Rail Accident Investigation Branch

Rail Accident Report

Signal passed at danger at Stafford Trent Valley Junction No. 1
22 August 2023

Report 05/2024
June 2024

This investigation was carried out in accordance with:

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

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

Front cover images courtesy of (left) John Neave and (right) Network Rail.

Preface

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

RAIB's findings are based on its own evaluation of the evidence that was available at the time of the investigation and are intended to explain what happened, and why, in a fair and unbiased manner.

Where RAIB has described a factor as being linked to cause and the term is unqualified, this means that RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident or incident that is being investigated. However, where RAIB is less confident about the existence of a factor, or its role in the causation of the accident or incident, RAIB will qualify its findings by use of words such as 'probable' or 'possible', as appropriate. Where there is more than one potential explanation RAIB may describe one factor as being 'more' or 'less' likely than the other.

In some cases factors are described as 'underlying'. Such factors are also relevant to the causation of the accident or incident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, words such as 'probable' or 'possible' can also be used to qualify 'underlying factor'.

Use of the word 'probable' means that, although it is considered highly likely that the factor applied, some small element of uncertainty remains. Use of the word 'possible' means that, although there is some evidence that supports this factor, there remains a more significant degree of uncertainty.

An 'observation' is a safety issue discovered as part of the investigation that is not considered to be causal or underlying to the accident or incident being investigated, but does deserve scrutiny because of a perceived potential for safety learning.

The above terms are intended to assist readers' interpretation of the report, and to provide suitable explanations where uncertainty remains. The report should therefore be interpreted as the view of RAIB, expressed with the sole purpose of improving railway safety.

Any information about casualties is based on figures provided to RAIB from various sources. Considerations of personal privacy may mean that not all of the actual effects of the event are recorded in the report. RAIB recognises that sudden unexpected events can have both short- and long-term consequences for the physical and/or mental health of people who were involved, both directly and indirectly, in what happened.

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

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Signal passed at danger at Stafford Trent Valley Junction No. 1, 22 August 2023

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Summary

At about 16:41 hrs on 22 August 2023, an electric locomotive operated by Freightliner passed a signal at danger (red) on the approach to Stafford Trent Valley Junction No. 1. The locomotive was on a test run, after repair work, and continued for 740 metres beyond the signal, before running through points as it came to a stand at the junction.

The position where the locomotive stopped conflicted with a route that had been set for a southbound train, although that train was not in the immediate vicinity at the time that the locomotive stopped. A second, northbound, train had passed the junction a few seconds before the locomotive reached the points, but the locomotive did not foul the line that the northbound train had been travelling on.

No one was injured in the incident and the locomotive did not derail, although some damage was sustained to the points which were run through.

The investigation found that the locomotive had been travelling too quickly as it approached the red signal before the junction, meaning it was unable to stop before passing it. This was because the driver's focus was diverted from the aspects showing at previous signals which warned that a red signal should be expected ahead. This took place while the driver was dealing with a fault that had occurred on the locomotive and which had caused the driver to bring the locomotive to a stand at a previous signal. It is possible that this previous signal was not clearly visible to the driver when they restarted the train after resetting the fault, and that the presence of the fault, and the need to rectify it, distracted the driver, who had not experienced that scenario before.

RAIB found that Freightliner had no formal process for managing the risks associated with the operation of test runs and light locomotives, and that its competence management system had not equipped the driver to deal with an unexpected and potentially distracting situation in an effective and safe manner.

RAIB also found that the consequences of the incident were exacerbated by the high level of acceleration applied after the driver cleared the fault, the configuration of the locomotive and by the locomotive being driven at speeds above those permitted by relevant operating rules. RAIB also found that no engineered safety system intervened to apply the locomotive's brakes before they were applied by the driver.

RAIB has made two recommendations to Freightliner. The first deals with reviewing risk assessments and processes for the operation of light locomotives and test runs, to better manage the operational risk. The second relates to how train drivers are trained and assessed in the skills required to manage out-of-course, abnormal and potentially stressful events.

Three learning points have also been identified. These relate to the need to comply with rules relating to locomotive speeds, the requirements for the development and maintenance of route knowledge, and settings for train protection systems.

Introduction

Definitions

1 Metric units are used in this report, except when it is normal railway practice to give speeds and locations in imperial units. Where appropriate the equivalent metric value is also given.

2 The report contains abbreviations and acronyms, which are explained in appendix A. Sources of evidence used in the investigation are listed in appendix B.

The incident

Summary of the incident

3 At around 16:41 hrs on Tuesday 22 August 2023, a class 90 electric locomotive passed a signal displaying a red (danger) aspect after the driver had applied the emergency brakes on approach to it. An incident of this type is known as a ‘signal passed at danger’ or a ‘SPAD’. The locomotive was not hauling any wagons or coaches (known as operating as a ‘light locomotive’) and had been undertaking a test run from Crewe to Nuneaton and back after some repairs.

4 Before the SPAD occurred, the driver had brought the locomotive to a controlled stop after it had experienced a fault that had resulted in the electrical supply being lost. After correcting the fault, the driver reapplied power and gained speed before seeing the upcoming signal at red and applying the brakes.

5 The locomotive eventually came to a stop on the points at Stafford Trent Valley Junction No. 1 (figures 1 and 2). No other trains were in the immediate vicinity, although a northbound train had passed these points on an adjacent track less than 60 seconds earlier. A second, southbound, train had not yet stopped at Stafford station when the signal allowing it to depart the station towards the junction reverted to red as a result of the SPAD.

6 No one was physically hurt, but the set of points was damaged, and there was some minor damage to the locomotive’s wheels. Train services were disrupted for several hours that evening.

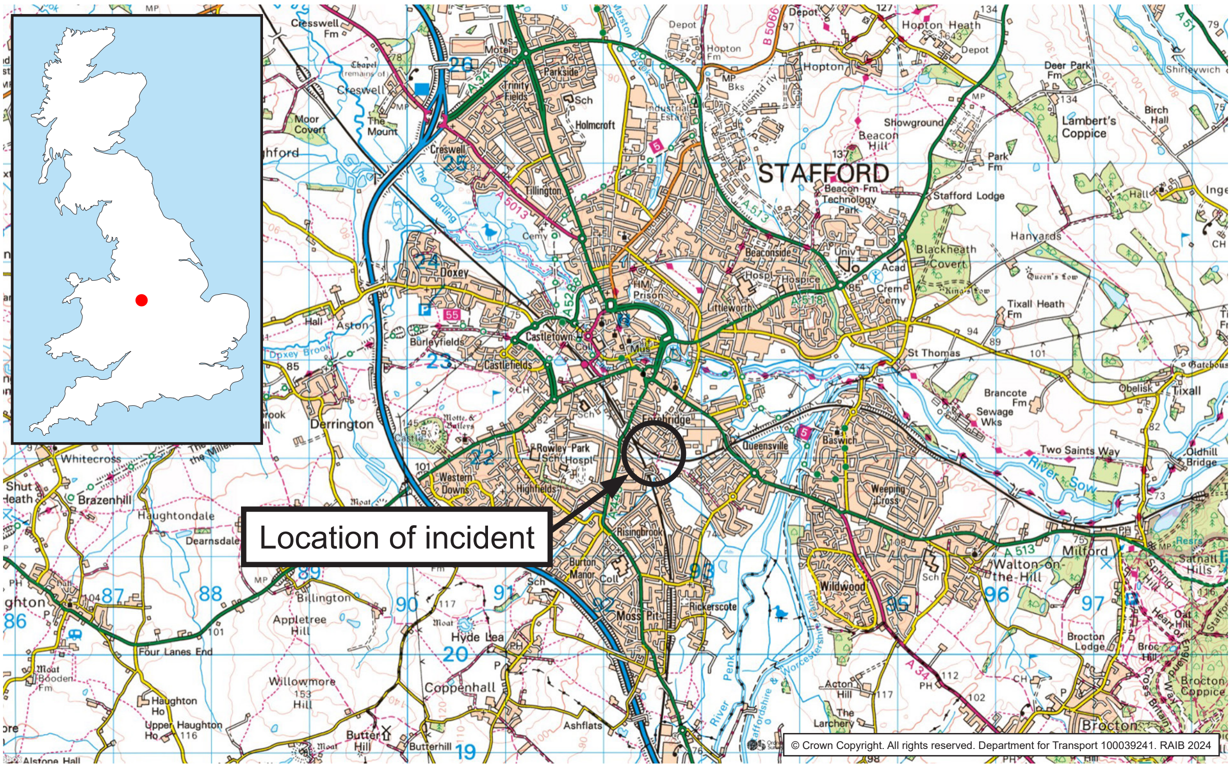

Figure 1: Extract from Ordnance Survey map showing the location of the incident at Stafford.

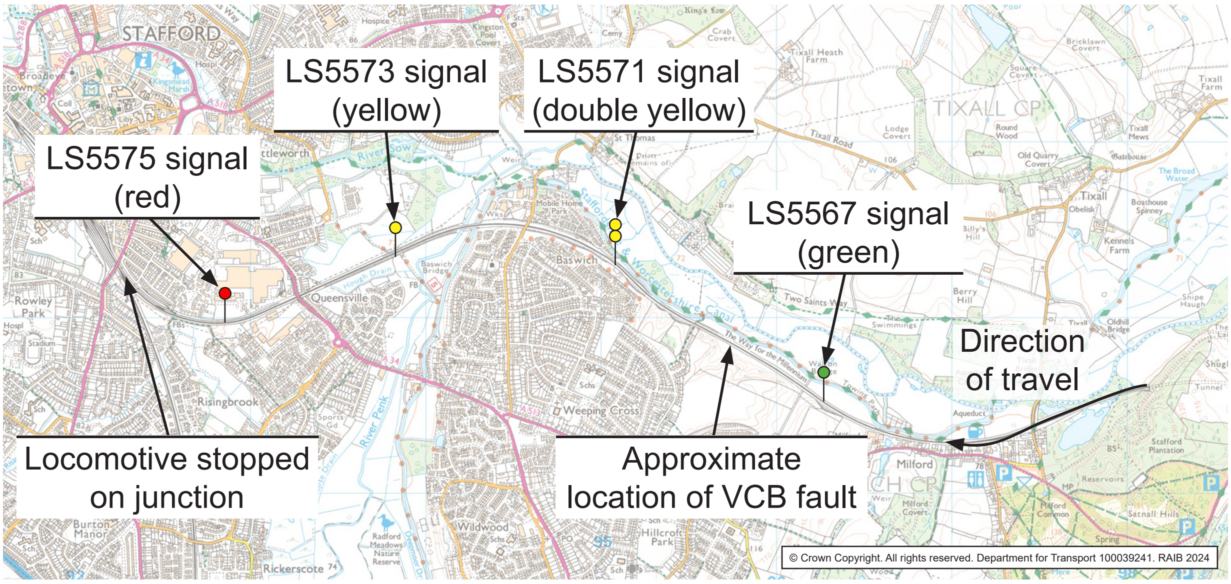

Figure 2: Route of the train approaching Stafford Trent Valley Junction No. 1.

