Rail Accident Investigation Branch

Rail Accident Report

Near miss between a rail grinding train and an empty passenger train at Sileby Junction, Leicestershire
5 May 2021

Report 06/2022
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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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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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Near miss between a rail grinding train and an empty passenger train at Sileby Junction, Leicestershire, 5 May 2021

Contents

Summary

At about 05:29 hrs on Wednesday 5 May 2021, a train made up of machines used for reprofiling (grinding) rails passed a signal at danger (red) at Sileby Junction, between Leicester and Loughborough, resulting in a near miss with an empty passenger train travelling in the opposite direction. The passenger train had cleared the junction less than 10 seconds before the rail grinding train reached it. There were no injuries or damage as a consequence, but the incident resulted in delays to several trains in the area.

The incident was caused by two factors. Firstly, the driver did not control the train's speed to be able to stop at the signal at danger, probably due to fatigue. Secondly, although the train's systems made an automatic emergency brake intervention, this did not stop the train before it reached a point at which it could collide with another train. A probable underlying factor was associated with the fatigue risk management processes used by the train operator.

RAIB has also made four observations which, although not linked to the cause of the incident, nevertheless had safety implications. The first observation identified that there was no system-wide risk assessment to control the risk of overruns arising from the operation of non-standard vehicles on the national rail network. The second observation noted that the train operator did not obtain safety-critical information about the driver when he joined the company. The remaining observations relate to industry processes for managing the operational and technical response to such incidents.

There are two recommendations arising from this investigation. These cover fatigue risk management and managing the risks of trains with lower braking rates passing signals at danger. RAIB has also identified three learning points, addressing the use of napping as a fatigue mitigation, the importance of organisations sharing safety-critical information when employees move between companies, and railway procedures for post-incident management.

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 about 05:29 hrs on Wednesday 5 May 2021, a train made up of machines used for reprofiling (grinding) rails passed signal LR477 at danger (showing a red aspect) on the down slow line at Sileby Junction, between Leicester and Loughborough (figure 1). This resulted in a near miss with an empty passenger train travelling in the opposite direction that had cleared the junction less than 10 seconds before the rail grinding train reached it (figure 2).

