirement appears in TRK/053 only for a detailed inspection. It is therefore possible that grease was obscuring the damage to the switch rail during the visual inspections.

Observations

Shrewsbury derailment mechanism may not be covered by TRK/053

75 The RAIB observes that the derailment simulation suggested the following:

- The flange climb mechanism initiated on the switch rail between the toe and the start of the damage. This part of the switch rail was worn but compliant with TRK/053. This means that the initiation of the derailment cannot be fully explained in terms of non-compliance with this standard (although the simulation indicated that without the damage and wear the conditions would not have been sustained for long enough to result in a predicted derailment).
- If the input parameters to the model were adjusted such that No. 75 points were marginally compliant to TRK/053 throughout the length of the switch rail a derailment might still occur for a coefficient of friction greater than 0.3 (dry conditions)[7].

These observations suggest that Network Rail may not have identified all derailment risks in TRK/053. This has already been raised as part of the Princes Street Gardens investigation (paragraph 79) and was the subject of an RAIB recommendation (Recommendation 2 in RAIB report 18/2012).

[7] This simulation involved changing the rail profiles for the switch rail in order to remove the three derailment hazards on which No. 75 points were failing the inspection (appendix B) in order to meet the exact requirements of the gauges used during the detailed inspections – (there are many possible variations of compliant switch rail profiles and hence the results have to be treated with caution).

TRK/053 and TEF/3029

76 The RAIB has identified that TRK/053 and its accompanying form (TEF/3029) are not consistent. TEF/3029 is the form used to record a detailed inspection. Examples of the lack of consistency include the actions to take to deal with hazards 1 and 2 which are different in TEF/3029 compared with TRK/053. Another example is that TEF/3029 suggests that all points should be assessed against derailment hazard 5 whereas TRK/053 is clear that derailment hazard 5 only applies to certain types of rail steel.

Wagon examination

77 The RAIB undertook an examination of wagon 370510 in York using the Vehicle Maintenance Instruction (VMI) provided by Freightliner. This VMI covers both the Vehicle Inspection and Brake Testing (VIBT) and Planned Preventive Maintenance (PPM). The RAIB observed that the VIBT checks by Freightliner are undertaken with the bogies still under the wagon. This restricts access and is not in accordance with the VMI which requires a body lift (job No. UU6002). This means that several of the bogie checks described in the VMI cannot be undertaken. The RAIB also observed that Freightliner does not carry out the verification of the bogie critical dimensions described in the VMI (eg check of clearances within suspension components).

78 Freightliner has reported that the lack of body lift practice had been identified in early 2011 and that it had initiated corrective actions to address the shortcoming but that these actions were still on-going by the time of the accident in July 2012.

Other similar incidents

79 On 27 July 2011, the leading bogie of the trailing vehicle of an empty passenger train derailed while traversing points in the Princes Street Gardens area in Edinburgh. The most likely cause of the derailment was that the switch rail profile and possibly an increase in friction enabled the wheel flange to climb the switch rail. Three days before the accident, the switch rail had been identified as having the potential to cause a derailment following a detailed inspection triggered by an unscheduled Assistant Track Maintenance Engineer visual inspection. The switch rail was reprofiled by grinding but this did not prevent the derailment. The RAIB investigated this accident (RAIB report 18/2012) and made five recommendations to Network Rail, three of them about standard TRK/053 and its content. The RAIB understands that as a response to the recommendations Network Rail has started an in-depth review of standard TRK/053 (paragraph 88).

80 On 1 May 2009, at Sudforth Lane in North Yorkshire, two empty HXA wagons of a freight train derailed on a newly-installed set of points in a siding. The initial point of derailment was the toe of the points. Inspection of the points against the requirements of TRK/053 indicated that contact between the TGP8 gauge and the switch rail occurred below the 60° marker line, indicative of a risk of derailment. On the basis of the low turnout speed and rarity of derailment on new points, the RAIB decided not to carry out a full investigation. Nevertheless, the RAIB issued a bulletin on the incident (RAIB bulletin 07/2009) highlighting learning points related to the manufacturing quality assurance checks of replacement switches and the applicability of checks to TRK/053 on newly installed replacement switches.