Context

Location

7 The SPAD occurred at LS5575 signal. This is the last signal before Stafford Trent Valley Junction No. 1 on the Down Stafford Slow line, approaching from the Trent Valley route of the West Coast Main Line. LS5575 signal is located at 132 miles 46 chains[1] and is approximately 740 metres on approach to the junction (figure 2). LS5575 signal shows a red aspect if the route from the Down Stafford Slow line through the junction towards Stafford station is not clear. There was no record of any previous SPADs having occurred at this signal.

8 The railway approaching LS5575 signal consists of four tracks, with the Stafford Slow lines to the left and the Stafford Fast lines to the right in the direction of travel of the train involved (figure 3). The Stafford Slow lines meet the Penkridge lines (the route to/from Wolverhampton) at Stafford Trent Valley Junction No. 1, while the Stafford Fast lines continue towards Stafford station. At the junction, the Down Stafford Slow line crosses the Up Penkridge line at a switch diamond, which has movable blades to close the gaps in the rails for the set route (figure 4).

9 The maximum permissible line speed at LS5575 signal is 50 mph (80 km/h). A maximum permissible line speed of 75 mph (121 km/h) was applicable until a point 216 metres on approach to LS5575 signal. However, the railway Rule Book mandates a reduced maximum permissible speed for light locomotives of 60 mph (97 km/h) before entering the 50 mph (80 km/h) restriction (see paragraph 99).

10 At LS5575 signal the gradient was slightly uphill (1 in 880), although it transitioned to being slightly downhill (1 in 452) between the signal and the junction.

11 The signalling at Stafford was controlled from the Stafford workstation which is located at Rugby Rail Operating Centre (ROC). The tracks are electrified using the overhead line, and this was controlled from the electrical control room at Crewe.

[1] This mileage is referenced to a zero point at the buffer stops in London Euston station, via Weedon and the Trent Valley route. One chain (1/80 of a mile) is equivalent to 22 yards or approximately 20 metres.

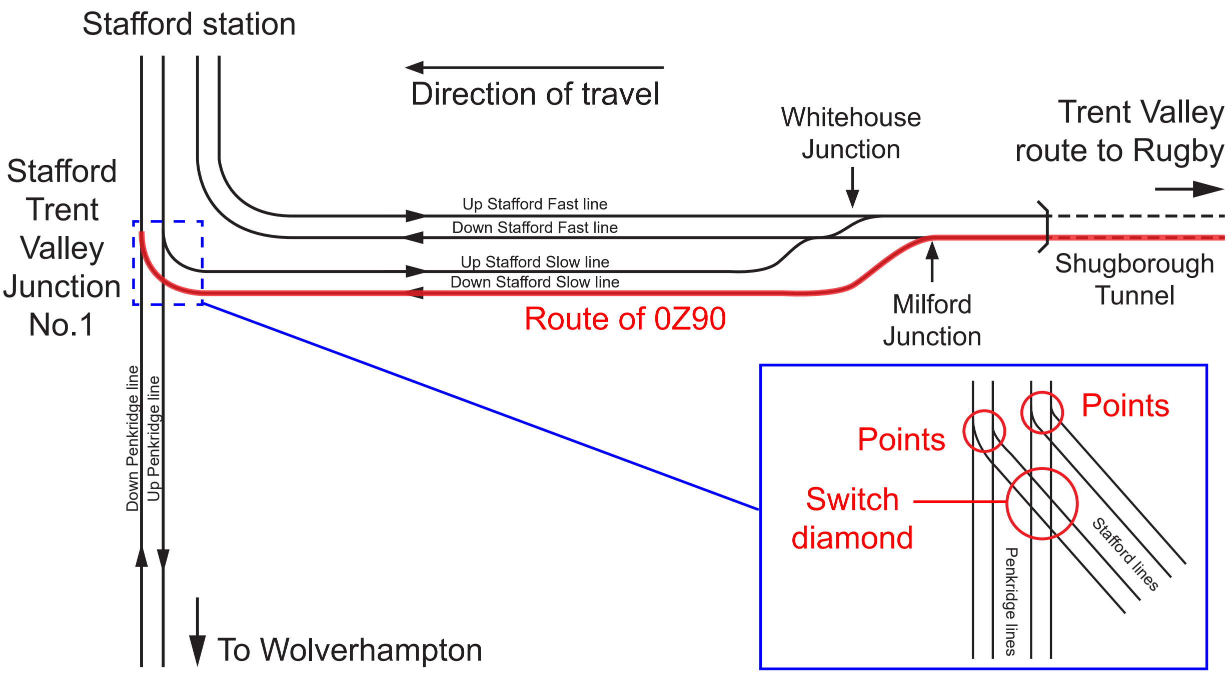

Figure 3: Track layout on the approach to Stafford Trent Valley Junction No. 1.

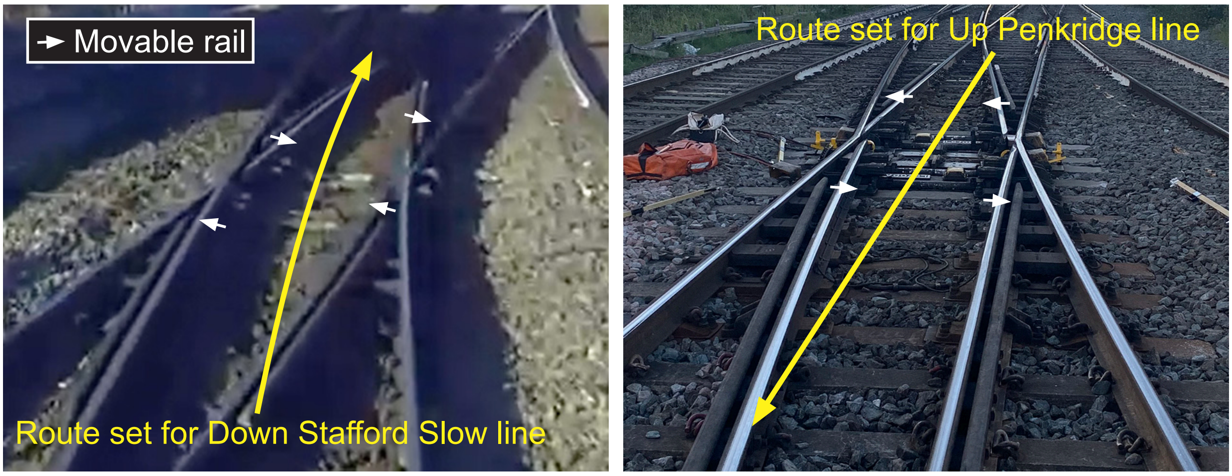

Figure 4: Switch diamond at Stafford Trent Valley Junction No. 1, showing possible set routes (courtesy of Network Rail with RAIB annotations).

Organisations involved

12 Freightliner owned and operated the locomotive that was involved in the incident. It also employed both the driver and fitter (technician) who were on board the locomotive at the time.

13 Network Rail owns and maintains the infrastructure in the Stafford area, which is on its West Coast South route. This route is part of Network Rail's North West and Central region.

14 Both Freightliner and Network Rail freely co-operated with the investigation.

Train involved

15 The train consisted of a class 90 electric locomotive (number 90006). It was operating as a light locomotive, so it had no wagons or coaches coupled to it (figure 5). The operational maximum speed of the locomotive was 110 mph (177 km/h), although this was operationally restricted to 75 mph (121 km/h) when hauling freight trains, and subject to further Rule Book limitations when operating as a light locomotive (see paragraph 99).

Figure 5: Class 90 locomotive during the test run (courtesy of John Neave).

16 The locomotive was operating as train reporting number 0Z90, the 14:27 hrs test train from Crewe to Nuneaton and back. The maintenance records for the locomotive showed that all routine maintenance had been undertaken in line with the relevant requirements, but that it was still under investigation for a known fault at the time of the incident. The fault resulted in the vacuum circuit breaker (VCB), which interrupts the electrical supply from the overhead line, tripping unexpectedly. The effect of a VCB trip is for the locomotive to lose power, but the brakes are not automatically applied. The test run was intended to check whether this fault was still present or not.

17 The class 90 locomotives are fitted with a friction brake system where brake blocks are applied to the treads of the wheels to stop the train. They are also fitted with a rheostatic brake system that uses the locomotive's traction motors to slow down the train, and dissipates the energy, via the electrical equipment, in a bank of electrical resistors. The braking system of the class 90 locomotive does not regenerate power to the overhead line on Network Rail infrastructure. The rheostatic brake results in greatly reduced wear to the friction brake on the locomotive. At low speeds, the friction brake is combined with the rheostatic brake to maintain performance. During an emergency brake application, the lower integrity rheostatic brake system is disabled, and the higher integrity friction brake is used to deliver the full braking performance.

18 The class 90 locomotive is equipped with a 'speed set' system, used by the driver to define a target speed for the locomotive. This system consists of a rotary dial in the cab (figure 6) that the driver uses to select the target speed. The locomotive then responds to the power controller as normal, but when the target speed is reached the power is automatically reduced and controlled so that the target speed is not exceeded. The acceleration to reach the target speed is determined by the position of the power controller chosen by the driver. If the speed exceeds the target speed, such as when descending a gradient, the rheostatic brake is automatically applied to reduce the speed back to the target speed. If additional braking is required, then this must be manually applied by the driver using the train brake control handle.

