Rail Accident Investigation Branch

Rail Accident Report

Derailment at Hampton Loade, Severn Valley Railway
28 September 2009

Department for Transport

Report 07/2010
April 2010

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.

Any enquiries about this publication should be sent to:

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

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

Derailment at Hampton Loade, Severn Valley Railway, 28 September 2009

Contents

This page is left intentionally blank

Summary

A derailment occurred on 28 September 2009 on the Severn Valley Railway heritage line between Kidderminster and Bridgnorth. The tender of a steam locomotive hauling a passenger train became derailed as it approached Hampton Loade station. There were no injuries. The causal factors were that a spring had been replaced on the tender with one which was not of the correct type and the track had become distorted without the track maintenance staff being aware of the problem.

The RAIB have made five recommendations to the Severn Valley Railway concerning its safety management system, its engineering procedures, communication of safety related information to its staff and volunteers and its audit process.

This page is left intentionally blank

Preface

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

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

Key Definitions

3 The derailment occurred on the Severn Valley Railway (SVR), which runs between Kidderminster in Worcestershire and Bridgnorth in Shropshire. The train involved was travelling from Kidderminster to Bridgnorth.

4 The terms left and right in this report are relative to the direction of travel.

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

- abbreviations are explained in appendix A; and
- technical terms (shown in *italics* the first time they appear in the report) are explained in appendix B.

The Accident

6 The accident occurred at 16:50 hrs on 28 September 2009 as the 16:00 hrs train from Kidderminster to Bridgnorth was approaching Hampton Loade station on the Severn Valley Railway (figure 1). The train consisted of a class 4MT steam locomotive and six ex-British Railways (BR) Mark 1 passenger coaches. The locomotive tender derailed to the right as it approached the passing loop at the station. The train was carrying 32 passengers and 8 staff. Nobody was injured in the derailment.

7 The train was slowing down to stop and was travelling at less than 10 mph (16 km/h) at the time the derailment occurred on *plain line* to the south of the station (figure 2). Significant damage was caused to the track and the tender. The *points* at the south end of the loop at Hampton Loade were damaged beyond repair and the line was closed for five days while repairs were carried out to reinstate a single line through the station. This prevented trains from passing at this station pending replacement of the points.

The organisations involved

8 The railway is owned by Severn Valley Railway (Holdings) Plc who also employ the permanent staff of the railway and operate the train service. The Severn Valley Railway (Guarantee) Company provides volunteer staff from its membership to operate the service. The two companies each have their own boards of directors and there is also a joint board which brings together the board members from each company. Both companies are referred to collectively in this report as Severn Valley Railway (SVR).

9 Severn Valley Railway (Holdings) Plc and Severn Valley Railway (Guarantee) Company freely co-operated with the investigation.

Location

10 The Severn Valley Railway is a heritage railway which operates tourist trains over a former BR *standard gauge* line between Kidderminster, in Worcestershire and Bridgnorth in Shropshire. The railway runs, for most of its route, along the side of the River Severn, from which it gets its name.

11 The derailment occurred to the south of Hampton Loade station where the line was carried on an ash embankment on the west side of the river. The railway was single track throughout with a number of passing loops, one of which was located at Hampton Loade.

Equipment

12 The train consisted of six ex-BR mark 1 coaches hauled by an Ivatt class 4MT 2-6-0 steam locomotive, number 43106. The locomotive was built by BR in 1951 to a London Midland and Scottish Railway design and was owned by the Ivatt Class 4 Group.

