Rail Accident Investigation Branch

Rail Accident Investigation: Interim Report

Collision between passenger trains at Salisbury Tunnel Junction
31 October 2021

Report IR1/2022
February 2022

Note: This interim report contains information obtained from the Rail Accident Investigation Branch's (RAIB) initial examination of the available evidence. Some of the information contained in this report may be refined or changed as the investigation progresses.

The purpose of an RAIB investigation is to improve safety by preventing future railway and tramway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability. Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

Collision between passenger trains at Salisbury Tunnel Junction, 31 October 2021

Summary

1 At around 18:43 hrs on 31 October 2021, train reporting number 1L53, the 17:20 hrs South Western Railway passenger service from London Waterloo to Honiton, collided with the side of train 1F30, the 17:08 hrs Great Western Railway passenger service from Portsmouth Harbour to Bristol Temple Meads. The collision took place at Salisbury Tunnel Junction, which is on the immediate approach to Fisherton tunnel, near Salisbury in Wiltshire.

2 The impact of the collision caused the front two coaches of train 1L53 and the rear two coaches of train 1F30 to derail. Both trains continued some distance into Fisherton tunnel following the collision, before they came to a stop. Thirteen passengers and one member of railway staff required treatment in hospital as a result of the accident, which also caused significant damage to the trains and railway infrastructure involved.

Figure 1: Aerial view of the trains involved once they came to a stand following the collision, showing the junction and tunnel mouth

3 Train 1L53 approached Salisbury Tunnel Junction on the down main line. The movement of train 1F30 across the junction was being protected from trains approaching on this line by signal SY31, which was at danger (displaying a red aspect). Train 1L53 passed this signal, while it was at danger, by 191 metres, before colliding with train 1F30.