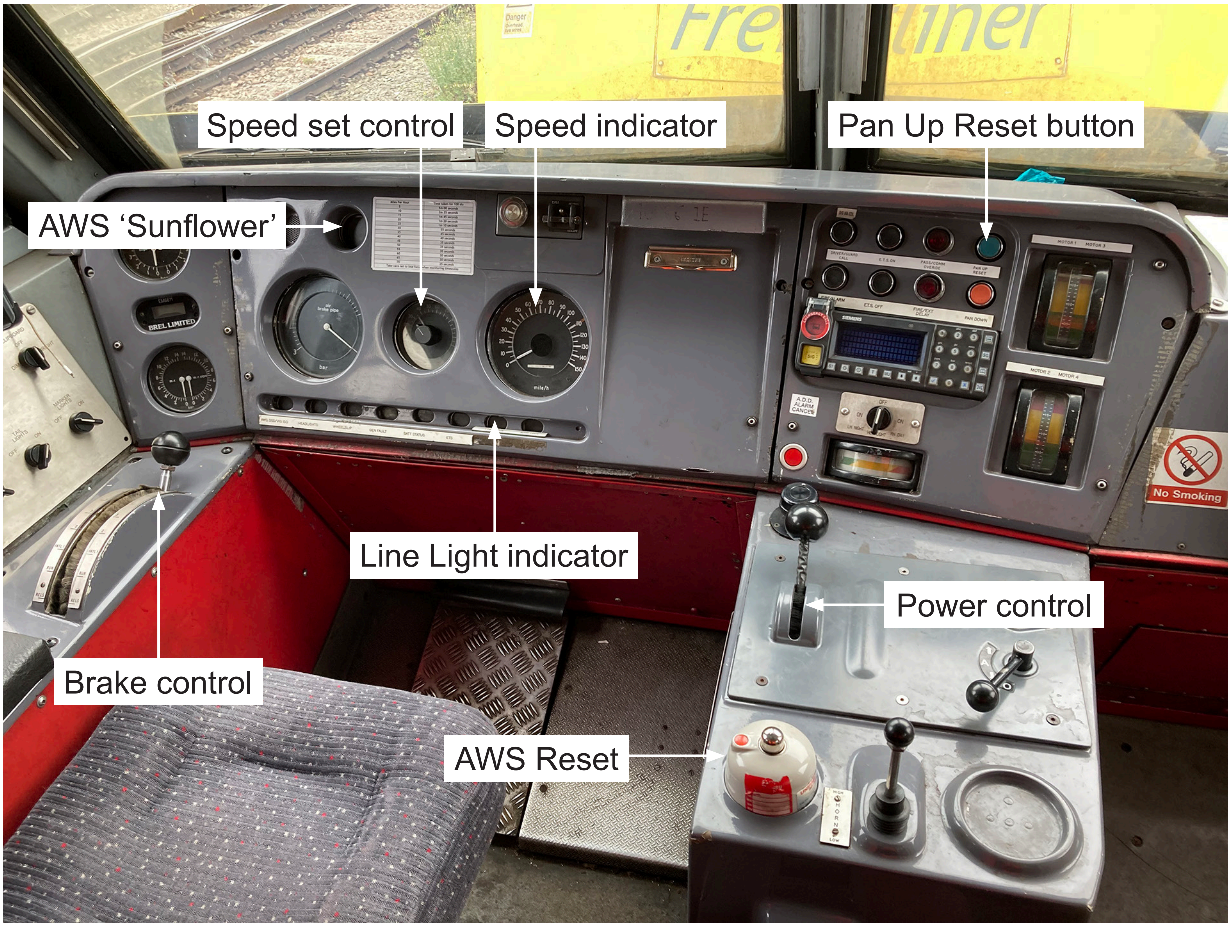

Figure 6: Class 90 locomotive driver controls (courtesy of Freightliner with RAIB annotations).

Railway systems involved

19 The railway in the area where the SPAD occurred is controlled using four aspect signals which are capable of showing four different light combinations to drivers. A red signal requires drivers to stop, while a yellow (caution) signal means that the driver should expect the next signal to be showing a red aspect and be prepared to stop. A double yellow (preliminary caution) signal means that the next signal should be expected to be showing a yellow aspect, with the one after expected to be showing red, thus giving additional time to prepare to stop if necessary. A green signal means that the next signal is either also showing green or possibly showing double yellow. The signal spacings are designed so that drivers do not need to brake before reaching the first signal showing a cautionary aspect. This signalling is supplemented by the provision of both the Automatic Warning System (AWS) and the Train Protection and Warning System (TPWS).

20 AWS provides an audible and visual warning to a driver on the approach to certain infrastructure features, such as signals and some speed restriction changes. It utilises track-mounted magnets which interface with receivers fitted to the underside of passing trains. The system onboard the train sounds a bell or chime when approaching a signal displaying a green aspect, and a horn when approaching a signal displaying any other aspect, or a change in permissible speed. This warning is intended to alert the driver to the upcoming signal or speed change. When receiving a horn warning, a driver must acknowledge this by pressing the 'AWS Reset' button on the driving desk (figure 6). On the class 90 locomotive, the driver must acknowledge the warning within two to three seconds or the train's emergency brakes will be applied. The driver's acknowledgement causes the AWS visual indicator in the cab to show a yellow and black 'sunflower' indication as a reminder of the warning.

21 TPWS was developed in the mid-1990s to address the risk arising from trains passing signals at danger. It is fitted at signals which can show a danger aspect to protect crossing or converging movements on passenger lines and certain other conflicting movements. The system is also used to enforce the observance of speed restrictions and to control the speed at which trains approach buffer stops. TPWS is not a failsafe signalling system; it is designed to reduce the likelihood and consequences of an undesirable event. It is also not intended to intervene across the full range of train speeds.

22 TPWS uses radio frequency transmitters (known as 'loops') placed between the rails. When used at signals, a pair of loops is placed at the signal itself. This is known as a train stop system (TSS). These are energised when the signal is at danger (showing a red aspect). The TPWS equipment installed on the train consists of a TPWS receiver, a combined AWS/TPWS control unit and a TPWS visual indicator in the cab. Should a train pass over the loops when they are energised, the TPWS equipment on the train will detect this and generate an emergency brake demand. The driver will receive a visual indication that the brake demand has occurred and will be required to acknowledge the demand as part of resetting the system.

23 At signals fitted with TPWS and on the approach to speed changes or buffer stops, another pair of loops is placed at a specified distance on the approach to the signal, speed change or buffer stop – this is known as an overspeed sensor system (OSS). The distance between the OSS and the signal, speed change or buffer stop is calculated to stop an approaching train wherever possible, or to at least reduce its speed, before any conflict point is reached. The OSS loops are activated if the associated signal is showing a danger aspect or are permanently activated at speed changes and on approach to buffer stops.

24 OSS loops are positioned a defined distance apart which is dependent on the speed setting. When the train passes over the first (arming) loop, the TPWS receiver will detect it and the system will enter the 'primed' state. This will start an electronic timer in the train-borne control unit. When the train passes over the second (trigger) loop, the control unit checks if the timer has expired. If it has, then the system resets and the driver receives no indication. If the timer has not expired (because the train has travelled too quickly between the two loops), then the system will trigger an emergency brake demand. The driver will again receive a warning that this has occurred. There are two operating modes, depending on whether the train has faster passenger braking performance, or slower freight braking performance. Passenger performance uses a TPWS timer setting of 974 milliseconds, while freight performance uses a setting of 1218 milliseconds.

25 On the approach to Stafford Trent Valley Junction No. 1, all the signals are fitted with AWS equipment. TPWS equipment is also provided as follows (figure 7):

a. LS5575 signal is fitted with TSS loops, set to apply the brakes on any train passing the signal when it is showing a red stop aspect.

b. LS5575 signal is fitted with OSS loops, positioned 350 metres before it, set to apply the brakes on any train passing the loops at a speed above 46 mph (74 km/h) when the signal is showing a red aspect.

c. A 50 mph (80 km/h) permanent speed restriction (PSR) that starts 216 metres before LS5575 signal is fitted with OSS loops, positioned 337 metres before the speed sign, set to apply the brakes on any train passing the loops at a speed above 76 mph (122 km/h).

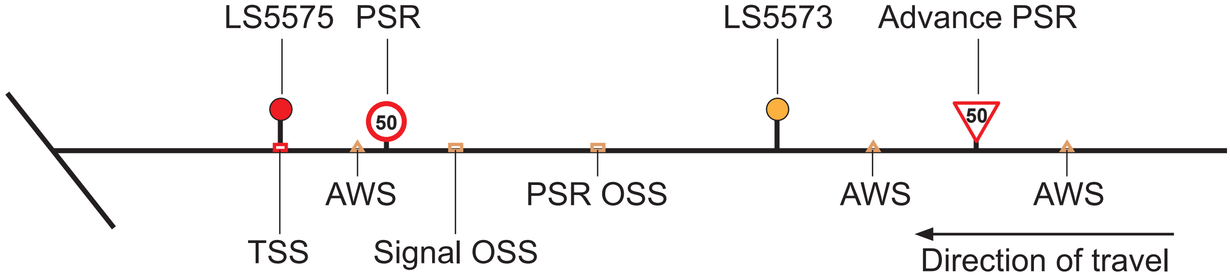

Figure 7: AWS and TPWS configuration approaching Stafford Trent Valley Junction No. 1.

26 The signals on the approach to Stafford Trent Valley Junction No. 1 (figure 2) were spaced as follows:

Signals	Distance (metres)
LS5575 to Stafford TV Jn No. 1	740
LS5573 to LS5575	890
LS5571 to LS5573	1390
LS5567 to LS5571	1530

Staff involved

27 The driver of the train involved in the SPAD had been driving trains for Freightliner for two years since completing their training. The driver had always been based at Crewe depot and held the relevant competences to drive the class 90 locomotive, although most of their experience was gained driving diesel class 66 and class 70 locomotives. The driver had also passed their route knowledge assessment for the lines between Crewe and Rugby, although most of their driving experience was gained on the routes from Crewe to Trafford Park, in Manchester, and Garston, in Liverpool.

28 The driver had been involved in one previous safety incident, where the side of a locomotive came into contact with a wagon during shunting. As a result of this, the driver was put on an enhanced monitoring and development plan that was still in place at the time of the incident at Stafford.

29 The fitter who was travelling on the locomotive at the time had over 20 years of experience working on class 90 locomotives and had been working for Freightliner in that role for seven years. The fitter held the relevant competence certificates to work on the class 90 locomotives and regularly did so at Crewe depot. These competences also allowed the fitter to travel with class 90 locomotives during test runs on the main line. There were no safety incidents identified on the fitter’s records.

External circumstances

30 The SPAD occurred during daylight. The temperature was about 23° Celsius and local weather stations recorded no rainfall and very little wind.

31 The sun was at an angle of about 30 degrees above the horizon, directly ahead of the locomotive, as it was passing the last two signals before the junction. However, there is no witness evidence to suggest that sun glare contributed to the incident.

32 There was no evidence of any abnormal environmental noise being present or that other external circumstances influenced the incident.

The sequence of events

Events preceding the incident

33 On 18 August 2023, four days before the incident, the VCB on locomotive 90006 had tripped out several times without any obvious explanation. It was initially suspected that this might have been due to water ingress as a result of localised heavy rainfall. Each time, the fault was able to be reset by pressing the 'Pan Up Reset' button in the driver's cab (figure 6).

34 Later that day, locomotive 90006 hauled a freight service south from Coatbridge, near Glasgow, and returned to the depot at Crewe for investigation and repair of the fault. Over the next two days, the locomotive systems were tested, and some equipment was replaced in an effort to identify and rectify the fault.