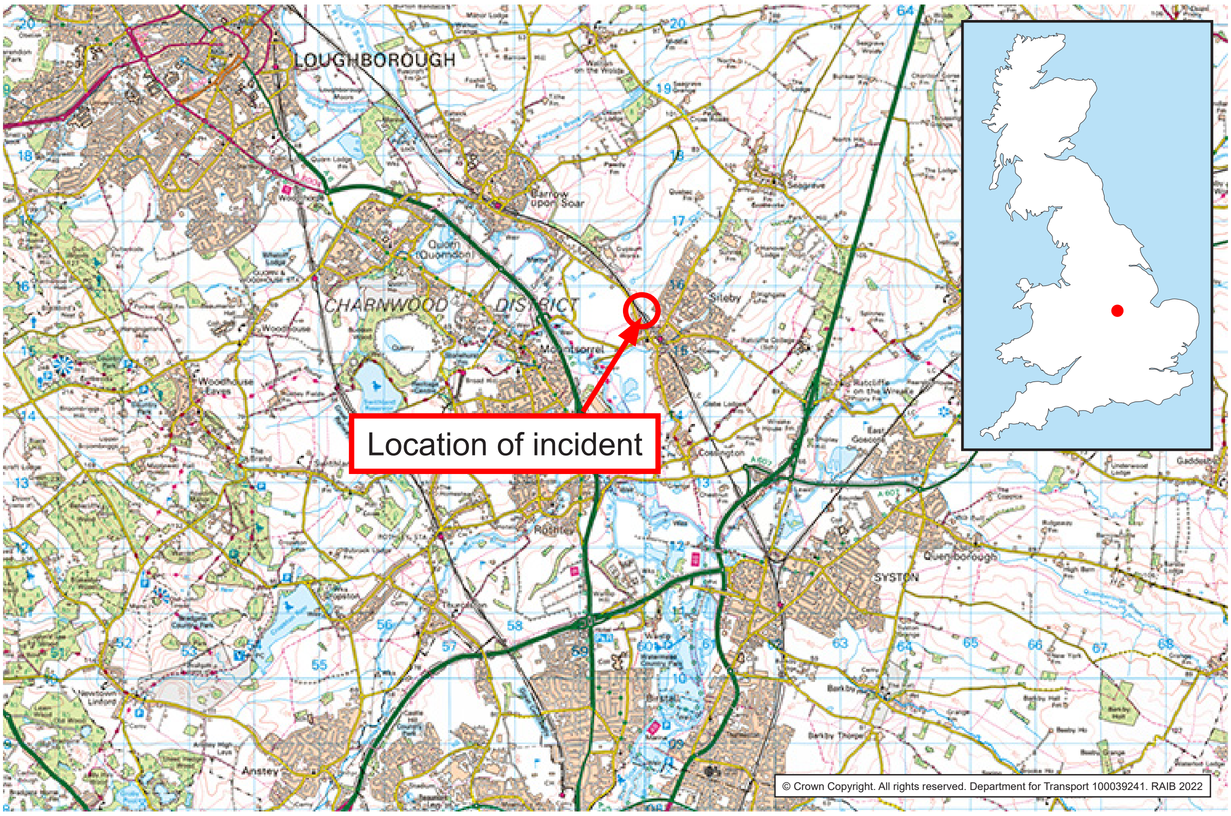

Figure 1: Extract from Ordnance Survey map showing location of incident

4 The rail grinding train, reporting number 6Z08, was travelling from Kilby Bridge Junction, south of Leicester, to Chaddesden Yard, Derby, having completed grinding work overnight. It passed signal LR477 by around 340 metres, stopping some 80 metres beyond the point at which it might have come into conflict with other train movements. The driver had applied brakes on the train shortly before the train protection and warning system (TPWS) intervened and made an emergency brake application.

5 Signal LR477 was at danger to protect train 5P01, the 04:57 hrs empty coaching stock (a passenger train not in service) movement from Etches Park, Derby, to Melton Mowbray, which was crossing from the up fast to the up slow line at the time (figure 3).

6 There were no injuries or damage as a consequence of the incident, but the disruption resulted in delays to several trains in the area.

Figure 2: Still image from the rearward facing closed-circuit television (CCTV) of train 5P01 having just crossed over from the up fast line to the up slow line, across the path of train 6Z08; image shows the leading end of rail grinding train 6Z08 (left) shortly before it came to a stop on the down slow line (East Midlands Railway)

Context

Location

7 Sileby Junction is located at 107 miles from London St Pancras station on the Midland Main Line, about 0.4 miles (0.6 km) north of Sileby station. The junction consists of a series of three crossovers, where trains can change tracks between the up and down fast lines, and the up and down slow lines (figure 3).

8 The maximum permitted speed on the down slow line at this location is 65 mph (105 km/h); this was increased from 50 mph (80 km/h) in 2010. There is a slight falling gradient of 1 in 508 for about one kilometre on the approach to signal LR477.

Organisations involved

9 Colas Rail UK (referred to as Colas in this report) operates the rail grinding train on behalf of Network Rail when it is running on the mainline network other than when it is working as a grinder inside possessions (where the railway is temporarily closed for engineering work to take place). Colas also employed the driver involved in the incident.

10 Loram UK Ltd (referred to as Loram in this report) is the owner and maintainer of the rail grinding train and operates it for grinding work inside possessions.

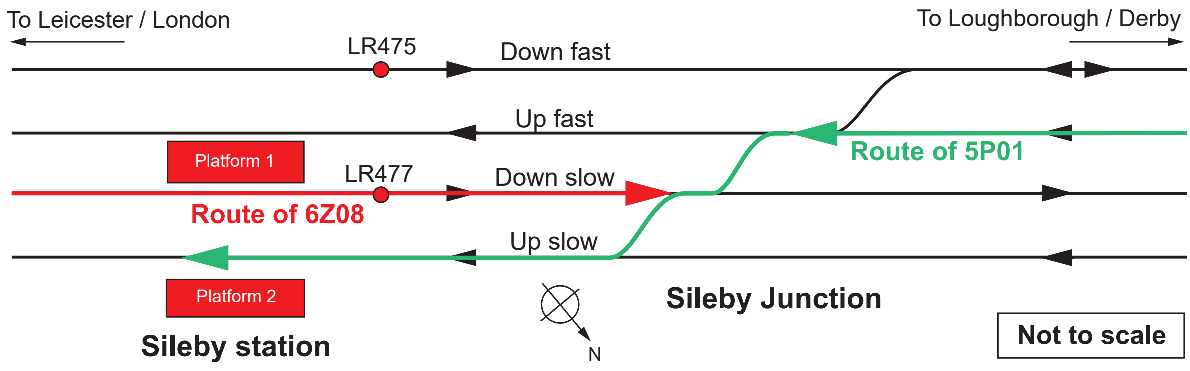

Figure 3: Track layout at Sileby Junction

11 Network Rail is the owner and maintainer of the railway infrastructure, including the signalling equipment.

12 East Midlands Railway is the operator of the empty passenger train involved in the incident.

13 All parties freely co-operated with the investigation.

Trains involved

14 Train 6Z08 was formed of rail grinding machine C2101, one of a fleet of three such machines operated by Loram which are used to reprofile the railhead, eliminating surface cracks and thereby increasing the lifespan of the rail. C2101 consists of five vehicles, including driving cabs at each end (figure 4). Its maximum permissible speed while travelling outside possessions is 55 mph (89 km/h).