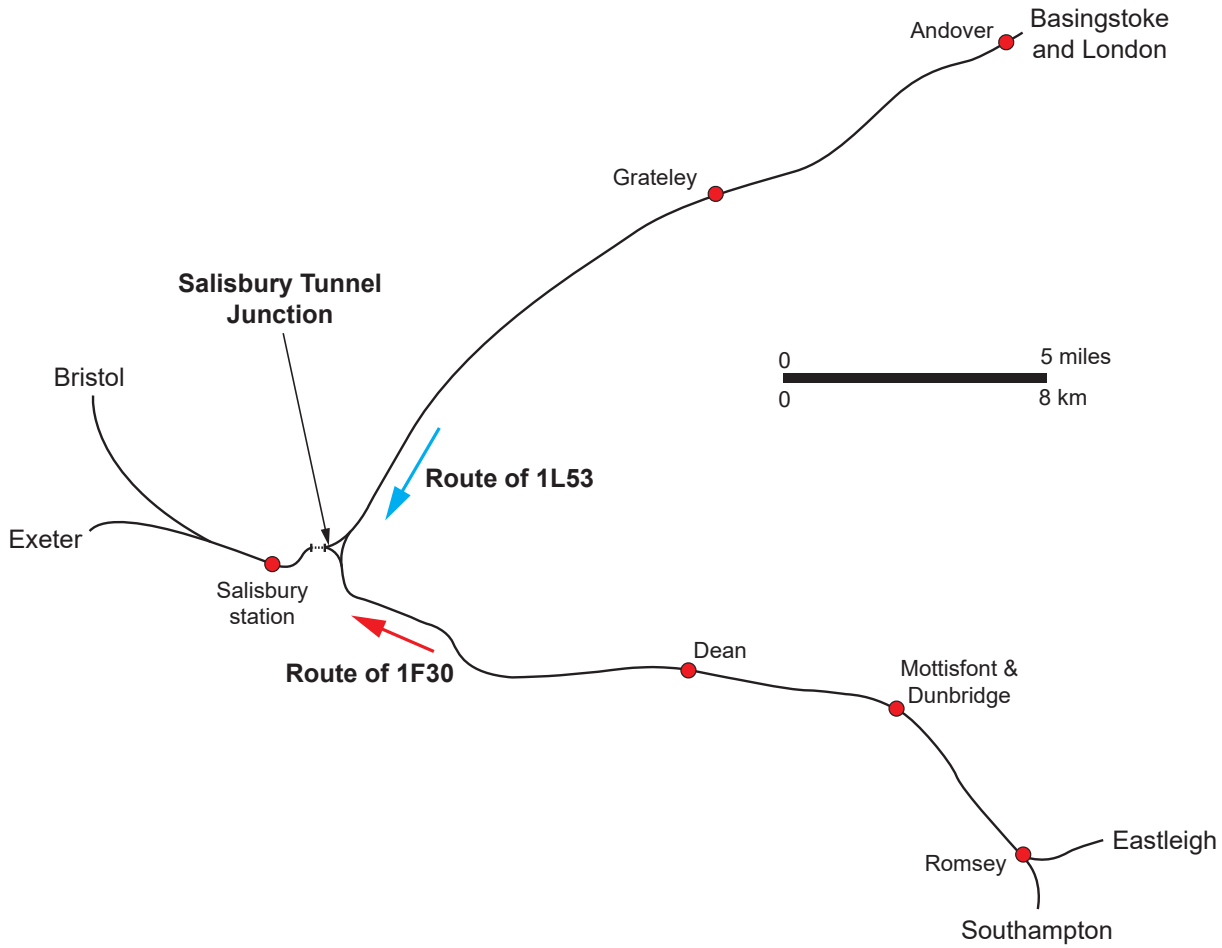

Figure 2: Rail routes around Salisbury

RAIB's role and the context of this interim report

4 RAIB is responsible for conducting independent investigations into railway accidents in the UK. The purpose of an RAIB investigation is to improve the safety of railways and to prevent further accidents from occurring. RAIB does not apportion blame or liability, enforce the law or carry out prosecutions.

5 RAIB investigations are independent of those undertaken by other public bodies, such as the Office of Rail and Road, and the railway industry itself. However, we will work alongside investigations being undertaken by others and may share certain evidence with them, where this is appropriate and allowed by the law.

6 This interim report provides some key information including the RAIB's findings from its initial investigation. It builds upon the information already provided on RAIB's website. A final report will be published on completion of the investigation. All RAIB investigation reports are available on the RAIB website.

Background information

People

7 In total, there were around 200 passengers on the two trains. Each train had a driver and guard on board when the accident occurred. There was also a GWR driver who was on duty and travelling as a passenger on train 1F30.

Parties involved

8 The railway infrastructure at Salisbury is owned, operated and maintained by Network Rail, who also employed the signallers at Salisbury signal box. Salisbury Tunnel Junction forms part of Network Rail's Wessex route, which is part of the Southern Region.

9 Train 1L53 was operated by First MTR South Western Trains Ltd, trading as South Western Railway (SWR), who also employed the train's driver and guard.

10 Train 1F30 was operated by First Greater Western Ltd, trading as Great Western Railway (GWR), who also employed that train's driver and guard.