35 On the morning of 22 August 2023, Freightliner proposed sending the locomotive out on a test run to check whether the fault would continue to occur. A path on the rail network was reserved to send the locomotive out as service 0Z90 from Crewe Basford Hall sidings to Nuneaton and back, departing at 14:27 hrs. The driver involved in the SPAD, who was in the depot as a standby driver, was identified to drive the locomotive. They were to be accompanied by a depot fitter, who would monitor how the locomotive was behaving.

36 After a brief chat with the driver about the journey, the fitter sat in the rear cab of the locomotive, as was normal practice, so as not to distract the driver. The driver occupied the front cab and the locomotive departed Basford Hall sidings six minutes early at 14:21 hrs. It was subsequently held for a few minutes to allow a slow-moving freight train to depart ahead of it.

37 The journey to Nuneaton was uneventful, with the locomotive crossing into platform 1 and arriving at 15:55 hrs, seven minutes behind schedule. At Nuneaton the fitter and the driver changed cabs, so that the fitter was again in the rear cab for the journey back to Crewe.

38 After seven minutes at Nuneaton, the locomotive departed at 16:02 hrs, one minute behind schedule. The northbound journey was uneventful until the locomotive reached Shugborough Tunnel (figure 3), on the approach to Stafford.

39 At 16:38 hrs, shortly after passing through Shugborough Tunnel, where the Stafford Slow lines diverge from the Stafford Fast lines, the VCB on the locomotive tripped after passing LS5567 signal, which was showing a green proceed aspect (figure 2). This occurred before the locomotive had reached LS5571 signal, which was showing a double yellow preliminary caution aspect.

40 The driver heard the ‘thump’ of the VCB tripping and recognised that the cab ‘line light’ indication (figure 6) had gone out, showing that the locomotive had lost its power from the overhead line. Ten seconds before acknowledging the AWS warning for LS5571 signal, the driver started to brake the locomotive towards LS5573 signal which was showing a single yellow caution aspect. During this brake application, the driver acknowledged the AWS advance warning for an upcoming reduction in the maximum permitted speed to 50 mph (80 km/h), which starts beyond LS5573 signal. After releasing the brake for a short period and acknowledging the AWS warning for LS5573 signal, the driver allowed the locomotive to coast at 9 mph (14 km/h) before reapplying the brake and stopping on the approach to LS5573 signal at 16:39:54 hrs.

41 The driver was preparing to call the signaller to advise them of the failure, but had not yet done so, when the fitter entered the front cab, having walked through the interior of the locomotive. The fitter asked the driver if they had pressed the Pan Up Reset button to see if the VCB would reclose. The driver did this and the VCB closed. After confirmation from the fitter that the locomotive should be able to to continue, the driver took power to resume the journey at 16:40:21 hrs, having been stopped for 27 seconds. The fitter remained in the leading cab as the journey resumed.

Events during the incident

42 With the ‘speed set’ control (paragraph 18) on the locomotive set to 75 mph (121 km/h), which was the maximum permissible line speed at that location, the driver applied maximum power and the locomotive accelerated very quickly. The data from the on-train data recorder (OTDR) showed that within 18 seconds, at 16:40:39 hrs, the locomotive had reached 70 mph (113 km/h) as it passed the TPWS OSS loops for the upcoming 50 mph (80 km/h) speed restriction.

43 At 16:40:45 hrs, the driver saw LS5575 signal in the distance showing a red aspect and immediately applied full-service braking and then emergency braking within 1 second. The locomotive was travelling at 75 mph (121 km/h) and was approximately 400 metres from LS5575 signal when the brakes were applied.

44 At 16:40:46 hrs, the locomotive was still travelling at 75 mph (121 km/h) as it passed the TPWS OSS loops associated with LS5575 signal. As these had a set speed of 46 mph (74 km/h), the TPWS system on the locomotive detected the overspeed and commanded an emergency brake application. However, because the driver had already made an emergency brake application, this had no further effect on the deceleration of the locomotive.

45 At 16:40:51 hrs, the locomotive’s speed had reduced to 70 mph (113 km/h) as it passed both the start of the 50 mph (80 km/h) speed restriction and the AWS for LS5575 signal. The driver acknowledged this AWS warning.

46 By 16:40:58 hrs, the locomotive's speed had been reduced further to 63 mph (101 km/h) as the locomotive passed LS5575 signal at danger. Passing the TSS loop at the signal resulted in a further demand for an emergency brake application from the TPWS system, but this again had no effect as it was already applied. The locomotive passing LS5575 at danger caused the signal in Stafford station that had previously been cleared for a train that was due to pass south towards Wolverhampton to revert to red. This occurred before that train had stopped in the platform at Stafford to pick up and set down passengers.

47 At 16:41:41 hrs, the rear end of a passenger train with reporting number 2K58, the 15:52 hrs service from Birmingham to Crewe, had just cleared the points at Stafford Trent Valley Junction No. 1, having approached them from the Wolverhampton direction on its way towards Stafford station. At the same time, the front of the locomotive forming 0Z90 was passing the switch diamond at the junction (paragraph 8), which was set for the passage of the next southbound train towards the Up Penkridge line. As it passed the switch diamond it deviated violently to the right towards the Up Penkridge line (figure 8) while travelling at about 13 mph (21 km/h).

Figure 8: The final stopping position of the locomotive (courtesy of Network Rail with RAIB annotations).

48 At 16:41:48 hrs, the locomotive came to a stop on the Up Penkridge line, between the switch diamond and the switch tips at Stafford Trent Valley Junction No. 1. The locomotive did not derail as it passed through the switch diamond.

Events following the incident

49 At 16:42:07 hrs, the driver of train 0Z90 used the in-cab radio to call the signaller to advise that the locomotive had passed a signal at danger and that they thought the locomotive had derailed. The driver did not use the ‘railway emergency call’ (REC) button which would have stopped all trains in the area. However, trains on the approach to Stafford Trent Valley Junction No. 1, that had not already passed the protecting signals, would have been shown red (stop) aspects as soon as the locomotive had passed LS5575 signal at danger. Train 2K58 had already passed the last protecting signal before the junction by the time the locomotive passed LS5575 signal. However, train 0Z90 arrived at the junction after train 2K58 had passed and never became foul of train 2K58’s route.

50 The signaller made an emergency call advising all trains in the area to come to a stop at 16:42:37 hrs. The signaller had already been alerted to a problem as the signalling equipment had reacted to both the SPAD and to the consequent track damage as the locomotive diverged at the switch diamond at the junction.

51 Network Rail and Freightliner mobilised staff to the incident, and after they had assessed the position of the locomotive, the Stafford Fast lines towards the Trent Valley (figure 3) reopened to trains at 17:18 hrs. The route towards Wolverhampton remained closed until 22:30 hrs. The Stafford Slow lines remained closed until 1 September, when repairs to the points and switch diamond were completed.

52 The driver was tested for drugs and alcohol after the incident, and this was found to be negative.

Analysis

Identification of the immediate cause

53 The manner in which the locomotive was driven meant that it was unable to stop before passing LS5575 signal, which was at danger.

54 When a locomotive is coupled to a train of freight wagons or passenger coaches, only the locomotive can apply tractive effort to the train. However, in most modern trains all the vehicles will be equipped with brakes which can be commanded by the driver, and provide retardation force.

55 When a locomotive is travelling light (not coupled to other vehicles), it still has the same available tractive effort as it had when hauling vehicles. In addition, the lower total weight being moved means that it has a much higher power to weight ratio and can accelerate a lot faster. Locomotives are generally not designed to develop high retardation rates themselves so that the energy required to be dissipated in braking a train is not concentrated at the front. Consequently, a locomotive running light does not have the additional retardation force provided by the brakes from coupled vehicles. The result of this is that a light locomotive can accelerate very quickly when power is applied, but its braking performance is no better, and often worse, than when it is attached to a fully braked train. This is normally managed by the application of lower speed limits for the operation of light locomotives on Network Rail infrastructure (see paragraph 99).

56 The way in which the locomotive was driven did not account for this available acceleration and braking performance on the approach to LS5575 signal, which was displaying a red aspect.

Identification of causal factors

Acceleration away from the yellow signal

57 After stopping close to a yellow signal, because of a fault that had occurred on the locomotive, the driver rapidly accelerated the locomotive towards red LS5575 signal once that fault had been reset.

58 The VCB tripped on the locomotive just as it was about to encounter a series of cautionary signals, after having passed a green signal shortly after Milford Junction (paragraph 39). It took the driver a few seconds to recognise what had happened after hearing the thump of the VCB opening and seeing that the line light (figure 6) had gone out (paragraph 40).

59 Figure 9 shows the speed profile of the locomotive as it entered the cautionary sequence of signals. As the locomotive passed the green aspect at LS5567 signal, the driver increased the speed to the maximum permitted line speed of 75 mph (121 km/h). This was in excess of the maximum permitted speed at that location for light locomotives of 60 mph (96 km/h) (see paragraph 99). The driver then allowed the locomotive to coast and slow gently as it approached the double yellow aspect at LS5571 signal.

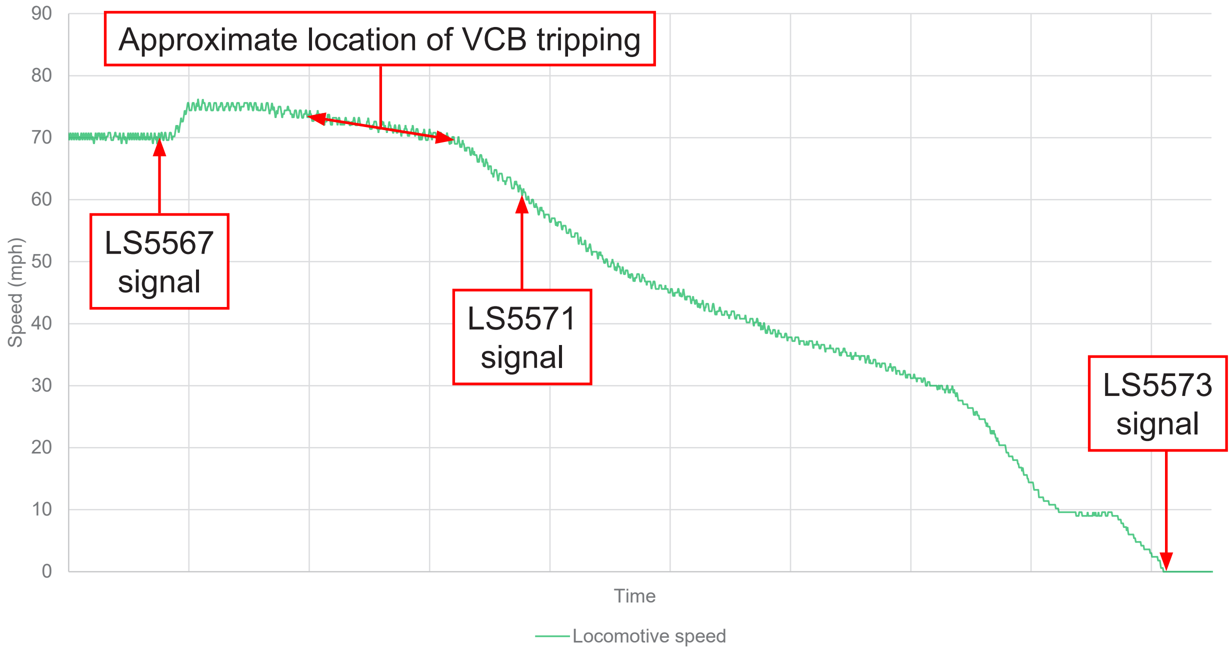

Figure 9: Speed profile of the locomotive between the VCB tripping and coming to a stop close to LS5573 signal.