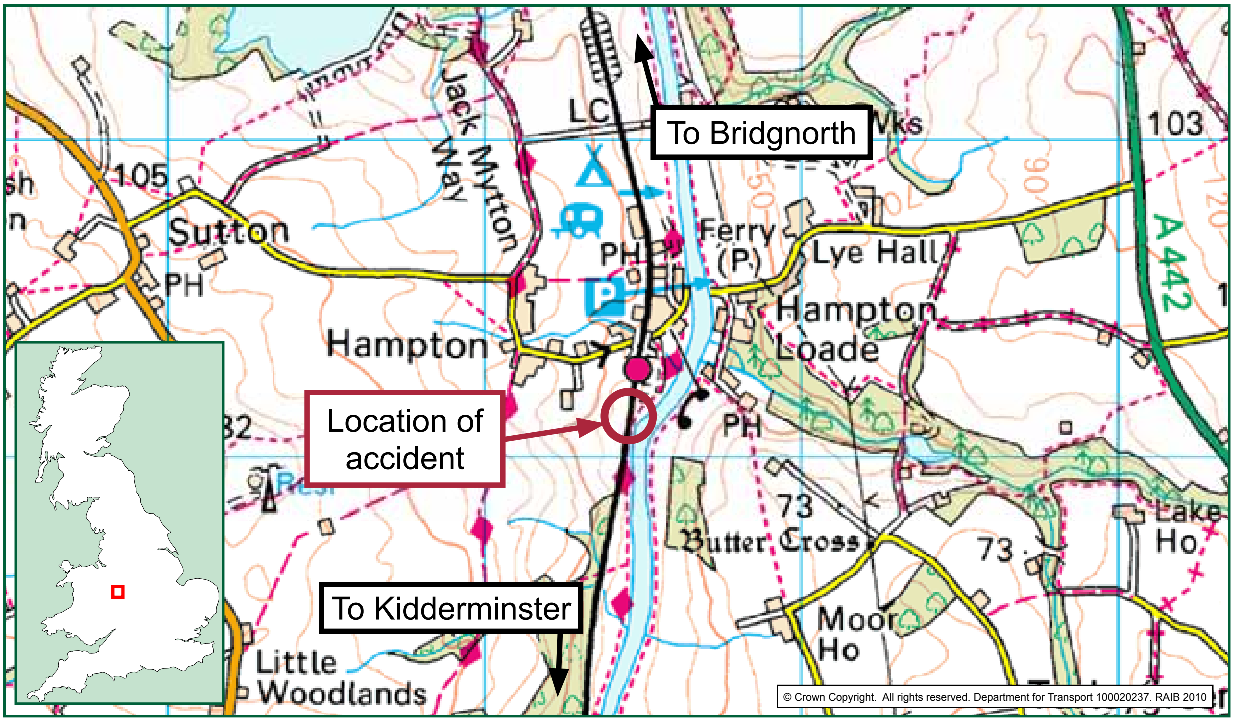

Figure 1: Extract from Ordnance Survey map showing location of accident

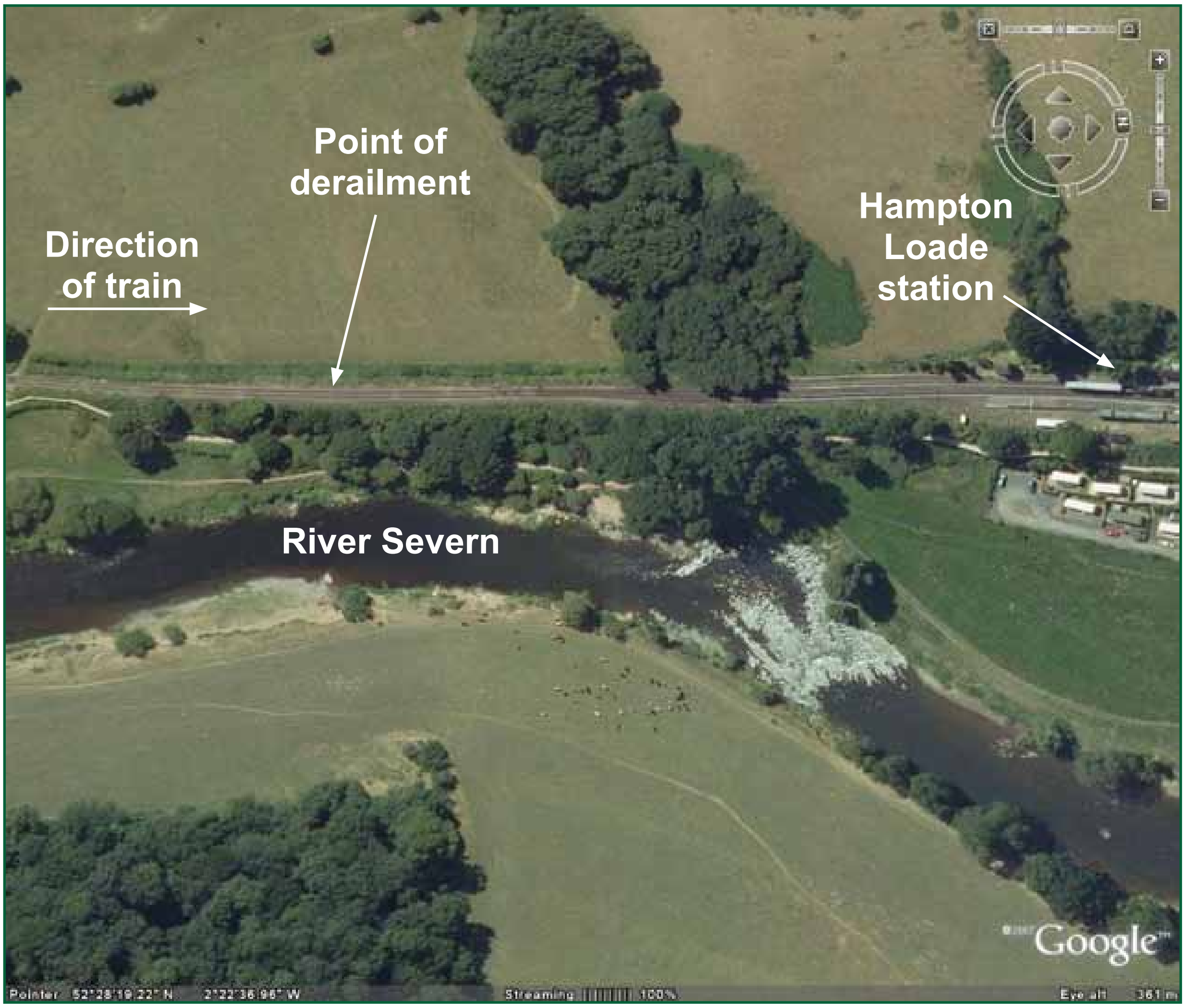

Figure 2: Aerial view of the site (courtesy of Google Earth)

13 The track at the site of the derailment consisted of 95 lbs/yard *bullhead* rails in cast iron *chairs* on concrete sleepers. The track was ballasted with a mixture of stone and ash.

Events preceding the accident

14 Locomotive 43106 had been undergoing major overhaul since 1999 and had returned to working order on 24 August 2009. The first runs of the locomotive were test runs which involved maintenance staff accompanying it to deal with any emerging problems. During one of these test runs a crack was discovered in the top leaf of the leading left side tender *axlebox* spring (an example spring is shown in figure 5).

15 A replacement spring was ordered from a spring manufacturer several weeks before the date of the accident (the date was not recorded). The order for the new spring was placed verbally and no specification or drawing was available to be supplied to the spring manufacturer. The original design of the springs would have been detailed on BR drawings at the time that the locomotive was built, but these drawings have not survived. An old spring was instead sent to the manufacturer as a pattern for the new one.

16 During the week commencing 14 September 2009 the spring manufacturer reported that they were unable to obtain the necessary 7/16" (11.1 mm) thick steel for the new spring, so on or about 23 September, SVR sent two old springs to them and asked them to make one good spring from them. The SVR needed to have the locomotive repaired and returned to service for a special event on 25-27 September 2009 and asked the spring manufacturer to ensure that the spring was ready by 24 September 2009.

17 The manufacturer delivered a new spring late in the afternoon of 24 September. The spring manufacturer told SVR that it had not been possible to reuse the parts from the old springs and so it had manufactured a new one. The manufacturer did not point out that the spring was of a different design to the old one, having fewer leaves of a thicker section. The SVR had not conducted a goods inwards inspection of the spring and there was no assessment of its suitability prior to fitting it to the tender.