Figure 4: Rail grinding train similar to C2101

15 Machine C2101 is fitted with two braking systems (see figure 5). The first is a conventional 'automatic' braking system, which controls brake cylinder pressures on all the machines via the brake pipe.[1] The automatic brake applies uniform brake cylinder pressure throughout the train; as such, it is used when travelling at higher speeds outside possessions. The second system is an 'independent' (or 'direct') brake, which rapidly changes brake cylinder pressure independently of the brake pipe. The independent brake operates more quickly than the automatic brake but, consequently, can result in the wheels sliding on the rails and being damaged as a result. Therefore, the independent brake should only be used when travelling below 20 mph (32 km/h). It is primarily for controlling speed during grinding work.

16 Emergency braking on the machine can be applied by three means, all of which have the effect of venting the brake pipe and so applying maximum pressure to all brake cylinders on the train. These means are pushing the automatic brake lever fully away from the driver; pressing the emergency brake plunger; or through an intervention from one of the train's automatic safety systems (such as TPWS).

17 On 23 March 2011, Network Rail's acceptance panel issued a certificate confirming that machine 2101 was compatible with its infrastructure over specified routes. In 2018, Loram modified C2101 from its original seven-vehicle configuration to the current five vehicles. Loram assessed the braking performance of the five-vehicle configuration against the requirements defined by curve A2 of Railway Group standard GMRT2045 (Issue 4, March 2016), equivalent to an average braking rate[2] of 4.6%g from 60 mph (97 km/h) and demonstrated that the modification did not affect the compatibility of C2101 with Network Rail's infrastructure. Loram recorded the accepted braking rate at 4.9%g, above the requirements of the Railway Group standard.

18 Loram carried out an annual test on the brake systems of C2101 on 3 April 2021, just over one month before the incident, and found them to be compliant with the vehicle maintenance instruction for yearly brake testing. Post-incident brake testing was carried out on 6 May 2021, and this found the systems to be compliant with the relevant vehicle maintenance instruction for post-incident testing.

19 C2101 is fitted with an Automatic Warning System (AWS, explained in paragraph 25), TPWS (explained in paragraph 26) and a Driver's Safety Device (DSD). The DSD sounds a warning every minute, which the driver must acknowledge via a foot pedal, otherwise an emergency brake intervention will occur. Post-incident testing of the AWS and TPWS systems on 6 May 2021 again revealed no issues of concern.

20 There is a convenience car behind the driving cab, equipped with chairs, tables and basic refreshment facilities, for use by train crew when they are not operating the train.

21 Train 5P01 was formed of a nine-coach class 222 (Meridian) train.

[1] A pipe running the length of a train that controls (and in the single brake pipe configuration also supplies) the air brakes on the rail vehicles forming the train. A reduction in brake pipe air pressure will apply the brakes.

[2] The value of an acceleration (or deceleration) expressed as a percentage of that achieved by a freely falling object under gravity, which is taken to be 9.81 m/s².