60 At some point before the locomotive reached LS5571 signal, the VCB tripped and the locomotive lost power. Once the driver had recognised this they applied the brakes. After acknowledging the AWS for the double yellow signal at LS5571, the driver continued to brake towards the single yellow signal at LS5573, while trying to remember what actions to take in the event of the VCB tripping. Shortly before LS5573 signal, the driver released the brakes and allowed the locomotive to coast towards it, before applying the brakes again to come to a stop, very close to the signal. RAIB has calculated from the OTDR data that the front of the stopped locomotive was probably less than 5 metres from the signal.

61 The driver was unable to recall making the conscious decision to stop at the yellow signal. However, the Rule Book requires drivers to be able to tell the signaller the exact location of a failed train, and stopping at an easily identifiable location, such as a signal, would be consistent with meeting this requirement. The driver did not make the call to the signaller because the fitter entered the cab before they were able to do so and asked the driver if the Pan Up Reset button had been tried.

62 Section 41 of Module TW1 of the Rule Book ‘Preparation and movement of trains’, issue 18.1 dated February 2023, states:

> ‘*If your train stops out of course for any reason, you must tell the signaller as soon as possible, including the reason for your train stopping*’.

However, Section 12.3 of Module AC of the Rule Book ‘AC electrified lines’, issue 7 dated December 2021, also states:

> ‘*If the line light goes out, you can continue normally if … you can reset at the first attempt, or the line light is restored*’ and ‘*you can regain power*’.

63 The driver's initial intent to call the signaller after coming to a stop complied with the first requirement. However, the fitter's subsequent intervention reminded the driver that one attempt to reset the VCB was allowed, with the locomotive being permitted to continue uninterrupted if the power came back on. The driver considered that the one successful attempt at resetting the VCB meant that the locomotive could continue normally, particularly given that they had only been stopped for a few seconds (paragraph 41). The driver then applied full power, with the speed set control still set to 75 mph (121 km/h), to get the locomotive moving again with minimal delay (paragraph 42).

64 After accelerating to 75 mph (121km/h), the locomotive was then travelling too fast to be able to stop before reaching LS5575 signal once the driver spotted the red aspect being shown by that signal. RAIB calculations show that the locomotive would have had to have been travelling at a maximum speed of 46 mph (74 km/h) to have been able to stop at the red signal after applying emergency braking at the location when LS5575 signal first came into view.

65 This causal factor arose because the driver's attention was distracted from the prevailing signal sequence by the unexpected fault.

Awareness of the signal sequence

66 The driver's attention was distracted from the prevailing signal sequence by the unexpected fault.

67 The driver could not recall seeing LS5573 signal showing a yellow aspect before restarting the locomotive after the fault was cleared. Had the driver seen or remembered that they were standing at a yellow signal, and rechecked its aspect before moving off, it is very likely that they would have recalled the guidance in Freightliner's professional driving policy not to apply full power when starting from a yellow signal and so would not have accelerated the locomotive in the way that they did. This is because they would have been expecting LS5575 signal to probably be showing a red aspect, which would require them to stop.

68 Because the driver acknowledged the AWS warning for the yellow aspect showing at LS5573 signal, it is likely that they were conscious that it was showing a caution aspect before the locomotive stopped. RAIB has therefore concluded that the driver's attention was diverted from the yellow aspect showing at LS5573 signal, and from the signal sequence leading up to it, while the locomotive was stopped at the signal.

69 It is possible that the driver's attention was diverted from the yellow aspect showing at LS5573 signal because the signal head was not clearly visible from the driving cab when they restarted the train. The limited braking capability of the locomotive (paragraph 54) meant that the driver stopped closer to LS5573 signal than intended and around 5 metres from the signal. For comparison, Freightliner's professional driving policy recommends that drivers stop 20 metres on approach to signals, so that they are clearly visible from the cab.

70 The position of the sun was directly ahead of the locomotive at yellow LS5573 signal (paragraph 31). However, witness evidence and the presence of partial cloud cover (figure 5) suggest that sun glare was not a factor in the driver not being aware of the yellow signal before restarting the locomotive.

71 As well as directly observing the signal, the AWS visual indicator in the cab would have been showing its yellow and black sunflower to indicate that the last AWS activity had been a warning (due to the single yellow signal being shown at LS5573). However, the visual indicator did not act as an effective reminder that the train had approached a restrictive signal aspect on this occasion.

72 It is also possible that the driver's awareness of the yellow signal at LS5573 and the previous signal sequence was affected by their focus on the VCB fault. The driver had received training on the class 90 locomotive, and this included a classroom session on the types of faults that might occur and how to deal with them. However, when the VCB trip occurred on 22 August on approach to Stafford, the driver of train 0Z90 recalled feeling under pressure due to them never having previously experienced a VCB trip while driving, and trying to remember what their training had told them needed to be done, should it occur. This is supported by it being the intervention of the fitter that reminded the driver that they should first try using the Pan Up Reset button to reset the VCB. The driver may also have been distracted by the process of preparing to call the signaller.

73 During initial training, the driver had been provided with a number of techniques (see paragraph 87), to reduce the likelihood of errors such as that which led to the incident. It is possible that the application of such techniques would have reinforced recall of the signal sequence, and the fact that the locomotive had stopped close to a yellow signal.

74 While there is witness evidence that the driver did not consider that there was direct pressure to get the locomotive moving again, the driver was aware that the locomotive had stopped on the West Coast Main Line close to an important junction. RAIB therefore considers that the driver may also have been focused on the need not to prolong the stop and to start moving again as soon as possible to reduce disruption to other services. This is supported by their decision not to call the signaller after realising that the locomotive could continue because the VCB had reset at the first attempt, and by the high acceleration applied when the locomotive moved off.

75 Witness evidence shows that the driver was not distracted by using a mobile telephone, or other portable electronic equipment, in the cab during the fault or when they restarted the locomotive. The presence of the fitter in the cab, who was assisting the driver with the fault, and the short time that the locomotive was stopped, both support the conclusion that such distractions were not present.

76 The driver had finished their previous shift at 11:48 hrs on 20 August 2023, with 21 August being a rest day. Analysis of the roster pattern provides no obvious evidence that the shift pattern would have given rise to a high risk of fatigue at the time of the incident. The driver also provided no evidence to suggest that there was additional fatigue risk arising from their domestic circumstances.

77 Because the fitter only entered the leading cab when the locomotive stopped (paragraph 41), they would not have been aware of the yellow signal's aspect as the locomotive was approaching it. Although it is not the role of the fitter to observe signals nor to supervise the driving of the locomotive, had the fitter seen the yellow signal before moving, it is possible that they would have drawn the driver's attention to this on experiencing the rapid acceleration as the locomotive started. However, the proximity of the locomotive to the signal would have meant the fitter would have had a similarly limited view of it to the driver (paragraph 69).

78 There were no problems with the driver's sighting of LS5575 signal (figure 10). The driver saw the red aspect at LS5575 signal approximately 400 metres before reaching it and applied the emergency brakes.

Figure 10: Visibility of signal LS5575 signal (not from the day of the incident) (courtesy of Network Rail with RAIB annotations).

Identification of underlying factors

Risk assessment of light locomotive operations

79 Freightliner had no effective processes for managing the risks specific to test runs using light locomotives.

80 Freightliner stated that it had no formal specific risk assessment for the operation of light locomotives. It considered that these risks would be managed through its processes for the training of drivers, and that any driver that had been passed as competent to drive a specific type of locomotive should be able to drive it either hauling a train or as light locomotive. It considered that its processes for risk-based monitoring and assessment of driver competence would be able to identify any specific training needs.

81 Similarly, Freightliner stated that it had no formal process for defining how test runs, which often involve light locomotives, should be risk assessed and managed. A result of this was that there was no requirement to either select drivers with a specific experience profile to drive test runs, or to brief those drivers on the reasons for the testing or any faults that might occur.

82 The fault that occurred on the locomotive during the incident was consistent with the fault that the test run was intended to check for (paragraph 33). That means that it was foreseeable that such a fault could occur. Despite this, Freightliner did not brief the driver that a fault on the VCB was being investigated and that it was possible that the VCB could trip during the test run. Freightliner considered that this driver, having completed the training, would be able to deal with any faults that arose on a test run as well as any other qualified driver.

83 The fitter and the driver did have a brief, informal conversation before the test run and this confirmed that a repair had been made. No detail was discussed about what had been repaired or what faults might subsequently arise.

84 The result of this was that a relatively recently qualified driver, with little regular experience of driving electric locomotives, was tasked to drive a locomotive with a potential fault that they had not previously experienced, with no briefing as to what faults might occur or what they needed to do if they did.

Management of driver competence

85 Freightliner's training and competence management of the driver had not equipped them to deal with an unexpected and potentially distracting situation in an effective and safe manner.

86 Part of the driver's training included 'non-technical skills' which are intended to cover the types of behaviours that should be applied both in normal operations and when things go wrong. This was delivered via a stand-alone series of slides in the classroom during the driver's initial training in 2020 and 2021, rather than being integrated into the wider training as currently recommended by the safety regulator, the Office of Rail and Road (ORR). Examples from the Freightliner training material of the skills which were covered include developing situational awareness, conscientiousness, communications, decision-making, co-operation, workload, and self-management.

87 The training highlighted good examples of behaviours that should be developed and bad ones that should be avoided. Examples of both good and bad behaviours from the Freightliner training include:

'Examples of Good Behaviours

- Remains calm when managing unusual or out-of-course situations

- Checks information sources on a regular basis

- Ensures signals are checked to ensure understanding of aspect displayed

- Reviews, monitors and cross checks actions conscientiously

- Uses techniques such as Risk Triggered Commentary'

'Examples of Bad Behaviours

- The driver displays extreme reactions to for example train failure or other pressure situations

- Displays nervousness or lack of confidence when pressured

- Errors are made when placed under pressure i.e. fails to check status of train before attempting to take power

- Makes substandard decision as a result of time or other pressure'.