18 SVR locomotive maintenance staff fitted the new spring to the tender, finishing late in the evening of 24 September. The fitters had some difficulty getting the spring to fit and had to trim approximately 25 mm off the right-hand end of the bottom leaf and at least 17 mm off the left-hand end with an angle grinder. There was no check of the installation by a person not involved with the work and no document was filled out to confirm that the work was complete and the locomotive was fit for traffic. Witnesses stated that it was customary to not produce such a document (paragraph 44).

19 The locomotive entered passenger service on the morning of 25 September and ran several return trips to Kidderminster during the special event weekend.

20 SVR's records show that, between the locomotive returning to working order and the derailment, it had covered 313 miles.

Events during the accident

21 The locomotive was running chimney first towards Bridgnorth. As the train was approaching Hampton Loade the locomotive crew heard an unusual sound from the tender and applied the brakes. The train was still slowing down as it reached the points into the loop when the tender pitched over to one side.

22 The train came to a stand with the tender on the points (figure 3).

Figure 3: The derailed tender following removal of the train's coaches

Consequences of the accident

23 Nobody was injured in the accident. All wheels of the tender derailed causing the leading and centre axle to be bent, damage to 35 metres of plain track and irreparable damage to the points.

24 The railway between Highley and Bridgnorth was closed for five days and the loop at Hampton Loade was put out of use pending installation of a new set of points.

Events following the accident

25 Two travelling ticket inspectors on the train went through the train to check the condition of the passengers. The train crew then contacted SVR traffic control to raise the alarm. SVR contacted the RAIB at 17:15 hrs.

26 Hampton Loade station is in a remote area where road access is very restricted. For this reason, the passengers on the train were evacuated by rail. The RAIB gave permission for the last coach in the train to be detached and all of the passengers on the train were moved to this coach. A locomotive was brought up to the rear of the train and took this coach back to Bewdley.

The Investigation

Sources of evidence

27 Evidence was obtained from the following sources:

- statements by SVR staff and volunteers;
- evidence gathered on site and from examination and weighing of the locomotive tender at SVR workshops;
- results of testing of the tender springs;
- photographs taken by the RAIB;
- track survey information gathered by the RAIB; and
- procedures and records supplied by the SVR.