81 On 26 November 1997, the trailing bogie of locomotive 47231 derailed all wheels on No. 75 points at Crewe Junction (Shrewsbury) whilst negotiating the turnout towards Crewe. The mechanism of derailment was by flange climb on the left-hand switch rail which was made out of Mill Heat Treated (MHT) steel. The derailment was investigated by Railtrack who concluded that it was caused by a hard edge at the top of the wear band on the switch rail which had "bitten into" the relatively softer steel of the recently re-profiled wheels of the locomotive (derailment hazard 5 in TRK/053).

Summary of conclusions

Immediate cause

82 Wagon 370510 derailed over No. 75 points on 7 July 2012 at Crewe Junction (Shrewsbury) because the points were unsafe to negotiate (**paragraph 23**). The simulation undertaken suggested that the derailment initiated close to the toe of the points and that the wear and damage were important factors in the derailment.

Causal factors

83 The wear and damage was present because:

a. the maintenance regime in place on No. 75 points did not control the risk associated with the degradation of the points (**paragraph 36**);

b. the inspection regime in place on No. 75 points did not detect the degradation of the points (**paragraph 40**); and

c. the increase in freight traffic over No. 75 points leading to an increased wear rate is a possible factor (**paragraph 39**).

84 The inspection regime on No. 75 points did not detect the degradation of the points because:

a. the inspection regime at Shrewsbury did not satisfy the intent of TRK/053 for high-risk points (**paragraph 42, recommendation 1**).

This happened because:

i. the wording of the section in TRK/053 dealing with periodicity of detailed inspection was open to misinterpretation (**paragraph 50, recommendation 1**); and

ii. the misinterpretation was not picked up by any follow-up checks (none planned) or subsequent internal compliance monitoring activities carried out by Network Rail (**paragraph 52, recommendation 1**).

b. the inspection regime in place at Shrewsbury did not detect that the points had degraded to an unsafe condition and did not trigger a detailed inspection to TRK/053 (**paragraph 53**).

This happened because:

i. it is difficult to identify wear visually (**paragraph 59, recommendation 3**);

ii. the supervisor's visual inspection on 19 June 2012 might have been carried out with the points in the normal position (facing Chester) and not reverse (towards Crewe) (**paragraph 61, recommendation 2**);

iii. the supervisor who carried out the supervisor's visual inspection on 19 June 2012 was not competent to TRK/053 and did not use the TGP8 gauge to determine whether a detailed inspection to TRK/053 was required (**paragraph 68, learning point and recommendation 2**); and

iv. the switch rail damage might have been obscured by grease (**paragraph 74, recommendation 3**).

Observations

85 The RAIB has observed that:

a. Network Rail's standard TRK/053 may not address all possible derailment causes on points (**paragraph 75**);

b. there are inconsistencies between TRK/053 and TEF/3029 (**paragraph 76, Recommendation 2**); and

c. Freightliner does not undertake its VIBT examination in accordance with its VMI (**paragraph 77, Recommendation 4**).

Actions reported as taken

86 Since the derailment, No. 75 points have been replaced with vertical curved inset straightcut switches[8]. The alignment at the rail joint in front of the toe of the points has been reported as improved. Network Rail expects that these actions will result in a lower wear rate being experienced on these points and is monitoring these points accordingly. Network Rail is considering making similar modifications to other points in the vicinity which are similar to No. 75 points.

87 Since the derailment Network Rail has reported that it has carried out a full review of rail lubrication in the Shrewsbury station area and that the procurement of new lubrication equipment has been agreed with a view to early installation.

88 Following the accident at Princes Street Gardens and the publication in August 2012 of the RAIB investigation report, Network Rail has started an in-depth review of TRK/053 in order to address the RAIB recommendations. At the time of publication, Network Rail had reported to the ORR that this review will be completed by March 2014.