Features of the route and accident location

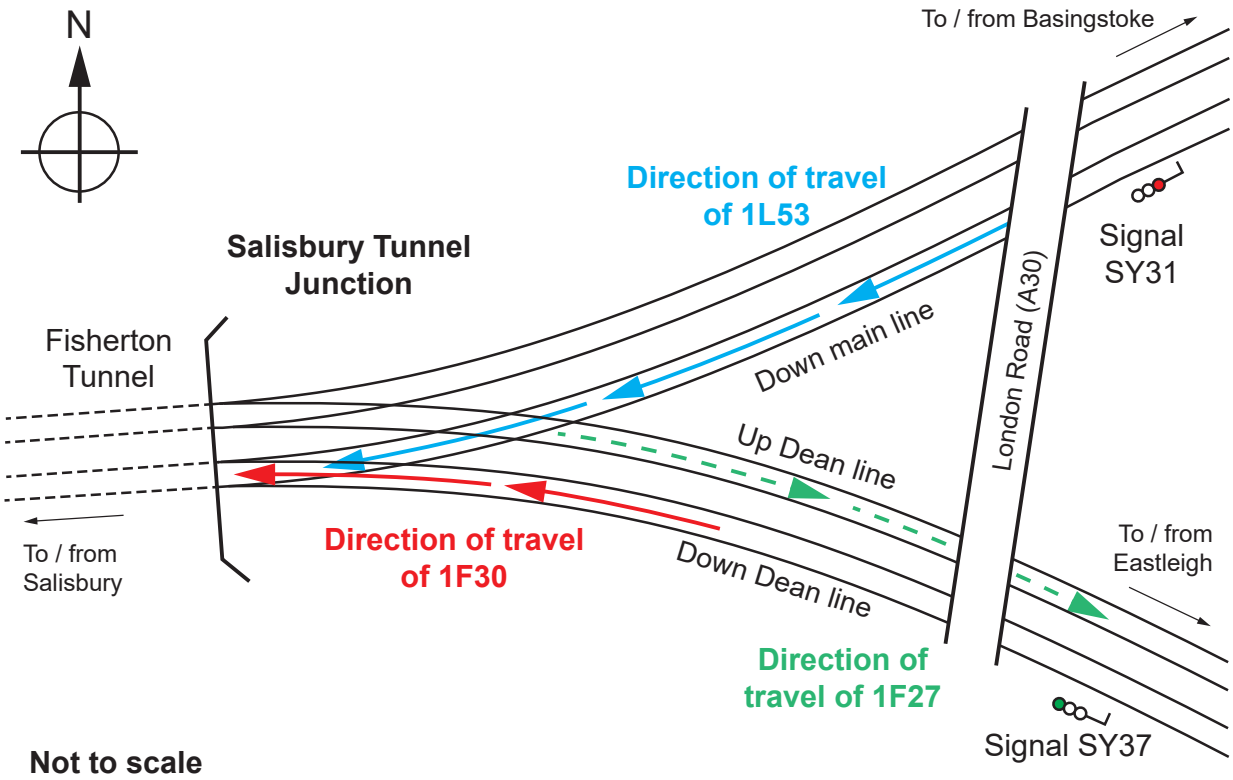

Figure 3: Diagram of location showing the approach of the trains involved in the collision

11 At the time of the accident, train 1L53 was travelling on the route from London (Waterloo) to Salisbury via Basingstoke, on the down main line. Train 1F30 was approaching Salisbury on the route from Southampton via Romsey, travelling on the down Dean line.

12 At Salisbury Tunnel Junction, the up and down main lines meet the up and down Dean lines. The junction is located immediately on the approach to Fisherton tunnel, which is 443 yards (405 metres) long, and located just over 1 mile (1.6 km) east of Salisbury station.

13 The maximum permitted speed for trains approaching the junction on the down main line is 90 mph (145 km/h), reducing to 50 mph (80 km/h) at a point 724 metres before the junction. The down Dean line is sharply curved on the approach to the junction and has a maximum permitted speed of 20 mph (32 km/h).

14 Signalling in the area is controlled from a signal box at Salisbury station. Signal SY31 protects the junction for trains approaching on the down main line. This is a three-aspect colour light signal, located around 191 metres from the point where the collision occurred. Before reaching signal SY31, trains approaching the junction on the down main line pass signal SY29R and signal SY29, which are respectively 3,314 metres and 978 metres from the point of collision.

15 Signal SY37 protects the junction for trains approaching on the down Dean line and is located 115 metres from the point of collision.

External circumstances

16 On 31 October, there were strong winds and heavy rain in the Salisbury area. Between 06:00 hrs and 18:00 hrs around 21 mm of rain fell, and in the morning wind from the west and south-west was gusting up to 63 km/h. The air temperature during the day rose to around 13°C, but at the time of the accident it was around 8°C. It is likely that the rain and wind were factors in the events leading up to the accident.

The trains

17 Train 1L53 was formed of a single three-coach class 159 diesel multiple unit (DMU), number 159102. Train 1F30 was formed of a pair of two-coach class 158 DMUs, numbers 158762 (leading) and 158763 (trailing). Both trains were built between 1989 and 1992 by BREL at Derby and were of a very similar design.