Previous occurrences of a similar character

28 There was a derailment on the SVR at Folly Point, between Arley and Bewdley, on 21 April 1991. A Stanier 2-6-0 locomotive, no. 2968, was running tender first on a passenger train when the leading axle of its tender derailed. The derailment occurred as the train was travelling at less than 5 mph on a right-hand curve over the site of an embankment slip, which was subject to a temporary 5 mph speed restriction. The leading left wheel of the tender derailed by flange climbing.

29 The locomotive crew noticed the derailment and quickly brought the train to a stand. The SVR's investigation found that the weight distribution between the wheels of the tender was not set up correctly following maintenance. No recommendations were made regarding locomotive maintenance in the SVR's investigation report. However, the SVR have since written a company procedure which requires wheel weight distribution of vehicles to be measured after overhaul of suspension components (paragraphs 44 to 46).

Analysis

Identification of the immediate cause[1]

30 The immediate cause of the accident was the flange of the leading right-hand wheel of the tender climbing over the right-hand rail. Flange climb derailments occur when a vehicle encounters a section of the track where the level of one rail relative to the other changes rapidly over a short length (a track twist) and the vehicle suspension is unable to keep one or more of the wheels firmly in contact with the rail. Twist within the frame of the vehicle can also cause a wheel to lose firm contact with the rail.

31 When observed by the RAIB following the re-railing operation, the leading right-hand wheel was not in contact with the rail. The track at the site of the derailment had a 1 in 94 *twist,* where the right rail was lower than the left. Marks on the rail and subsequent damage indicates that the leading right-hand tender wheel derailed on this twist.

Identification of causal[2] and contributory factors[3]

32 The RAIB identified the following causal factors to the derailment:

- the replacement of a spring on the tender with one of a different design without checking that the weight was evenly distributed between the wheels;
- SVR locomotive maintenance staff did not follow the SVR locomotive maintenance procedure when replacing the spring; and
- the track at the site of the derailment contained a track twist.

33 The permanent way staff were not aware of the track twist. This lack of awareness was a contributory factor to the derailment.

Tender wheel weight distribution

34 The new spring fitted to the leading left-hand wheel on 24 September 2009 was of a different design to the springs on the other five tender wheels (figure 4). Figure 5 shows the spring on the leading right side (the photographs in figures 4 and 5 were taken while the tender was derailed with all the weight of this axle on the right-hand side wheel). The new spring had 14 leaves, each ½" (12.7 mm) thick. The original spring had 15 leaves, each 7/16" (11.1 mm) thick. The other springs fitted to the tender also had leaves 7/16" (11.1 mm) thick except for the top leaf in each spring. The springs fitted to the centre axle of the tender both had top leaves ½" (12.7 mm) thick. On the rear axle the spring on the left side had a top leaf 5/8" (15.9 mm) thick and the spring on the right had a 7/16" (11.1 mm) thick top leaf.