88 Freightliner uses routine, normally annual, in-cab assessments of drivers to monitor how these behaviours are being applied. Any observed undesirable behaviours can lead to further training or enhanced monitoring. However, the infrequency of faults such as those experienced in this incident means that the assessments are unlikely to be able to identify how a driver would behave when under such pressure. No such observations of poor behaviour by the driver had been recorded by Freightliner before the incident.

89 Simulators, and other training tools, give the opportunity to expose drivers to stressful situations, such as train failures, and so to assess and develop their non-technical skills. Although some train operating and freight operating companies use simulators as part of their driver training, Freightliner does not routinely do so outside of a recent development for training drivers in new signalling systems.

Factors affecting the severity of consequences

90 The SPAD occurred because the train was travelling at a speed above 46 mph (74 km/h) when the driver saw the red signal ahead and applied the brakes (paragraph 43). However, the locomotive continued and came to a stop on the points at Stafford Trent Valley Junction No. 1 because the locomotive was travelling at 75 mph (121 km/h) when the brakes were applied. Had it been travelling at between 46 mph (74 km/h) and 72 mph (116 km/h) when the driver saw the red signal, the locomotive would still have passed LS5575 signal at danger, but it would have stopped clear of the points at Stafford Trent Valley Junction No. 1.

Driving technique

91 The driver used the maximum available power to accelerate the locomotive rapidly to 75 mph (121 km/h) after resetting the fault on the locomotive.

92 The driver accelerated the locomotive rapidly to 75 mph (121 km/h) after resetting the fault on the VCB (paragraph 42) by using the speed set control and applying maximum power. The accelerating performance of the light class 90 locomotive (paragraph 55) meant that it was able to reach 75 mph (121 km/h) in only 20 seconds before the speed set control limited the accelerating power, to maintain that speed.

93 This driving style was consistent with how the driver had been driving on the rest of the journey from Crewe to Nuneaton and return (figures 11, 12 and 13). The flat spots on the speed profile indicate that speed set was used to control the speed at locations where the train was not being cautioned by signals. Similarly, the driver had been using full power when accelerating earlier in the journey. During braking, the driver was correctly removing power and manually applying the brake rather than adjusting the speed set control down to reduce the speed.

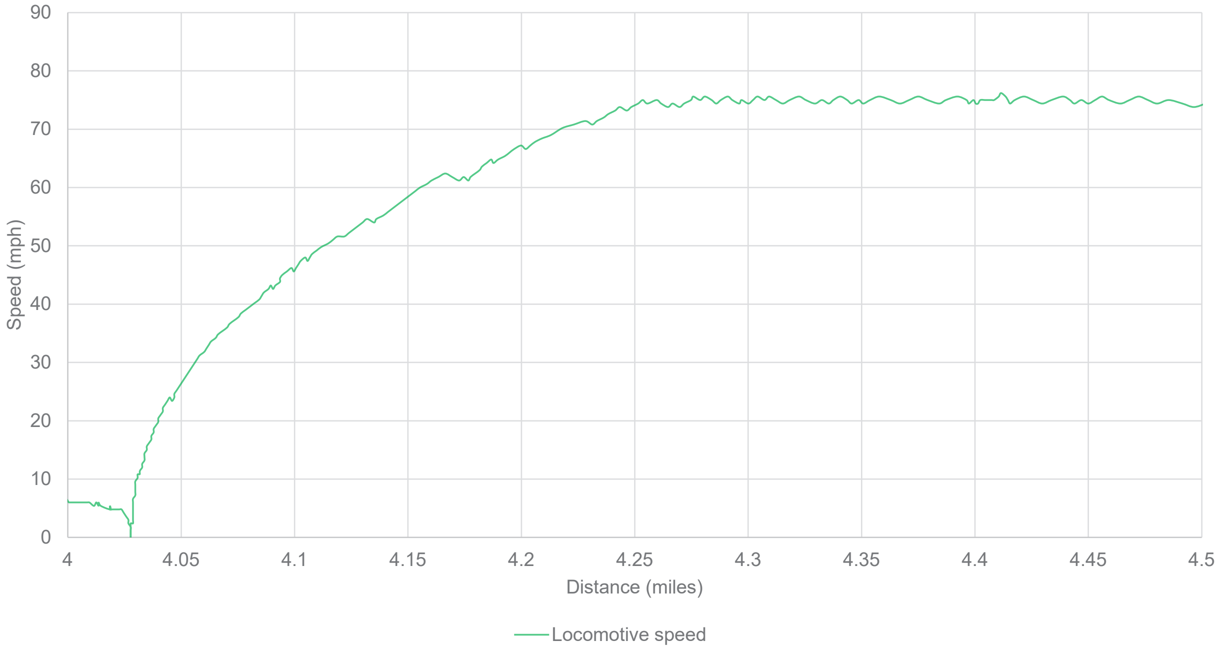

Figure 11: Speed profile showing use of speed set control at 75 mph (121 km/h).

94 Freightliner stated that there was no documented operational restriction preventing drivers from using this driving style.

95 However, it did state that its trainers would not teach this driving style and would suggest to drivers that they should take a more active role in managing the locomotive's speed. The original British Rail Train Crew Manual for the class 90 locomotives, dated January 1988, states that '*it is recommended that the speed control switch be used'.* It also states that '*drivers should not hesitate to use the fully open position of the power controller to achieve maximum acceleration and thereby conserve energy*' which suggests that this technique may once have been in use. Freightliner stated that it trains its drivers to drive more defensively than these older instructions suggest, to allow them more time to identify and react to upcoming hazards.

Compliance with light locomotive speeds

96 The driver was driving the locomotive at speeds above those permitted by the Rule Book for light locomotives.

97 The driver made an emergency brake application when they saw the red signal. The effect of this was to fully apply the friction brake on the locomotive. The rheostatic brake is not applied in an emergency brake application, because the high integrity friction brake is fully rated to be able to stop a locomotive in the distances defined by Railway Group Standard GMRT 2045 'Compatibility requirements for braking systems of rail vehicles', issue 4 dated March 2016.

98 After the driver applied the brakes at 75 mph (121 km/h), the locomotive came to a stop in 1140 metres. This is consistent with the 1144 metres braking distance required for ex-British Rail locomotives, as defined in curve A1 from standard GMRT 2045.

99 Despite being compliant with the relevant standards, light locomotives have a limited braking capability (paragraph 54). As a mitigation against the risks this poses, the Rule Book mandates the application of reduced maximum permitted speeds when locomotives are running light. Section 2.2 of Module SP ‘Speeds’, issue 6 dated September 2021, states that:

‘You must make sure that locomotive-hauled trains in the formation shown, or locomotives running light, do not exceed the speeds shown in the table below where the permissible speed is more than 60 mph (95 km/h).’

Train formation	***Permissible speed***	
	90 mph (145 km/h) or above	***85 mph (135 km/h) or less***
Any number of locomotives running light, or one or two locomotives with one, two or three coaching stock vehicles, or three or more locomotives and any number of coaching stock vehicles	*75 mph (120 km/h)*	*60 mph (95 km/h)*

100 At LS5573 signal, the maximum permitted line speed was 75 mph (121 km/h), meaning that the maximum permissible light locomotive speed was 60 mph (96 km/h). However, the driver accelerated the locomotive to 75 mph (121 km/h) and it was travelling at this speed when the red signal came into view. At that location, 75 mph (121 km/h) was 15 mph (24 km/h) above the permitted maximum for a light locomotive. Had the driver complied with the light locomotive permissible speed limit, the locomotive would have stopped approximately 320 metres before its actual stopping position on 22 August. This would still have been approximately 420 metres beyond the red signal at LS5575, but approximately 240 metres short of fouling the points at Stafford Trent Valley Junction No. 1.

101 Examination of the data from the locomotive‘s OTDR showed multiple instances of the driver exceeding the maximum permissible speeds for light locomotives on the day of the SPAD (circled in figures 12 and 13). The driver was largely compliant with the signposted maximum permitted speeds for trains not operating as light locomotives, suggesting that they were not applying the additional speed restrictions required when running light throughout the day.

102 The driver stated that they were aware that, when travelling light, the class 90 locomotive could accelerate quickly and that the braking was limited. However, the driver had not had many opportunities to experience this performance, particularly under hard braking, and had never had any practical training when travelling light locomotive in the class 90. The driver also stated that although they had been trained in light locomotive speed restrictions, they had not had the opportunity to apply them very often and that they must have forgotten them when driving on that day.

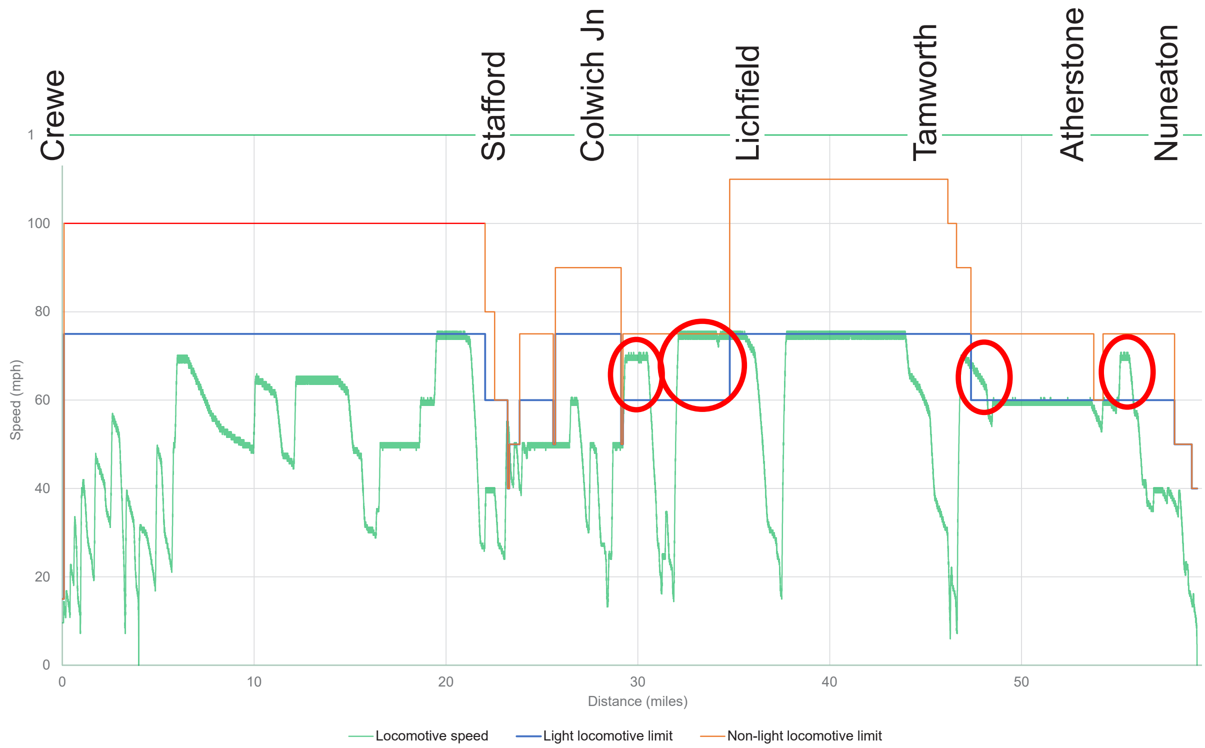

Figure 12: Locomotive speeds on the southbound journey from Crewe to Nuneaton.