The accident

18 Train 1F30 left Portsmouth on time at 17:08 hrs, but was 18 minutes late by the time it left Romsey at 18:27 hrs. The signaller at Salisbury decided to hold train 1L53 at signal SY31 to allow train 1F30 to proceed into Salisbury station. This would also allow train 1F27, the 16:58 hrs GWR service from Bristol Parkway to Fratton, to be routed across Salisbury Tunnel Junction towards Romsey and Eastleigh. The signaller set the route to permit these movements, clearing signal SY37 for train 1F30 and signal SY40 for train 1F27. Signal SY31 was maintained at danger to protect these movements. Train 1F27 left Salisbury at 18:38 hrs and passed clear of Salisbury Tunnel Junction and onto the up Dean line around 18:42 hrs.

19 Train 1L53 is normally formed of nine vehicles, consisting of three DMUs coupled together, each of three coaches. However, services were disrupted by strong winds on 31 October which brought down trees throughout the network and resulted in many delays and cancellations. This meant that only a single three-coach DMU was available to form train 1L53.

20 The train left Waterloo one minute late at 17:21 hrs, and called at Clapham Junction and Woking, where congestion meant it left six minutes late, at 17:52 hrs. Train 1L53 then called at Basingstoke and Andover, which it departed from at 18:30 hrs. After leaving Andover, the on-train data recorder (OTDR) shows that the train was travelling at around 90 mph (145 km/h), the permitted speed for the section of line, when it passed Grateley, 11 miles (18 km) from Salisbury. It continued to run at around this speed towards Salisbury.

21 At 18:41:09 hrs, 1 minute and 47 seconds before the accident (timings in this section are taken from the train's OTDR, adjusted to synchronise with the time recorded by the signalling system), the driver of train 1L53 shut off power and allowed the train to coast down the prevailing 1 in 169 gradient. Ten seconds later he acknowledged the AWS warning for signal SY29R, which was showing a double yellow preliminary caution aspect. At 18:42:03 hrs, around 1,600 metres after passing signal SY29R and with the train travelling at 86 mph (138 km/h) on level track, the driver made a step 2 brake application. This was in accordance with his usual practice and was done with the intention of being able to stop the train at signal SY31, which was at this point around 1,500 metres away. Although the train's speed began to reduce, analysis of OTDR data shows that its wheels began to slide almost immediately after this brake application was made. The driver made a full-service brake application five seconds later and moved the brake controller to the emergency brake position after a further six seconds. The train's wheel slip/slide prevention (WSP) system was active throughout this braking, but the train's speed reduced only slowly.

22 As the train approached signal SY31, which remained at danger, the Train Protection and Warning System (TPWS) fitted to the train detected that it was travelling above the set speed of the overspeed sensor (OSS) system fitted on approach to the signal, 34.5 mph (55.5 km/h). The TPWS system therefore made an emergency brake demand. This had no effect on the degree of braking demanded, because the maximum available braking had already been applied by the driver.

23 Train 1F27 passed across and clear of Salisbury Tunnel Junction less than 40 seconds before train 1L53 arrived. Subsequently, the driver of train 1L53, which was still sliding and rapidly approaching signal SY31, saw train 1F30 appear from the left and move into the path of his train. Train 1F30 was at this point travelling at 20 mph (32 km/h).

24 At the point where the two trains collided, train 1L53 was travelling at between about 52 and 56 mph (84 and 90 km/h). Train 1L53 struck 1F30 on its right-hand side near the front of the fourth coach, as both trains crossed the junction and as 1F30 was entering Fisherton tunnel.

Consequences

25 As a result of the collision, the coupling between the two DMUs which formed train 1F30 parted, and the leading two coaches, which were otherwise undamaged, came to a stop as their brakes applied automatically. The third vehicle of train 1F30 was derailed and forced to the left, against the tunnel wall. The last vehicle of this train was also derailed, and its front left corner struck the tunnel portal.

Figure 4: Estimated position of trains when they collided

26 Train 1L53 was travelling much faster than train 1F30, and the front corner of its leading vehicle first struck the leading end of the fourth coach of train 1F30, and then scraped along the side of the third coach until it stopped, tilted over to the right and inside the tunnel. The second coach of train 1L53 also derailed and tilted over to the right and came to rest immediately outside the tunnel, alongside the last coach of train 1F30. The last coach of train 1L53 was not derailed and remained upright.