---

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

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

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

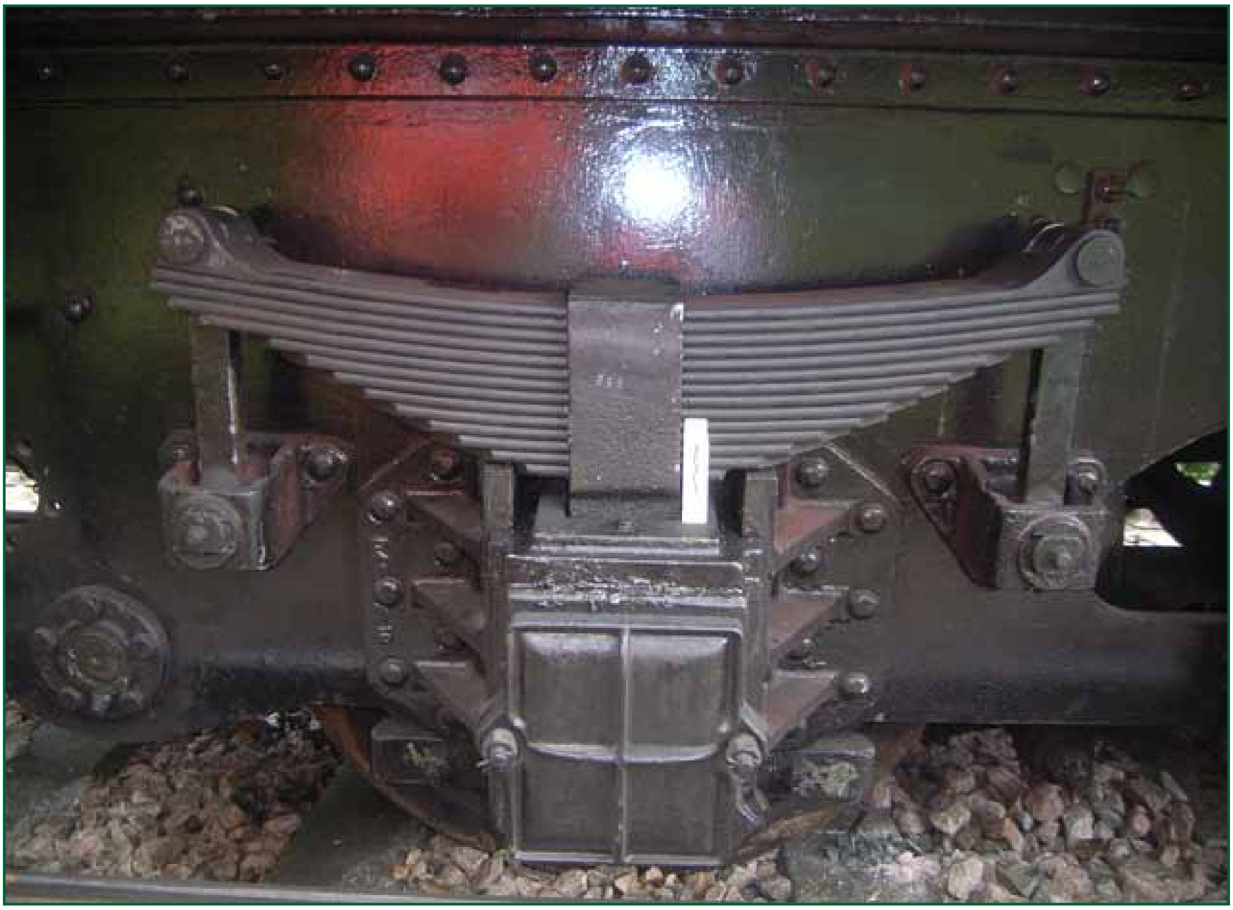

Figure 4: New spring fitted to leading left side of tender

Figure 5: Existing spring fitted to leading right side of tender

35 The RAIB measured the loads on each wheel of the tender after the locomotive had been recovered to the SVR maintenance shed at Bridgnorth. The results are given in figure 6. The high load on the leading left wheel would typically cause the wheel at the rear right side of the tender to also have a high load, in order to maintain the static equilibrium of the tender. However, in this case the centre wheel on the right side had a higher load than the rear wheel. When dismantled, the spring at the rear right side had three cracked leaves. This reduced its stiffness and would have led to a lower wheel load than would otherwise be the case.

36 The wheel loads shown in figure 6 were recorded after the tender had been rerailed and taken to Bridgnorth. It is likely that it suffered some damage to its suspension in the derailment, as evidenced by the bent front and centre axles, so the load on the leading right wheel was likely to have been reduced, but not zero, at the time of the derailment. If it had been zero before the incident it is likely that the tender would have derailed on any left-hand curve. The extent of the bend in the front axle was such that, when rotated, the wheel rim run out was approximately ¼” (6 mm).