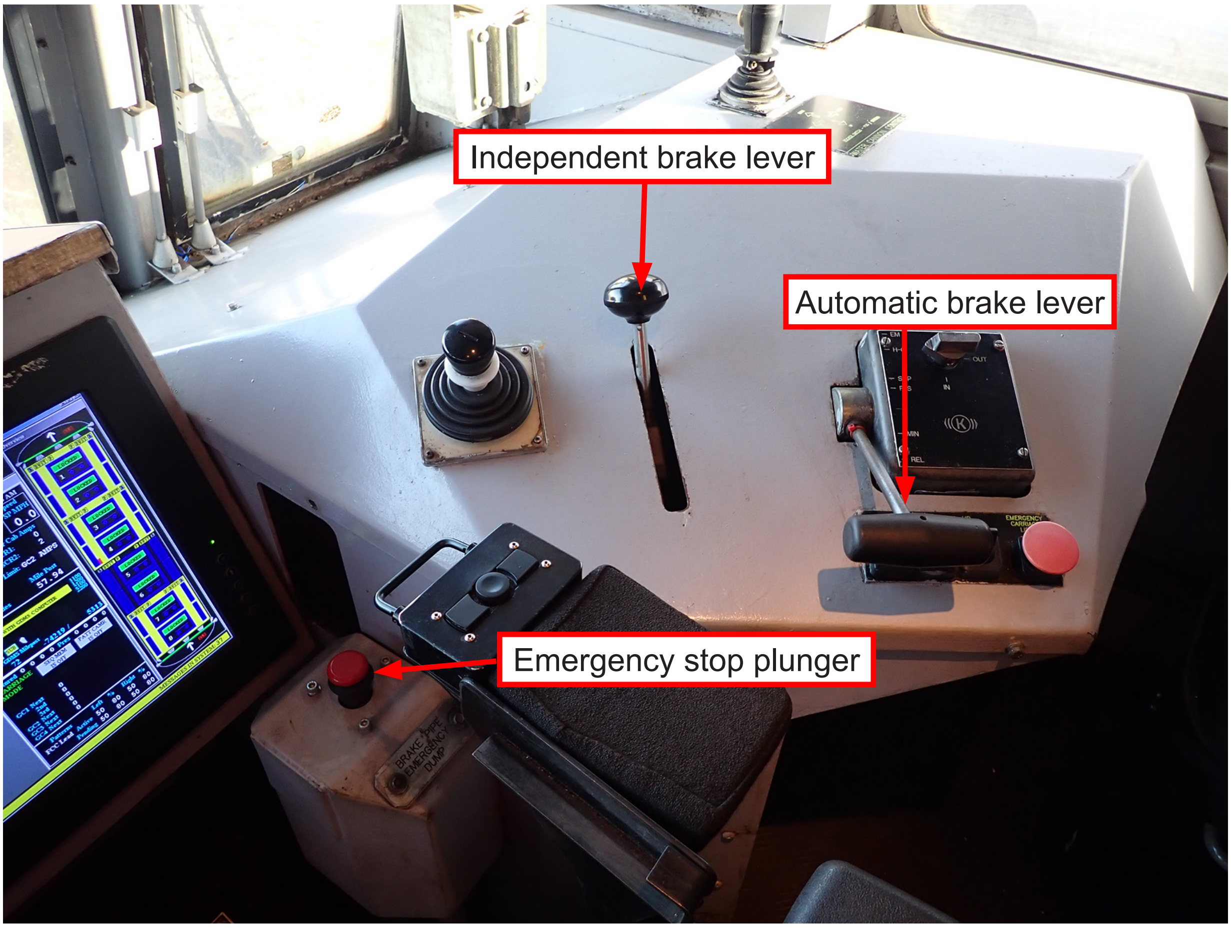

Figure 5: Driver's braking controls for the rail grinding machine. These controls are situated to the right-hand side of the driving seat.

Rail equipment/systems involved

22 Signal LR477 is a three-aspect colour light signal with a junction indicator[3] (which is lit for trains taking the left-hand crossover at Sileby Junction), located at 106 miles 1278 yards on the down slow line. The signal is controlled by the signaller to protect movements across Sileby Junction. The signal is mounted 5.1 metres above the running line on an overhead gantry (figure 6). Also mounted on the same gantry is signal LR475 for the down fast line, parallel and to the left of signal LR477.

23 On the approach to signal LR477, there is a slight left-hand curve before the track straightens through Sileby station, which itself is around 160 metres on the approach to signal LR477. A post-incident signal sighting committee convened by Network Rail determined that the signal was first visible from 450 metres on the approach.

24 When signal LR477 is at danger, the preceding signal (LR473) displays a single yellow caution aspect. Signal LR473 is mounted on a post to the left-hand side of the track; a straight approach to this signal affords a sighting distance of 800 metres. The distance between signals LR473 and LR477 is 2,580 metres.

[3] An arrangement of lines of white lights mounted above a junction signal in colour light signalled areas which, when lit, displays the diverging route through a junction to a driver (definition from Ellis's British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com).

Figure 6: Signal LR477 (Colas Rail UK)

25 Signal LR477 is fitted with both AWS and TPWS equipment. AWS provides a visual and audible reminder to drivers of the state of signals. It uses an electromagnet between the running rails on the approach to the signal, the state of which is detected by equipment on board the train. If the signal is displaying any aspect other than a green aspect, a horn warning sounds in the cab which the driver must acknowledge promptly, otherwise the system makes an automatic brake application. Acknowledging the horn warning also displays a persistent visual reminder in the cab. The AWS magnet for signal LR477 is positioned 153 metres on the approach to the signal.

26 As explained in the 2001 joint inquiry into train protection systems,[4] TPWS is not designed to prevent trains passing signals at danger, but to mitigate the consequences of such incidents by preventing trains from reaching a 'conflict point' at which they might collide with other trains.[5] At signals such as LR477, TPWS uses pairs of electromagnetic loops placed between the rails, the state of which is again detected by equipment on board the train. One pair of loops (the overspeed sensor system, OSS) is placed at a distance on the approach to the signal while another (the train stop sensor system, TSS) is placed at the signal itself. If the signal is at danger and a train either passes the OSS at a speed higher than its 'set speed' (which is based on factors such as the permitted line speed, gradient, distance to conflict point and braking characteristics of the rolling stock using the line) or passes the TSS at the signal, then the TPWS equipment on the train demands an emergency brake application. At signal LR477, the OSS loops are placed 20 metres apart and at 272 metres from the signal, with the set speed for freight traffic being 33 mph (53 km/h).