27 Witness evidence indicates that the driver of train 1L53 remained in the driving cab until he realised that he could do nothing more to prevent the collision. The impact occurred as he was attempting to leave the cab, when he was knocked unconscious and became trapped. The driver sustained serious injuries as a result of the collision and was subsequently freed from the cab by the emergency services.

28 The driver of train 1F30 felt the impact of the collision and immediately made a railway emergency call on the GSM-R system to say that his train was derailed. This call was received at Salisbury signal box. The signaller at Salisbury put all signals in the area to danger, which caused train 1F27 to stop at signal SY34, between Salisbury and Dean.

29 On completion of the emergency call, the driver of 1F30 left his cab to investigate what had happened. He went back through the train and found the rear two coaches had become detached, and only then realised that another train had collided with his own train. He returned to the cab and made another railway emergency call to the signal box to report this.

30 The emergency services arrived at the scene around 19:03 hrs. A major incident was declared by Network Rail at 19:06 hrs and by the Dorset and Wiltshire Fire and Rescue Service at 19:14 hrs. Passengers in both trains were assisted from the damaged vehicles by the emergency services and railway staff. Evacuation of the trains was completed by 19:56 hrs.

Figure 5: The scene inside the tunnel, showing the third coach of train 1F30 (right) and the leading coach of train 1L53 (left). Parts of the driving cab of train 1L53 have been cut away by the emergency services to release the trapped driver

31 As well as the serious injuries sustained by the driver of train 1L53, thirteen injured passengers were taken to hospital in Salisbury. Two were kept in hospital overnight and were discharged the next day.

32 The accident caused extensive damage to both trains, the track and the interior of Fisherton tunnel. Recovery of the damaged vehicles began on 4 November and was completed on 7 November. Repair and reinstatement of the track and signalling was completed on 15 November, and services through the junction to Salisbury resumed on 16 November.

Figure 6: The scene during recovery of the damaged vehicles, showing the rear of the third coach of train 1F30 (left) and the first coach of train 1L53 (right), after the removal of the vehicles that had been behind them

The investigation

33 The collision was notified to RAIB by Network Rail around ten minutes after it happened. The investigation began immediately, with inspectors arriving on site from 21:10 hrs on 31 October.

34 Since the accident, RAIB has:

- surveyed the accident site, including a detailed survey of railhead condition on the down line for the two miles (3.2 km) leading up to the point of collision
- commissioned measurements of railhead friction and analysis of railhead contaminants over the length of the down line surveyed
- moved the damaged vehicles to a secure location and started their examination and testing
- obtained data from the OTDRs from both trains involved, and from other trains that passed through the area before the accident
- gathered physical, documentary, and electronic evidence
- gathered evidence from witnesses.

Initial findings

Railhead condition

35 RAIB's survey of the down main line on the approach to the accident site found evidence of railhead contamination at twelve sample locations from 80 miles 32 chains to immediately before the point of collision at 82 miles 36 chains, a length of two miles (3.2 km).

36 The railhead was found to be contaminated throughout the areas surveyed with a black deposit. This deposit consisted of leaf material which had been crushed under the wheels of passing trains and which is often associated with low adhesion conditions. Analysis showed that many areas had a medium or heavy level of contamination, and that the thickness of the leaf deposit was relatively consistent through each of the areas surveyed. It is likely that the rails were wet at the time of the accident. Wet values of the coefficient of friction measured as part of the post-accident survey were found to be between 0.2 and 0.02, suggesting that there was low friction between the wheels and the railhead. The average rate of deceleration of train 1L53 suggests adhesion levels closer to the 0.02 value were prevalent at the time of the accident. Samples taken from the area around signal SY29 and between there and the junction showed that the deposits were smeared and flaky and typical of the sort of contamination layers which exist after train wheels have slid over them.