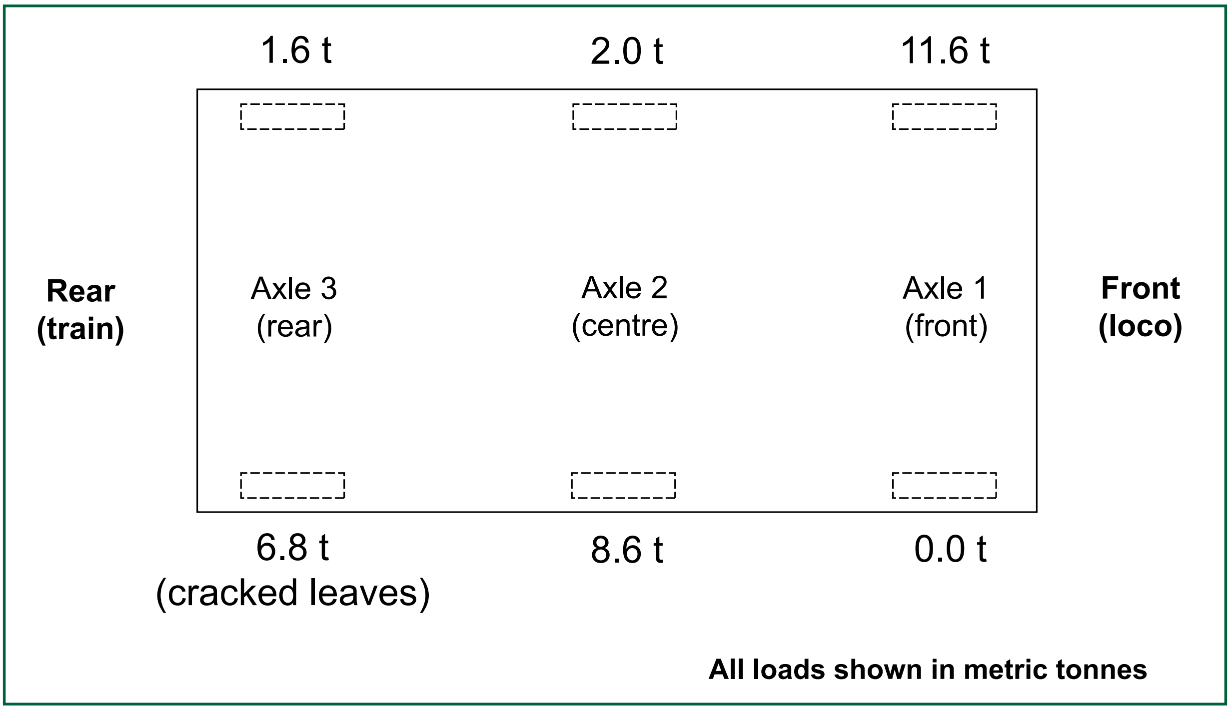

Figure 6: Plan showing wheel loads on tender following re-railing

37 The SVR removed all six springs from the tender and measured their *free height* and stiffness, using a simple test rig. These results were supplied to the RAIB. The springs were then taken to the manufacturer for further examination and testing, which was carried out by an independent test organisation. These results were also supplied to the RAIB. The results were found to be in close agreement.

38 There are two important parameters relating to a spring; its free height and its stiffness. The greater the free height of a spring, the more it needs to be compressed to fit a given space. This compression increases the load taken by that spring (the *preload)*. The stiffness of the spring determines how much load it requires to be compressed by a given amount. The stiffness and free height must both be defined when specifying a spring for a given application.

39 Differences in the free height between springs on the tender were allowed for by inserting shims between each spring and its axlebox. The thickness of the shims present on each axlebox was measured by the SVR when the springs were removed.

40 When tested, all springs, including the new spring, were found to have stiffnesses that were within 10% of the mean stiffness of the group, except for the spring on the rear right side, which was found to have three cracked leaves.

41 When the free height of the springs was measured, the new spring on the front left side had a greater free height than the others (257 mm compared to 217 mm – 229 mm for the original springs). This meant that it had to be compressed further to fit the tender. The RAIB calculated the theoretical weight on each wheel based on the measured spring stiffness and the initial free height plus packing thickness of each spring. The results of this calculation were in agreement with the wheel loads measured following the derailment (see figure 6) and showed that the effect of the increased preload of this spring led to that wheel carrying a disproportionately high load whilst the load on the other wheel on the axle was reduced to almost zero.

Locomotive maintenance procedures

42 The SVR's procedure for the maintenance of locomotives was not followed when the replacement spring was fitted to the tender. Not following the engineering department company procedure was a causal factor to this derailment.

43 The SVR have a safety management system (SMS) which is contained in an appendix to their rule book. This starts with a statement of the safety and environmental policies of the SVR which include the statement 'This advice will be supplemented as necessary by more detailed requirements within the various SVR Departments, to cover specific tasks or conditions'.

44 Although not referenced directly from the SMS, the SVR issued engineering department company procedure CE007 'The overhaul and maintenance systems for Severn Valley Railway based steam locomotives' in October 2003. This document included the following requirements:

- purchase orders for goods or services to be made in writing;
- the specification of any parts to be manufactured shall be detailed on the purchase order issued to the supplier;
- any change to the specification of safety critical parts to be approved by the chief engineer; and
- all repair work to be inspected by the chief engineer, or a competent person appointed by him, and a written record of the inspection to be kept.

The document also included a list of the responsibilities of key staff, including the chief engineer and locomotive production manager. The requirement for the inspection of safety critical parts was repeated in several places within the document and the responsibility for this work was variously ascribed to the chief engineer and the locomotive production manager. No details were given of the extent of the inspection that was required.

45 The SVR did not have a drawing or specification for the new spring, so the spring supplier was not supplied with this information. The spring supplier, having been unable to repair the old spring (paragraph 17), supplied a spring of a different design, with fewer, thicker leaves. When delivered to the SVR for fitting to the tender, nobody checked that the new spring was of the correct type. The SVR procedure does not include a requirement for such checks and, in any case, there was no drawing or specification to compare it to. The spring was fitted to the tender without checking that it was of the same design as the other springs and no check was done that the spring installation was correct.

46 The responsibilities of the locomotive production manager in CE007 include the following:

- day to day management of the maintenance staff;
- ensuring that all work undertaken on safety critical components is checked by a competent person independent of those carrying out the work; and
- retaining certificates on file of mandatory tests (which included wheel weight distribution).