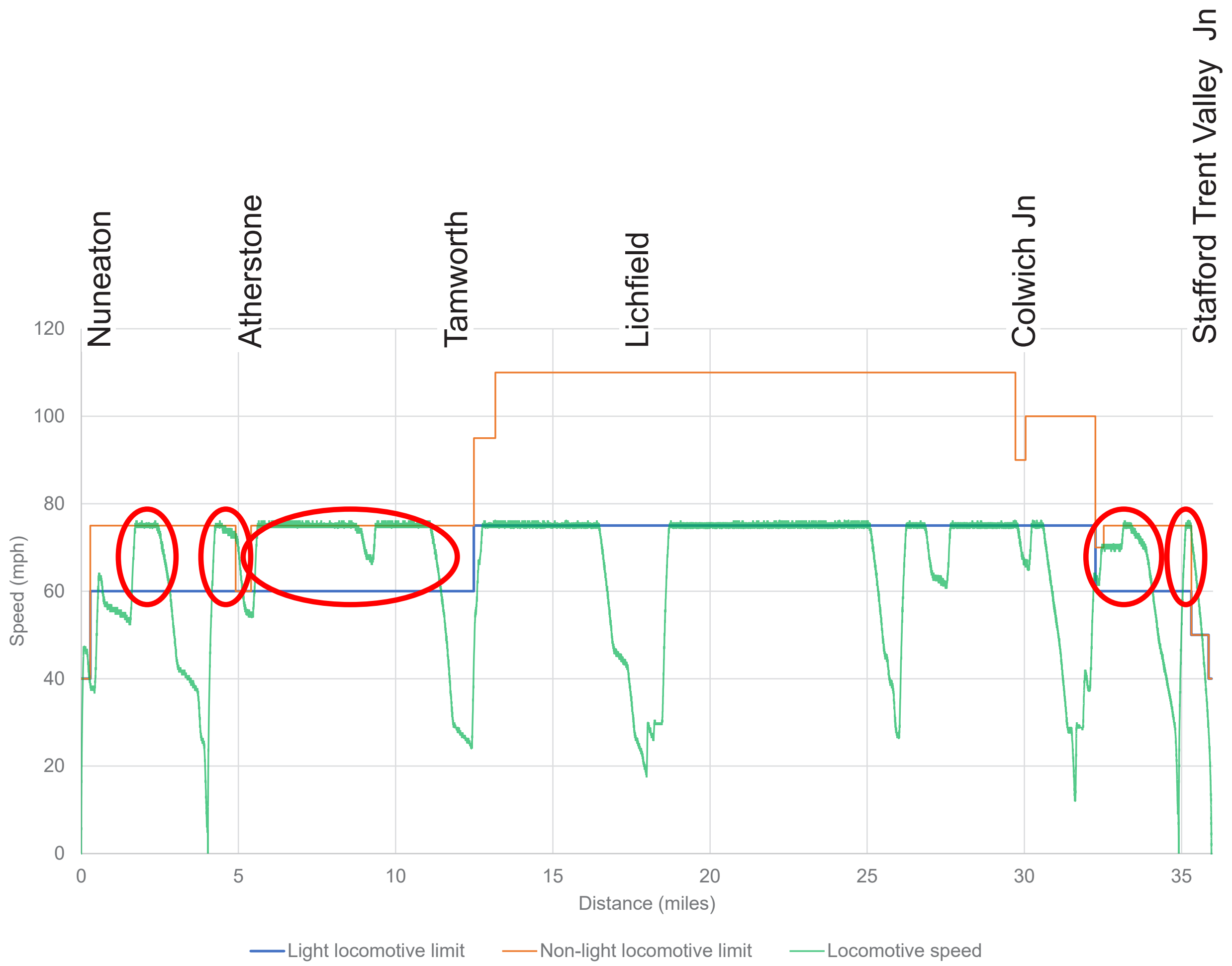

Figure 13: Locomotive speeds on the northbound journey from Nuneaton to Stafford Trent Valley Junction No. 1.

103 The driver's formal training had covered the relevant Rule Book section relating to light locomotive permissible speed limits. In two separate written exam assessments on 11 and 18 September 2020, the driver correctly answered a question about the reduced applicable light locomotive speed limits. The driver also demonstrated the application of the reduced speed limits on a practical driving assessment in a class 66 diesel locomotive from Crewe to Carlisle and return on 4 July 2021. Freightliner drivers are routinely reassessed on their knowledge of the Rule Book, but this driver had not yet reached their first post-training assessment, which was due to be undertaken in the months after the incident.

104 The driver's training records show that, during their initial training, their light locomotive class 90 experience was limited to a total of one hour of driving over five separate sessions, all of which took place while shunting in sidings. This confirms that they had no experience of class 90 driving as a light locomotive at mainline speeds during that training.

105 Following the driver's initial training period, the driver recalled that they had only driven a light class 90 locomotive twice on the main line, on the routes from Garston and Trafford to Crewe. Freightliner was unable to provide any detail about the number and duration of such trips that the driver had driven.

106 Freightliner had no specific process in place to ensure that monitoring of light locomotive speed limit compliance was taking place. Freightliner operates a regime of routine driver monitoring, where OTDR data is downloaded and analysed to check for compliance with line speeds and driving technique. This is normally undertaken twice per year for every driver and usually covers a relatively long driving shift, so that sufficient data can be analysed. As the driver had had very few opportunities to drive light locomotives, none of the downloads which were analysed covered such trips. This meant that Freightliner had not checked this driver's compliance with light locomotive speeds since training.

Awareness of the permanent speed restriction

107 The driver's attention was distracted from the approaching 50 mph Permanent Speed Restriction (PSR) after the fault on the locomotive had occurred.

108 Approximately 670 metres after setting off from LS5573 signal, the locomotive passed a sign indicating the start of a 50 mph (80 km/h) maximum permitted speed limit (figure 14). By this point, the locomotive's speed was 70 mph (113 km/h) with the emergency brake applied (paragraph 45).

109 As well as losing focus on the signalling sequence and the fact that there may be a red signal ahead when they applied power and accelerated away from LS5573 signal (paragraph 66), the driver also did not recognise that they were approaching a 50 mph (80 km/h) speed restriction. This was despite the driver having passed an advance warning sign for the speed restriction (paragraph 40) approximately 400 metres before stopping at LS5573 signal (figure 15) and having acknowledged an AWS warning associated with the sign. The reasons for the driver losing awareness of the PSR AWS warning are almost certainly the same as those for losing awareness of the signalling sequence (paragraphs 66 to 78).

Figure 14: Speed restriction between LS5573 and LS5575 signals (courtesy of Network Rail).

Figure 15: Advance warning sign located on approach to LS5573 signal (courtesy of Network Rail).

110 Had the driver recognised the upcoming 50 mph (80 km/h) speed restriction, and accelerated the locomotive accordingly, the emergency brake application the driver made when red LS5575 signal came into view would have stopped the locomotive around 540 metres earlier. This would still have been approximately 200 metres past the red signal at LS5575, but 460 metres short of fouling the points at Stafford Trent Valley Junction No. 1.

111 Because this speed restriction is permanent, route knowledge is another means by which the driver could have been aware of the PSR ahead. The driver had passed a route knowledge assessment for the route between Crewe and Rugby in June 2023. Freightliner's risk assessment for this route, for a driver with the same experience, required 15 'trips' over the route, along with a written and practical assessment. This risk assessment, and the resulting assessment regime, was based on the requirements of Rail Industry Standard RIS-3702-TOM 'Management of Route Knowledge', issue 3 dated March 2020. Successful completion of these meant that the driver held the required route knowledge to be able to drive over that route.

112 During the driver's initial training, before June 2021, the driver had driven over the route from Crewe to Rugby several times in both directions, while accompanied by a trainer/assessor. The driver was not trained and assessed for acquisition of the route knowledge competence for the lines between Crewe and Rugby at this time, and did not drive or travel over the route again until May 2023.

113 During May 2023, the driver was rostered to acquire the necessary 15 trips over the line in order to acquire the necessary route knowledge qualification. Most of these trips were made with the driver observing the route while sitting in the second seat in the cab, with other drivers driving the train over the route. Freightliner was unable to provide evidence of which services the driver had ridden on, and hence the directions travelled, during these route knowledge acquisition trips. Two days were also allocated to route learning using training videos, after an initial route briefing day in the classroom.

114 The driver sat their written route assessment and drove for their practical assessment on 1 June 2023. The practical assessment was undertaken while driving a diesel service southbound from Crewe to Rugby, under the supervision of an assessor. No practical assessment was undertaken in the northbound direction from Rugby to Crewe. The driver passed both the written and practical assessment and the driver was signed off as holding the required route knowledge competence for the lines between Crewe and Rugby, in both directions.

115 The result of this was that, although the driver had ridden over the route in both directions, they had not driven over the route in the northbound direction since their initial training in 2021 and had only driven over it twice southbound, including during the practical assessment, in that time. Freightliner stated that its route knowledge assessment process did not specify how many of the 15 required route trips were to be undertaken in each direction, nor whether the practical driving assessment had to be carried out in both directions. The written assessment covered both directions.

116 Although the driver had just passed an advance warning board for that speed restriction and had acknowledged the associated AWS warning, it is possible that a lack of route knowledge contributed to the driver not recognising that there was an upcoming speed restriction after accelerating away from LS5573 signal.

Engineered safety systems

117 No engineered safety system intervened to apply the locomotive's brakes before they were applied by the driver.

AWS infrastructure

118 All the signals approaching Stafford Trent Valley Junction No. 1, and the advance warning sign for the 50 mph (80 km/h) speed restriction, were fitted with AWS (paragraph 20). The AWS magnets were positioned at the standard distance of 180 metres from the signals and from the warning sign. Because the driver acknowledged the AWS warnings for the signals and for the speed restriction advance warning sign, the AWS did not intervene to apply the locomotive's brakes.