89 Since the accident at Shrewsbury, TRK/001 has been re-issued by Network Rail. The updated version of TRK/001 makes it clear the person undertaking the supervisor's visual inspection must be competent to TRK/053. The updated version of TRK/001 also makes it clear that a risk-based approach to the management of all track assets (including points) should be embraced by the local management teams. It defines the people responsible for the implementation of the risk-based approach (TME and SM(T)).

90 Freightliner has reported to the RAIB that the VMI for HXA wagons has been updated and that some of the activities in the original VMI have been removed. Freightliner has also reported that it has undertaken a thorough internal review to assess the impact of the activities that have been removed from the VMI. In accordance with the current legislation (the Railways and Other Guided Transport Systems (Safety) (Amendment) Regulations 2011), this work has been reported as having been reviewed by an independent competent person.

91 Freightliner has reported to the RAIB that it has improved its processes to monitor maintenance standards and the process to determine actions required if deficiencies are identified. It has also reported that all HXA wagons are now the subject of a body lift during VIBT.

[8] The stock rail is machined to accommodate the vertical inside face of the switch rail. The switch rail in an inset switch is larger than in a conventional set of points and hence is less prone to switch rail damage by chipping.

Learning point[9]

92 When developing standards which require specific competence for staff undertaking safety critical functions, it is important that corresponding training and assessment modules are provided (paragraphs 65 and 84b.iii).

[9] '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

93 The RAIB has made the following recommendations[10]:

1 *The purpose of this recommendation is for Network Rail to ensure that the risk-based approach to inspection of points to reduce the risk of derailment, as intended by TRK/053 and as mandated by TRK/001, is correctly implemented by all of its maintenance delivery units.*

Network Rail should identify the maintenance delivery units which have not correctly adopted the risk-based approach to inspection of points intended by TRK/053 and mandated by TRK/001. It should then re-brief these maintenance delivery units on the requirement in TRK/001 and undertake follow up compliance monitoring activities to confirm that each maintenance delivery unit has adopted an appropriate regime, that all points have been the subject of a risk assessment and that all high-risk points are the subject of regular periodic TRK/053 detailed inspections (paragraph 84a).

continued

[10] Those identified in the recommendations, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail Regulation to enable it to carry out its duties under regulation 12(2) to:

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 200 to 203) can be found on RAIB's website www.raib.gov.uk.

2 *The purpose of this recommendation is to ensure that Network Rail's update of TRK/053 in response to Recommendation 2 of the RAIB report (18/2012) regarding the Princes Street Gardens' derailment also includes the findings of this investigation that have not already been addressed by other actions.*

Network Rail should rewrite TRK/053, its supporting Track Engineering Form and associated training and competence assessment material to:

- remove inconsistency between them (eg TRK/053 and TEF/3029) (paragraph 85b);
- align the competence requirements for supervisors in TRK/053 and TRK/001 and define how supervisors must gain and retain this competence in areas where all detailed inspections are undertaken by others (paragraph 84b.iii);
- make clear that a routine measurement (currently using a TGP8 gauge) to identify wear is mandatory (paragraph 84b.iii); and
- mandate that the routine measurement should be repeated for points in both normal and reverse positions (paragraph 84b.ii).

3 *The purpose of this recommendation is for Network Rail to consider whether it needs to mandate the removal and re-application of the grease during supervisor's visual inspections of points.*

Network Rail should determine if it is possible for supervisors to properly and reliably identify wear and damage and to use the TGP8 gauge without removing the grease and accumulated residue. Network Rail should also consider the risks associated with removing and re-applying the grease against the risks associated with a lack of detection of wear or damage. Depending on the outcome of this study, Network Rail should incorporate the findings into a future rewrite of TRK/053 (paragraphs 84b.i and 84b.iv).