47 The SVR did not measure the wheel weight distribution of the tender after installation of the new spring.

Figure 7: Site of the derailment

Track Twist

48 The track at the point of derailment contained a twist which had not been identified by the SVR permanent way staff. This track twist was a causal factor to the derailment.

49 The section of track on which the tender derailed was surveyed by the RAIB after the derailment. The *cant* and *gauge* of the track was measured in the unloaded state and the extent of *voiding* beneath the sleepers was measured as the coaches were taken back over that section of track. Figure 7 shows a general view of the track at the site of the derailment.

50 The static track twist was found to be 1 in 94, measured over a 3 m base. The Network Rail limit for track twist over 3 m is 1 in 90. If a track twist of 1 in 94 had been found on Network Rail tracks it would have been considered a defect requiring attention within 36 hours.

51 SVR had a draft engineering department company procedure for track maintenance, CE021, but at the time of the incident it had not been issued. CE021 did not contain any limits for track twists. SVR had a document entitled 'Severn Valley Railway Permanent Way Department Maintenance Policy Statement' dated 20 October 1995. This stated that traffic will not be permitted to operate over track twists in excess of 1 in 150. The track maintenance staff were not aware of the existence of this document at the time of the derailment and stated that they worked to the Network Rail limits.

52 The SVR SMS quoted Network Rail standard RT/CE/S/104 as a reference standard for SVR track. The twist limit contained in RT/CE/S/104 is the 1 in 90 figure mentioned in paragraph 50. SVR staff did not have formal access to Network Rail standards.

53 The track was patrolled twice a week during the railway's operating season. These intervals were in accordance with the draft engineering instruction CE021. The last patrol before the derailment was on 27 September 2009 and no defects were found at this location. The track patrollers did not carry a cant measurement gauge with them when patrolling and instead relied on visual cues to identify geometrical defects in the track, such as dips.

54 The SVR permanent way department records showed the last item of work done at this location was *fishplate* oiling on 21 June 2009. Witness evidence stated that maintenance was undertaken to remedy some dipped rail joints at this location in the week before the derailment, but this was not shown in the permanent way department records. No cant measurements were taken during this work. The fact that the SVR permanent way staff were unaware of the twist at this location was a contributory factor to the accident.

Identification of underlying factors[4]

Track Maintenance

55 The SVR did not routinely measure the track geometry and did not have a procedure to require such measurements. Track geometry defects were identified by visual inspection. No geometry defects had been identified at the site of the derailment. Deficiencies in the SVR system for track maintenance were an underlying factor to this accident.

[4] Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

Safety Management System

56 SVR's non compliance with their SMS and their engineering department company standards was an underlying factor to this accident.

57 The SVR's SMS was contained in appendix K to the rule book. This was issued to all staff and volunteers. The version current at the time of the derailment was version 1.0 dated 30 October 2008.

58 The SVR did not brief their staff and volunteers on the content of the SMS but relied on them to read it for themselves. Each copy of appendix K contained an acknowledgement slip which asked the recipient to 'certify that I have received a copy of the general appendix section K and will read and abide by all those sections relevant to my work on the Severn Valley Railway'.

59 The engineering department company standards were drawn up between 2003 and 2007 and SVR considered that they represented the systems and processes that were being followed at the time. For this reason, there was no briefing of CE007 to the staff as it was considered that they already knew what was in it. Witness evidence showed that locomotive maintenance staff were unaware of some of the requirements of CE007, in particular the need to measure and record the wheel weight distribution following replacement of the spring and the need to have the repair work checked and signed off by a competent person not involved with the work.

60 Appendix K did not refer directly to the engineering department company standards; instead it had a general statement that it would be supplemented by more detailed requirements in each department (paragraph 43). Details of where these more detailed requirements could be found were not given. There was no system of routine briefing of standards to staff and volunteers. The view of senior SVR staff was that the organisational structure of SVR, with two separate companies, may have made the communication of safety information more difficult than would have otherwise been the case. Poor communication of information regarding engineering standards to the staff responsible for implementing those standards was a probable causal factor to this accident.

61 Appendix K included a cross reference table between the basic elements of an SMS, as defined in the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (known as ROGS), and appendix K. This table sets out which parts of the appendix implemented each basic element of the SMS. One such element was the need to audit compliance with the SMS. The SMS stated that audit reports were to be presented to the safety committee in the first instance. The SVR had not carried out any such audits.

62 The engineering department company standard CE007 stated that audits of compliance with the standard must be carried out. The SVR had not carried out any such audits.

63 Duty holders have a responsibility, under the ROGS regulations, to put in place an SMS and to establish and maintain it. There is no requirement for the Office of Rail Regulation (ORR) to carry out audits of compliance with the SMS, unless they have specific concerns. This was the case before 2006 under the Railways (Safety Case) Regulations 2000 and is still the case under the ROGS regulations.