[4] Professor John Uff QC FREng and The Rt Hon Lord Cullen PC (2001). The Joint Inquiry into Train Protection Systems. Sudbury: HSE Books.

[5] RS/522 AWS and TPWS Handbook, Issue 3, December 2015.

27 Signalling diagrams show that the conflict point for signal LR477 is 262 metres past the signal, at the leading end of the crossover between the up slow and down slow lines at Sileby Junction.

28 Since January 2012, signal LR477 has been controlled from the Leicester workstation at Network Rail's East Midlands Control Centre in Derby. The incident on 5 May 2021 is the first recorded occasion that signal LR477 has been passed at danger.

Staff involved

29 The driver of 6Z08 had over 25 years' railway experience, 22 years of which were spent driving freight and maintenance trains. From 2007 until March 2013 he worked for English, Welsh and Scottish Railway (EWS, which became DB Schenker in 2009), but he was dismissed from this company after passing a signal at danger at a level crossing near Nottingham on 26 November 2012 (see paragraph 89). In February 2014 the driver joined Balfour Beatty, transferring across to Colas in July 2015 when it secured the contract to operate the rail grinding trains.

30 On joining Balfour Beatty, the driver began a period of route knowledge training, which included the route through Sileby Junction, and was passed as competent on this route in September 2014. He initially started driving freight trains in December 1998 and was passed as competent to drive the rail grinding trains on 6 February 2019. The driver was therefore certified as competent for the route and the train and, having most recently passed over the route in the same rail grinding train the day before the incident, was also familiar with both. Before the incident on 5 May 2021, in accordance with Colas' processes, the driver's last practical driving assessment was on 20 January 2021, and his most recent medical was in June 2020; the driver passed both of these assessments. A post-incident screening test for the presence of alcohol and proscribed drugs revealed no issues of concern.

External circumstances

31 The weather at the time of the incident was cold with an ambient temperature of 3°C and a 15 km/h westerly wind. Local sunrise was at 05:26 hrs; CCTV images from train 5P01 showed that visibility was good with a clear sky and post-dawn light conditions (figure 2).

32 Other than the time of day (see paragraph 54), external circumstances are unlikely to have played a part in the incident.

The sequence of events

Events preceding the incident

33 Around 21:30 hrs on 4 May 2021, the driver of 6Z08 booked on for his shift remotely from home. He carried out a check on his road vehicle, then drove to Chaddesden sidings in Derby, where the rail grinding train had been prepared. The driver then set up the train, carried out a static brake test as required by operating procedures, and departed at 22:53 hrs for Kilby Bridge, south of Leicester, where the grinding work was to take place that night. As soon as the train had accelerated to its maximum permitted speed of 55 mph (89 km/h), the driver also carried out a running brake test which he deemed satisfactory.

34 The journey to Kilby Bridge took around 35 minutes. The driver stopped the train at a designated signal and the engineering possession was set up around the train. He then drove the train into the worksite and handed it over to Loram operatives, who were to use the train to carry out the grinding work. After handing over the train, the driver retired to the convenience car and then occupied his time browsing social media and watching television shows on his mobile devices.

35 At around 03:43 hrs, the grinding work had finished, so the driver returned to the leading cab and took over the train from the Loram operatives. About 10 minutes later, the driver drove the train out of the worksite to Wigston South Junction, where the engineering possession was given up. The train departed for its return journey to Chaddesden sidings in Derby at 05:11 hrs.

36 The first part of the journey back to Derby was largely uneventful, with the train running on proceed (green) signals at speeds of around 40 and 50 mph (64 to 80 km/h), with the exception of a single yellow caution signal at Leicester at 05:19 hrs, for which the driver slowed the train to around 15 mph (24 km/h). When he braked the train for this caution signal, the driver used the automatic brake to slow the train to around 25 mph (40 km/h), before switching to the independent brake to control the train at slower speeds.

Events during the incident

37 At 05:27:25 hrs, and with train 6Z08 travelling at 53 mph (85 km/h), the driver acknowledged the AWS horn warning for signal LR473, which was displaying a single yellow caution aspect.

38 At 05:29:07 hrs, and with train 6Z08 still travelling at 53 mph (85 km/h), the driver partially applied the independent brake. At this point, the train had travelled for around 5.5 seconds and 130 metres beyond the first point at which the danger aspect at signal LR477 could be seen and was 75 metres on approach to the TPWS OSS loops. About one second later, the driver slightly reduced the level of independent brake application.

39 Two seconds after the driver reduced the independent brake application, and with the train travelling at 52 mph (84 km/h), train 6Z08 passed over the OSS loops for signal LR477. As it was travelling above the OSS set speed for freight trains of 33 mph (53 km/h) the TPWS equipment on the train intervened and demanded an emergency brake application.