4 *The purpose of this recommendation is to ensure that Freightliner assesses the risks of continued operation when deficiencies in its maintenance practices have been identified.*

Freightliner should confirm that, where disparities are identified between working practices and the requirements of the maintenance instructions, it has arrangements in place to ensure that risks are adequately managed in the interim until the discrepancy is resolved (paragraph 85c).

Appendices

Appendix A – Glossary of terms

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

Alert limit	Measurement limit defined in TRK/001 beyond which the local management team needs to start planning actions to address the concern within routine maintenance.
B-type	The letter used to describe the length and radius of a set of points. Generally starting at A for the shortest, tightest radius and typically having the lowest turnout speed, the highest letter depends on the rail type (flat-bottom or bull-head) and grade of steel.
Buffer	An impact absorbing device fitted to rail vehicles to accommodate changes in alignment between adjacent vehicles and to prevent them from colliding heavily during braking.*
Cant	The design amount by which one rail of a track is raised above the other rail, measured over the rail centres.*
Chain(s)	A unit of length, being 66 feet or 22 yards (approximately 20.117 metres). There are 80 chains in one standard mile.*
Check rail	A rail and other special section provided alongside a running rail to give guidance to flanged wheels by restricting lateral movement of the wheels.*
Chipped	A form of switch rail damage characterised by the breaking away of pieces of metal from the top surface of the switch rail within the machined length. It can be in the form of long thin slivers or as irregular 'saw tooth' shape. Likewise, pieces can break out from a very thin sideworn switch rail.
Colour light signals	Signals which convey movement authorities to train drivers by means of coloured lights.*
Detected	A failsafe arrangement that proves that a set of points are correctly set in the normal or reverse position. Correct detection must be obtained before the protecting signal can be cleared.*
Down main	A track on which the normal direction of trains is away from London.*
Equivalent tonnage	A method of normalising the damage caused to track by trains. This figure is used to assess maintenance quality and to mandate forms of track construction. Typical values range from 2 million for a lightly used line to over 40 million for a busy main line.*

Facing direction	Direction of travel over a set of points in which a vehicle can be directed to one of two or more diverging routes.*
Facing point lock	A device fitted to a set of facing switches at the front stretcher bar position which positively locks the switches in one setting or the other totally independently of any other switch operating mechanism.*
Flange	The extended portion of a rail wheel that provides it with directional guidance.*
Flat-bottomed rail	A type of rail characterised by a broad and shallow base or ‘bottom’.
Full depth	A switch assembly in which the switch rail and stock rail are manufactured from the same initial rail section.*
Inclined baseplate	A cast or rolled steel support designed to hold the running rail inclined at 1 in 20 towards the centreline of the track.*
Intervention limit	Measurement limit defined in TRK/001 beyond which the local management team needs to implement corrective actions within a prescribed timescale.
Jointed track	Track constructed from lengths of rail shorter than 36.6 metres (120 ft) and connected together with fishplated joints.
Locked	The term describing that the points were being prevented from accidentally changing state.
Lock stretcher bar	A bar that links the two switch rails located at the switch toe which forms part of the facing point lock mechanism fitted to facing points in areas of mechanical signalling.*
Normal	For a set of points, this is the default position which permits the passage of trains on the most used route. The opposite is reverse.*
On-Train Data Recorder	A data recorder fitted to a train that records information on the status of train equipment, including speed and brake applications.
Patroller	A person who carries out a pedestrian visual inspection of the track on a regular basis.*
Permanent way stretcher bar	A bar that links the two switch rails in a set of points and maintains their correct relationship, eg one is open when the other is closed.*
Points	Points are provided to allow trains to move from one track or route to another. This is achieved using a pair of rails that move from one side of the track to the other and allow the route to be selected, normally by the signaller. These rails are known as switch rails and are designed to abut against static rails known as stock rails.