Figure 7: The railway at signal SY29R, looking towards Salisbury

Figure 8: Railhead contamination on the down main line near signal SY29R

Figure 9: The down main line near SY31 signal, showing railhead contamination (image courtesy of British Transport Police)

Train driving

37 OTDR data shows that train 1L53 was travelling within the permitted speed as the train approached Salisbury Tunnel Junction. RAIB's investigation will continue to consider the driver's actions and factors that may have influenced them, including the industry's arrangements for advising drivers about poor adhesion conditions and the guidance and instructions relating to reporting low adhesion and driving in such conditions.

Signalling

38 Evidence indicates that the signalling system was operating as designed before the accident. Signal SY31 was at danger as train 1L53 approached it, and the routing of trains across Salisbury Tunnel Junction on the day of the accident was in accordance with normal signalling practice.

Management of low adhesion

39 Network Rail has arrangements for managing the risk of low adhesion during autumn. These are set out in its document NR/L2/OPS/021 issue 8 'Weather – managing the operational risks'. This covers both its planning for seasonal management arrangements, and its response to forecast and actual extreme weather events.

40 Network Rail is divided into routes, which are the company's devolved management organisations covering sections of the network. Each route is required to implement seasonal management arrangements and to review and re-issue these at least annually. The arrangements for Wessex route for 2021 were described in the document 'Autumn working arrangements', issued on 15 September 2021. These arrangements included railhead treatment trains (RHTT), which take the form of multi-purpose vehicles which can deliver high-pressure water jetting and which may also apply an adhesion modifier gel.

41 The object of this treatment regime is to remove crushed leaf film or other contaminants from the railhead and to apply a sand-based gel as required, once the railhead is clean. The gel is intended to help break up any remaining leaf film on the railhead, and to raise the adhesion level by introducing a friction improver into the wheel/rail interface.

42 With reference to the RHTT programme, the Wessex route Autumn working arrangements document stated that '*Wessex aspire for all routes to be covered once in 24 hours throughout the Autumn period.'* On weekdays (Monday to Friday) two RHTT were scheduled to operate over each section of line each day. The working arrangements document stated that this was '*to maximise the chance of each site being treated at least once* [every 24 hours]. *One set of circuits run at weekends.'*

43 On the day of the accident (a Sunday), the RHTT that was due to treat Salisbury Tunnel Junction on the down main line at 17:03 hrs had not yet passed through the area because it had been rescheduled. This rescheduling meant that it would (but for the accident) have passed the junction at around 23:00 hrs. The revised schedule, which was a consequence of planned engineering work between Southampton and Brockenhurst, meant that there would have been an interval of 36 hours between the RHTT runs over the weekend.

44 The last RHTT to run over the junction passed over it at 11:06 hrs on 30 October, around 32 hours before the accident occurred. This RHTT delivered high-pressure water jetting, and although it could apply adhesion modifier gel, it was not required to do so on this section of track.

RAIB's future action in the investigation

45 RAIB's objectives for the investigation are to:

- Continue to identify the sequence of events
- Continue to establish, as far as practical, the level of wheel/rail adhesion present on the down main line on approach to Salisbury Tunnel Junction
- Establish the status and performance of the braking, wheel slip/slide protection and sanding systems on train 1L53
- Consider the behaviour of both trains during and following the collision and the damage caused to each
- Consider the actions taken on the day of the accident to manage the risk of low adhesion given the time of year and prevailing weather conditions
- Consider the actions of the driver of 1L53 and any factors which may have influenced them
- Consider South Western Railway's policies and processes relating to operating trains in conditions of low wheel/rail adhesion including the dissemination and responses to information
- Consider Network Rail's policies and processes relating to low wheel/rail adhesion and how it managed the risk of low adhesion in the Salisbury area, including:
  - Risk assessment and management systems
  - Collation, analysis and dissemination of data
  - Railhead treatment
  - Monitoring of railhead conditions and information disseminated to operators
  - Regulation of trains at high-risk locations
  - The management of vegetation
- Identify any relevant underlying factors, including any actions taken in response to previous safety recommendations and research conducted related to managing the risks of low adhesion
- Make recommendations, as appropriate, to prevent a recurrence.

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