Conclusions

Immediate cause

64 The immediate cause of the accident was the leading right-hand wheel of the tender flange climbing over the rail at the site of a track twist. An incorrect spring had been fitted to this axle of the tender (paragraph 30 and recommendations 1, 2 and 3).

Causal factors

65 The causal factors were as follows:

- The SVR's procedure for maintenance of locomotives, CE007, was not followed (paragraph 42 and recommendations 2 and 3). In particular:
  - there was no check that the new tender spring was of the correct type;
  - there was no check by a competent person not involved with the work that the spring had been installed correctly;
  - the wheel loads were not checked before placing the locomotive back into service; and
  - the chief engineer did not approve the change to the spring design (the arrangements were such that he was unaware of the change).
- A significant track twist was present at the site (paragraph 48 and recommendation 1).

66 The following factor was probably causal;

- SVR staff were unaware of the requirements of their engineering department company standard for maintenance of locomotives (paragraph 60 and recommendations 3 and 4)

Contributory factors

67 Contributory factors were:

- The SVR permanent way staff were unaware of the presence of the track twist (paragraph 54 and recommendation 1).
- The SVR SMS did not include the engineering department company standards (paragraph 60 and recommendation 2).

Underlying factors

68 The underlying factors were that:

- The SVR track maintenance system was deficient, in that there was no process for routine measurement of track geometry (paragraph 55 and recommendation 1).
- The SVR did not follow their SMS and their engineering department company standards (paragraph 56 and recommendation 5). The extent of the non-compliance had not been identified to the management due to the absence of audits.

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

69 The SVR relaid the track at the site of the derailment and have subsequently commissioned a geotechnical site investigation to determine the reason for the track movements there. The embankment has been reconstructed and new track and points installed.

70 The SVR have replaced all of the springs on the locomotive tender with ones that have been tested and declared by the spring manufacturer to be suitable for use as a set. On completion of this work the wheel weight distribution was checked.

71 The SVR joint board have clarified that full responsibility for safety rests with the SVR (Holdings) plc board of directors and audits are being undertaken by the safety committee.

72 The SVR have reported that they have commenced revision of their SMS and departmental standards, including the engineering procedures for permanent way and for maintenance of locomotives.

73 The SVR have purchased equipment for static weighing of locomotives and for dynamic weighing of vehicle axles in service.

74 The SVR locomotive department reported that it is developing a database of required design parameters for locomotive springs.

Recommendations

75 The following safety recommendations are made[5]:

Recommendations to address causal and contributory factors

1 SVR should review and revise as appropriate the adequacy of its procedures for managing the risk arising from track conditions. This should include, but not be limited to, reference to periodicity of checks, measurement techniques, maintenance and safety limits on track geometry and actions to be taken on reaching those limits. Where external documents are referenced, SVR should make these available to their staff. Associated management arrangements should be recorded in the SMS.

2 SVR should revise its SMS to reference the engineering department company standards.

3 SVR should re-brief all staff and volunteers on the SMS and their responsibilities within it.

4 SVR should review their management structure with the aim of making changes to improve the communication of safety related information within the railway.

5 SVR should put in place procedures to ensure that audits of compliance with the SMS are carried out in a timely and effective manner.

---

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

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

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

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

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

Appendices

Appendix A - Glossary of abbreviations and acronyms

BR	British Rail(ways)
ROGS	Railways and Other Guided Transport Systems (Safety) Regulations 2006
SVR	Severn Valley Railway
SMS	Safety Management System

Appendix B - Glossary of terms

Axlebox	The metal housing on the end of an axle which contains the bearing.
Bullhead (rail)	A rail cross section which has a bulbous head and foot and a straight web.
Cant	The elevation of one rail above the other in a curve.
Chair	A metal casting which supports a bullhead rail on the sleeper.
Fishplate	Steel plate used to join rails together.
Free Height (of a spring)	The overall height of a spring when it has no load applied to it.
Gauge	The distance between the rails.
Plain line	A section of railway track which does not include any points.
Points	A section of track with moveable rails that can divert a train from one track to another.
Preload	The amount of force in a spring after it has been compressed to fit into the space allocated to it.
Standard gauge	The distance between the rails on most UK railways. This is between 1432 and 1438 mm.
(track) Twist	The difference in cant between two points a fixed distance apart (the twist base).
Voiding	A track defect whereby gaps form beneath sleepers which allow the rail to move downwards when a train passes.

This page is left intentionally blank

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

Any enquiries about this publication should be sent to:

RAIB
The Wharf
Stores Road
Derby UK
DE21 4BA

Telephone: 01332 253300
Fax: 01332 253301
Email: enquiries@raib.gov.uk
Website: www.raib.gov.uk