Reverse	For a set of points, this is the position when set for the opposite route to the normal route through it.
Screw coupling	A variety of coupling used to connect rail vehicles together. It consists of a pair of loops connected by a threaded bar with left and right-hand threads on opposite ends, allowing the coupling to be lengthened and shortened as required.*
Semaphore signals	Mechanical signals generally consisting of moveable arms, the shape, disposition and attitude of which all carry meaning.*
Supplementary drive	An arrangement of rodding and cranks, hydraulics or torsion drives that transfers some of the motion of the switch toes to one or more locations further down the points.*
TGP8 gauge	A go/no-go device fitted with a specific wheel profile (P8) used to visualise the contact between a wheel and the track. The aim is to confirm that contact is made above a marker on the gauge (the 60° marker line).
Theatre indicator	A route indicator that displays letters and numbers to describe the route ahead to the driver.*
Toe	The end of a switch rail that is first traversed by a rail vehicle negotiating a switch in a facing direction.*
Track gauge	The distance between the running edges of related running rails, measured between two points just below the top of the rail (14 mm on Network Rail).*
Track twist	The change in cant, along the track, measured over a specific distance.
Vertical alignment	Describes the alignment of the top of the running rail over a short distance.
Vertical baseplate	A cast or rolled steel support designed to hold the running rail vertically rather than inclined at 1 in 20.*
Wheelchex	Locations around the network at which the load imparted by a moving wheel is measured over a distance with the aim of identifying variation in the load indicative of the presence of a wheel flat or an out-of-round wheel.

Appendix B – Summary of detailed inspection results of No. 75 points on 7 July 2012 against the requirements of TRK/053

TRK/053			On-site inspection (7 July 2012)		
Derailment Hazard	**Abbreviated inspection criteria**	**Tell tale signs**	**Output of inspection**	**Pass / Fail**	**Min. action**
Hazard 1 Sideworn stock rail	Check that top of switch rail is below base of sidewear on stock rail. Check for hogging	▪ Switch tip projects above the bottom of the sidewear scar ▪ Switch tip has been struck by wheels ▪ Switch tip has been deformed by wheels into the sideworn stock rail	Top of switch rail in line with or above sidewear scar on stock rail for 100 mm starting 100 mm from the toe	Fail	Within 7 days, grind to correct profile or ban facing moves and order replacement
Hazard 2 Stock rail and switch rail both sideworn	Check that sidewear angle on switch rail is not less than 60° for more than 200 mm. Check for hogging	▪ Switch rail may be more worn and display a flatter sidewear angle than the stock rail ▪ The wheels have formed a ramp on the switch rail ▪ Markings shave been left by the wheel flange as it has begun to climb the switch rail and then slipped back	Contact with the TGP8 gauge below the 60° marker for 240 mm starting 120 mm from the toe	Fail	Apply lubrication and within 36 hrs, grind until sidewear angle is steeper than the angle of the stock rail or ban facing moves and order replacement
Hazard 3 Stock rail headwear with less worn switch rail	Check the relative height of the switch rail compared with the stock rail. Check for hogging	▪ The switch tip has been struck by wheels	Gauge 1 passes over the top of switch rail 40 mm from toe	Pass	-
Hazard 4 Switch blade damage	Check extent and position of any damage to switch rail. Check for hogging	▪ Lipping on the gauge face of the stock rail and/or the back edge of the switch rail ▪ Horizontal cracking under lipping on switch rail ▪ Small pieces of metal chipped out of switch rail ▪ Hogging of switch rails associated with lipping	Gauge 2 vertically above the top of the damaged switch rail	Fail	Weld repair within 7 days or ban facing moves and order replacement
Hazard 5 Sharp profile (applies to hardened rails made from MHT and austenite manganese steel (AMS)	Check that square lip has not been formed on switch rail	▪ A noticeable edge or faceted surface at the gauge corner ▪ Metal dust or shavings near switch ▪ Bright marking indicating wheel contact with a sharp radius	Switch rail contacts with radius gauge Tactile evidence of a pronounced corner profile	N/A	Grind to correct profile within 3 days

* Measurements undertaken on 18 July 2012 by the RAIB

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