TPWS infrastructure

119 LS5575 signal was fitted with TPWS TSS and OSS loops (paragraph 25). The 50 mph (80 km/h) speed restriction was also fitted with OSS loops.

120 The layouts of the TPWS system for this signal and the speed restriction were designed to comply with Railway Group Standard GERT8030 'Requirements for the Train Protection and Warning System (TPWS)', issue 3 dated April 2010, which was current at the time the latest signalling plan was prepared. This states that '*the primary purpose … is to minimise the consequence of a train passing a TPWS fitted signal at danger and a train overspeeding at certain other locations on Network Rail managed infrastructure*'.

121 The positioning and the associated timings of the TSS and OSS loops were found to be in accordance with Network Rail standard NR/SP/SIG/10138 'Train Protection & Warning System – Transmitter Loop Requirements and Positioning', issue 3 dated April 2004. The configuration of TPWS assumes certain limits on train performance and a driver's use of that performance and the system is not always capable of providing protection against all overruns and conflicts if these limits are exceeded. In this incident, both the TSS and the OSS at LS5575 signal operated as designed, but because the driver had already applied the emergency brake, neither had any additional effect on the length of the overrun.

122 When the locomotive passed the OSS for the speed restriction, the locomotive was travelling at 70 mph (113 km/h) and still accelerating towards both the red signal and the speed restriction. This was below the OSS set speed of 76 mph (122 km/h) and so TPWS did not apply the locomotive's brakes. This acceleration was counter to the TPWS design assumption.

Locomotive TPWS configuration

123 The class 90 locomotive, like many freight locomotives, is equipped with a 'Passenger/Goods changeover switch' (figure 16). This is intended to alter the flow rate of air in the braking system, with slower apply and release rates in the freight setting. Application and release rates are generally faster on passenger trains compared to freight trains, which can be much longer. This changeover switch ensures that the braking rate of the locomotive is approximately matched to that of the type of train which it is hauling. The operation instructions for the class 90 state that this switch should be set to passenger mode when operating as a light locomotive, and this was found to be the setting on locomotive 90006 at the time of the incident.

Figure 16: Passenger/Goods changeover switch on the class 90 immediately after the incident (courtesy of Freightliner).

124 The changeover switch also links to the TPWS system on the locomotive. This alters the TPWS timings, and hence the trip speeds applicable at OSS loops (paragraph 24). The goods setting applies trip speeds approximately 20% lower than those in the passenger setting. RAIB analysis shows that, had the lower goods settings been enabled, then the set speed for OSS at the speed restriction would have been 61 mph (98 km/h) instead of 76 mph (122 km/h). As the locomotive travelled at 70 mph (113 km/h) over the OSS at this speed restriction, this means that the emergency brake would have applied. This would have been six seconds before the driver applied the emergency brake during the incident and the locomotive would have stopped approximately 200 metres earlier. This would still have been approximately 540 metres past the red signal at LS5575, but approximately 120 metres short of fouling the points at Stafford Trent Valley Junction No. 1.

125 Although the brake timing and TPWS timing functions of the Passenger/Goods switch are interconnected on the class 90 locomotive, it is technically possible for these to be separated. This would allow Passenger brake timings to be used with Goods TPWS timings, potentially improving the ability of TPWS to protect against the effects of signals passed at danger.

Previous occurrences of a similar character

126 RAIB is aware of a number of incidents and accidents where trains have passed signals at danger, with some resulting in trains fouling the routes of other trains or in derailment. Some of these incidents have involved light locomotives or excess speed or management of driver competence, and so are relevant to the causes of this incident.

127 On the afternoon of 26 April 2012, a light locomotive operated by Devon & Cornwall Railways passed a red signal at Stafford Trent Valley Junction No. 1 by about 94 metres. RAIB's investigation (RAIB report 16/2013) identified non-compliance with the rules for maximum permitted light locomotive speeds and driver competence management as causal factors.

128 In the early hours of 3 February 2012, a class 90 locomotive that was being driven light engine derailed at Bletchley Junction, while travelling at 65 mph (105 km/h) through a 15 mph (24 km/h) speed restriction. RAIB's investigation (RAIB report 24/2012) observed that there had been a lack of monitoring of driver compliance with the rules for light locomotive speeds. RAIB published a learning point highlighting the importance of such monitoring in the report.

129 RAIB is also aware of many incidents where trains have experienced faults which have resulted in additional workload and/or pressure on drivers, as they deal with out-of-course scenarios. One such incident resulted in a driver making decisions or taking actions that led to a safety incident, and so is relevant to the causes of this incident.

130 On the evening of 7 November 2017, a passenger train, with about 450 passengers, came to a stand near Peckham Rye station, with the driver unable to release the brakes. After confusion between the driver and the control office, the passengers were detrained onto track where the third rail conductor was still live. RAIB's investigation (RAIB report 16/2018) identified a causal factor, that the driver's skills and experience hadn't equipped them to deal with the pressure and workload of the situation. The report made a recommendation relating to the training of drivers that could be relevant to other train operators.

Summary of conclusions

Immediate cause

131 The manner in which the locomotive was driven meant that it was unable to stop before passing LS5575 signal, which was at danger (paragraph 53).

Causal factor

132 The causal factor was:

a. After stopping close to a yellow signal, because of a fault that had occurred on the locomotive, the driver rapidly accelerated the locomotive towards red LS5575 signal once that fault had been reset (paragraph 57). This causal factor arose due to the following:

    i. The driver's attention was distracted from the prevailing signal sequence by the unexpected fault (paragraph 66, **Recommendation 2** and **Learning point 2**).

Underlying factors

133 The underlying factors were:

a. Freightliner had no effective processes for managing the risks specific to test runs using light locomotives (paragraph 79, **Recommendation 1**).

b. Freightliner's training and competence management of the driver had not equipped them to deal with an unexpected and potentially distracting situation in an effective and safe manner (paragraph 85, **Recommendation 2** and **Learning point 2**).

Factors affecting the severity of consequences

134 Factors that exacerbated the consequences of the event were as follows:

a. The driver used the maximum available power to accelerate the locomotive rapidly to 75 mph (121 km/h) after resetting the fault on the locomotive (paragraph 91, **Recommendation 2**).

b. The driver was driving the locomotive at speeds above those permitted by the Rule Book for light locomotives (paragraph 96, **Learning point 1**).

c. The driver's attention was distracted from the approaching 50 mph Permanent Speed Restriction (PSR) after the fault on the locomotive had occurred (paragraph 107, **Recommendation 2** and **Learning point 2**).

d. No engineered safety system intervened to apply the locomotive's brakes before they were applied by the driver (paragraph 117, **Learning point 3**).

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

135 The driver has been subject to Freightliner disciplinary processes.

136 Immediately after the incident, Freightliner sent out a safety briefing to all its drivers, reminding them of the Rule Book requirements for maximum permitted light locomotive speeds and the importance of complying with them.

137 Freightliner has updated its guidance note on driving cab discipline, to include a section relating to the operation of test runs. This requires that technical staff riding on a test run should brief the driver on any faults that might occur and what actions should be taken if they do occur.

138 Freightliner has stated that it is undertaking a review of its route knowledge process, to identify any areas for potential improvement or clarification. It is liaising with other freight operating companies to ensure that an industry-wide approach to managing route knowledge is maintained.

139 Freightliner is reviewing the configuration of the Passenger/Goods selector switch on the class 90 locomotives, to understand if there is an operational safety benefit gain from setting the TPWS to goods timings while retaining the selectable brake timings.

140 Freightliner is completing the rollout of non-technical skills training to those drivers who did not receive it at the time of their initial training, with the objective of completing this by the end of 2024.

Recommendations and learning points

Recommendations

141 The following recommendations are made:[2]

1 *The intent of this recommendation is for Freightliner to more effectively manage the risks associated with the operation of light locomotives.*

Freightliner should review its risk assessments and processes associated with the operation of light locomotives, including those for managing test runs, to ensure that any inherent operational risk is recognised and mitigated. This review should include consideration of the required competence and experience of staff involved, their training and the provision of any information to them that could be relevant. Freightliner should introduce any necessary changes identified as part of this review (paragraph 133a).

This recommendation may also be applicable to other freight operating companies and to any other transport undertakings that operate light locomotives.

2 *The intent of this recommendation is to improve the ability of Freightliner's train drivers to effectively deal with out-of-course scenarios.*

Freightliner should review how it trains and assesses train drivers to effectively and safely manage abnormal, out-of-course and potentially stressful situations. This review should consider whether the use of training simulations, or other means, has the potential to better equip train drivers to safely manage such situations. Freightliner should introduce any necessary changes identified by this review (paragraphs 132a.i, 133b, 134a and 134c).

This recommendation may also be applicable to other freight operating companies.

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[2] 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 and Road to enable it to carry out its duties under regulation 12(2) to:

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

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

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

Learning points

142 RAIB has identified the following important learning points:[3]

1. Train drivers are reminded of the importance of being aware of, and complying with, the Rule Book requirements for maximum permissible light locomotive speeds. These requirements exist because light locomotives are capable of rapid acceleration, while having reduced braking capability. This increases the risk of passing signals at danger and can weaken the protection offered by engineered safety systems, such as TPWS (paragraph 134b).

2. Transport undertakings are reminded that their processes for developing and maintaining driver route knowledge must be effective in providing drivers with sufficient knowledge and experience to drive trains safely over the required routes. This includes driving over routes in both directions (paragraphs 132a.i, 133b and 134c).

3. Transport undertakings are reminded that locomotive Passenger/Goods timings selector switches may affect TPWS speed settings, as well as brake timings, and that this should be considered as part of any operational risk assessments. Operators should be aware that TPWS protection assumes different braking rates for passenger and for freight trains, and that passenger overspeed protection timings may not offer sufficient protection from overruns for light locomotives or for freight trains operating in passenger brake timings (paragraph 134d).

[3] 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where 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.

Appendices

Appendix A - Glossary of abbreviations and acronyms

AWS	Automatic Warning System
ORR	Office of Rail and Road
OSS	Overspeed sensor system
OTDR	On-train data recorder
PSR	Permanent Speed Restriction
RAIB	Rail Accident Investigation Branch
REC	Railway emergency call
ROC	Rail Operating Centre
SPAD	Signal passed at danger
TPWS	Train Protection and Warning System
TSS	Train stop system
VCB	Vacuum circuit breaker

Appendix B - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- information taken from the train's OTDR
- information from signalling logging data and signalling plans
- recorded voice communications from Network Rail
- site photographs
- weather reports and observations at the site
- operational procedures provided by Freightliner
- personnel, training and competence records from Freightliner
- a review of previous RAIB investigations that had relevance to this incident.

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

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