40 Train 6Z08 passed signal LR477 at danger at 05:29:24 hrs, while travelling at 40 mph (64 km/h). At this point, the front of train 5P01 had just traversed from the up fast onto the down slow line, before continuing its movement onto the up slow line. About 20 seconds later, the rear end of train 5P01 cleared the junction, just before train 6Z08 reached the conflict point (figure 3). Train 6Z08 stopped after a further 10 seconds, having travelled around 340 metres beyond the signal (figure 7).

Figure 7: Stopping point of the train after the incident, showing the crossover used by train 5P01 from the down slow to the up slow line (Network Rail)

Events following the incident

41 The signaller was alerted to the incident by an alarm on their workstation and contacted the driver using the GSM-R radio system to complete the incident documentation and discuss subsequent actions. The duty manager at Colas was advised of the incident at 05:45 hrs. A mobile operations manager from Network Rail attended the site to confirm that there had been no damage to the tracks or points.

42 At 06:36 hrs, under instruction from the signaller, the driver moved the train back behind signal LR477 to allow normal working to resume on the other lines in the area. At 06:46 hrs, the driver resumed driving the train to Chaddesden sidings accompanied by a supervising driver from Loram in the cab. The train arrived at Chaddesden at 07:33 hrs, 58 minutes later than scheduled.

Analysis

Identification of the immediate cause

43 The train passed signal LR477 at danger and did not stop before the conflict point.

44 Train 6Z08 travelled for around 340 metres past signal LR477 and reached the conflict point at Sileby Junction. Under slightly different circumstances, there could have been a collision with train 5P01 which was crossing the junction ahead and only cleared it just before train 6Z08 reached the conflict point (paragraph 40).

Identification of causal factors

45 Post-incident testing (paragraph 18) and witness evidence did not reveal any problem with the braking system on train 6Z08. RAIB has therefore concluded that the accident occurred due to a combination of the following causal factors:

a. The driver did not control the speed of train 6Z08 on the approach to signal LR477 to enable it to stop at the signal. This was due to a loss of awareness of the driving task probably caused by fatigue (paragraph 46).

b. The TPWS emergency brake demand did not stop train 6Z08 before it reached the conflict point at Sileby Junction (paragraph 58).

Each of these factors is now considered in turn.

Factors affecting the actions of the driver

46 The driver did not control the speed of train 6Z08 on the approach to signal LR477 to enable it to stop at the signal. This was due to a loss of awareness of the driving task probably caused by fatigue.

47 Data from the on-train data recorder (OTDR) fitted to train 6Z08 showed that the driver acknowledged a DSD warning about four seconds before the AWS warning horn for the caution aspect at signal LR473. The driver responded to both these DSD and AWS warnings (paragraph 37), although he initially used the DSD foot pedal to try and cancel the AWS warning horn before pressing the AWS plunger about one second later. There was a further DSD warning one minute later, when the train was between signals LR473 and LR477. The driver responded to this DSD warning appropriately.

48 The driver made no further actions to control the train until about 43 seconds later when OTDR data shows that the independent brake was applied (paragraph 38), even though the automatic brake should have been used since the train's speed was above 20 mph (32 km/h) (paragraph 15). This independent brake application occurred shortly before TPWS intervened to demand an emergency brake application (paragraph 39).

49 The driver stated that he remembered seeing the caution signal (LR473) but, as he subsequently came around the left-hand curve approaching signal LR477, he looked up and suddenly became aware that the signal was at danger and started applying the brakes. He stated that his normal practice would be to start braking at an appropriate point on seeing the single yellow signal to bring the train gradually to a stop on approach to the subsequent danger signal. However, because the distance between the caution and danger signals at this location allows more distance than is required to stop for this type of train[6] in advance of the red signal, he did not need to start braking immediately.

50 Had the driver made an emergency brake application via the automatic brake at the point he saw the danger signal, instead of using the independent brake, it is probable that the train would still have reached the conflict point. RAIB calculated that at the speed the train was travelling, for the emergency rate of braking to have stopped the train at signal LR477, such a brake application would need to have been made around 11 seconds before the driver applied the independent brake on the day of the incident, which is around 5.5 seconds before the red signal came into view.

51 RAIB's analysis of OTDR data suggests that the driver's reaction times to AWS and DSD warnings became longer and more variable in the period directly preceding the incident. OTDR data also shows the late application of the brake, and the fact that the driver applied the independent brake rather than the automatic brake when he became aware that the approaching signal was at danger. RAIB has concluded from this evidence that the driver of train 6Z08 lost awareness of the driving task during the time that the train was travelling between signals LR473 and LR477, probably due to fatigue. Witness evidence suggests that the driver may have had a microsleep after passing signal LR473.

52 There is no evidence that the driver was distracted during the journey. He was alone in the cab before the incident, and RAIB's inspection of his mobile devices found no evidence that they were being used while driving on the morning of the incident. However, the changes in performance recorded could be indicative of the effects of fatigue.[7] The driver was working his sixth consecutive night shift when the incident occurred, which resulted in a cumulative total of over 62 hours since his last rest day (table 1). Had the incident not occurred, the driver was rostered for two more similar night shifts on 5 and 6 May 2021. Fatigue management guidance[8] from the Office of Rail and Road (ORR) suggests that staff work a maximum of three consecutive night shifts where those shifts are over eight hours long, and a cumulative limit of 55 hours in a rolling seven-day period.

53 According to witness evidence, the driver finished his previous shift early on the morning of 4 May and slept from around 07:00 hrs to 11:30 hrs. He then obtained about two more hours sleep in the early evening before remotely booking on for work at 21:30 hrs. This total of around 6.5 hours sleep is less than the average requirement of 8.2 hours cited in the ORR guidance.

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[6] The distance between the signals on this section of line is over 2.5 km, because they are located in parallel with those on the down fast line, which are spaced to provide adequate braking distance for its line speed of 110 mph (177 km/h).

[7] Dorrian, J., Roach, G.D., Fletcher, A. & Dawson, D. (2007). Simulated train driving: Fatigue, self-awareness and cognitive disengagement. Applied Ergonomics, 38(2), 155-166.

[8] ORR (2012). Managing rail staff fatigue. Available at: https://www.orr.gov.uk/media/10934

54 The driver stated that he felt fine when he booked on and was no more tired than usual toward the end of the night shift. Nevertheless, the incident occurred in the early hours of the morning at a time when alertness can be lower due to daily variation in the human 'body clock'.

Date	Shift start time	Shift end time
29 April 2021	21:30	07:30
30 April 2021	21:00	08:00
1 May 2021	21:46	10:34
2 May 2021	21:45	06:30
3 May 2021	21:49	07:36
4 May 2021	21:50	07:36

Table 1: Driver's roster leading up to the incident on the night of 4-5 May 2021 (highlighted in red). On the night of 4 May 2021, the driver booked on at 21:30 to allow time for a road vehicle check before setting off (paragraph 33)

55 There is a considerable amount of dormant time on the shift for the train driver, particularly during the period while the grinding work takes place. The driver spent this time in the convenience car (paragraph 34) but did not nap, because he believed that it was a disciplinary offence to do so while on duty. He did not have anything to eat throughout the shift, which may have further affected his alertness.

56 OTDR data also shows that the train's DSD and AWS systems sounded several warnings directly before the incident. RAIB's previous investigations[9] and industry research[10] have shown that drivers can respond to AWS and DSD warnings in an automatic manner, even while fatigued. In any case, these warnings apparently did not serve to alert the driver or raise his awareness while the train was travelling between signals LR473 and LR477.

57 The driver left Colas prior to any post-incident medical examination. RAIB has been unable to determine from other evidence gathered during the investigation whether he suffered from any sleep disorders. However, the driver stated that he did not suffer from sleep apnoea.

TPWS intervention

58 The TPWS emergency brake demand did not stop the train before it reached the conflict point at Sileby Junction.

59 The conflict point at Sileby Junction is 262 metres beyond signal LR477 (paragraph 27), while train 6Z08 passed signal at danger by around 340 metres (paragraph 40). Therefore, despite the emergency brake demand made by TPWS at the OSS loops for signal LR477, the train travelled nearly 80 metres beyond the conflict point. However, without the emergency brake demand made by TPWS, and assuming no other further action was taken by the driver, RAIB's analysis shows that train 6Z08 would have reached the junction while train 5P01 was still crossing over it, at a closing speed of around 70 mph (113 km/h). This shows that while TPWS did not prevent train 6Z08 from reaching the conflict point, its intervention might have prevented a collision between trains 6Z08 and 5P01.

[9] For instance, RAIB report 23/2008 (Signal passed at danger and subsequent near miss at Didcot North Junction, 22 August 2007) and RAIB report 15/2011 (Uncontrolled freight train run-back between Shap and Tebay, Cumbria, 17 August 2010).

[10] RSSB (2003). Extended use of AWS (project T021). Available at https://www.sparkrail.org/Lists/Records/DispForm.aspx?ID=196

60 While TPWS is not designed to prevent signals being passed at danger, it is generally expected to prevent trains from reaching the conflict point beyond the signal (paragraph 26). To achieve this, TPWS designs[11] assume a braking rate for passenger trains of 12%g or, for trains on freight-only lines, 7.5%g. RAIB calculated the average braking rate of train 6Z08 during the incident as approximately 4.9%g, consistent with the accepted braking rate (paragraph 17).[12]

61 Network Rail calculates the effectiveness of TPWS at a given signal (that is, the probability of a train being stopped before reaching the conflict point) using a Signal Overrun Risk Assessment Tool (SORAT[13]). This is applied to existing junction signals every five years. The SORAT process is based on train movements between 07:00 hrs and 19:00 hrs in the industry's working timetable. It therefore does not make explicit provision for movements of the type made by machines such as train 6Z08, which tend to be outside those hours and are not usually included in the working timetable.

62 Before the incident on 5 May 2021, the most recent SORAT evaluation at signal LR477 was carried out on 31 July 2017. The evaluation determined a TPWS effectiveness score for the signal of 86.24%. In other words, for trains passing the signal at danger, just over 86% of them will be stopped by TPWS before reaching the conflict point. This placed the signal in risk band 'J2', which Network Rail described as a medium risk category. Trains with lower braking rates than those accounted for by TPWS, such as train 6Z08, will therefore fall into the 13.76% likelihood of not stopping before the conflict point.

63 Following the incident, Network Rail commissioned a review of TPWS effectiveness at signal LR477 and other signals in the area. This review also did not account for trains with less than 7.5%g braking rates, but observed that the TPWS at signal LR477 was not fully effective even for freight trains with 8%g braking rates approaching at 60 mph (97 km/h), calculating that these would pass the conflict point by 205 metres.

[11] Network Rail standard NR/SP/SIG/10137 Train Protection and Warning System (TPWS): Selection of New Signals and Other Locations for Provision of TPWS, Issue 3, April 2004.

[12] Although not the subject of this investigation, RAIB notes that not all passenger trains are capable of such braking rates. RAIB's investigation into the near miss at Didcot North Junction on 22 August 2007 (RAIB report 23/2008), for example, found that the class 43 High Speed Train involved achieved an average mean retardation of around 9%g following an emergency brake application.

[13] Network Rail standard NR/L2/SIG/14201/Mod04 Signalling Risk Assessment Handbook: Prevention and Mitigation of Overruns – Signal Overrun Risk Assessment Tool Specification, Issue 3, 5 December 2020.

Identification of underlying factor

Fatigue risk management

64 Fatigue risk management processes at Colas did not prevent the driver from being affected by fatigue. This is a probable underlying factor.

65 Colas' fatigue management procedure[14] covers working time limits and requirements for designing and evaluating rosters, as well as wider controls for factors that can influence fatigue. There is also some relevant guidance in Colas' professional driving policy[15] on areas such as lifestyle, fitness for duty (including sleep) and rest breaks.

66 Although the fatigue management procedure reflects some of the current good practice as outlined in ORR's guidance document, it essentially relies on working time limits implemented following the inquiry into the 1988 Clapham Junction accident, known as 'Hidden limits' (after the chair of the inquiry, Sir Anthony Hidden QC). The ORR's guidance cautions that it is possible to devise a working pattern which complies with these limits yet still gives rise to significant fatigue. It also states that knowledge of fatigue risk management has improved since the Clapham Junction accident, and that the Railway Group standard which incorporated the Hidden limits was withdrawn in 2007.

67 Colas' fatigue management procedure also sets out the process for evaluating rosters using a fatigue assessment tool called the Fatigue and Risk Index (FRI), developed by the Health and Safety Executive (HSE).[16] The FRI produces two numerical outputs for a given roster pattern: a fatigue index and a risk index, which respectively reflect benchmarked probabilities of an individual becoming fatigued or the risk of an incident. Neither HSE nor ORR advocate the use of FRI thresholds to determine if a roster is satisfactory or otherwise; the point of using such a model is to reduce the scores to as low as reasonably practicable. In June 2021, HSE removed the FRI calculator from its website, citing among other concerns 'cases of the FRI being misused in order to justify work patterns that clearly require further action to reduce fatigue-related risk'.

68 Although Colas' procedure does not explicitly specify thresholds for the FRI, it does refer to a Network Rail standard[17] which states indicative thresholds for the fatigue index of 30 for day shifts and 40 for night shifts. In practice, Colas applies rules embedded into the rostering system whereby fatigue index scores of 40 or lower are deemed to be not at risk, between 40 and 45 are 'close to being fatigued', while scores of 45 or over are at risk of being fatigued. These scores then drive any risk mitigations for the individual concerned, such as later start times, longer rest periods, or reminding the individual how they can manage their own fatigue risk.

[14] Colas Rail procedure HS-A3-011 Control of Excess Hours and Management of Fatigue, Issue 2, May 2019.

[15] Colas Rail document TO2-208 Professional Driving Policy, Issue 3, February 2019.

[16] https://www.hse.gov.uk/research/rrhtm/rr446.htm

[17] NR/L2/OHS/003/01 Fatigue Risk Index Principles, Issue 1, 2 June 2018.

69 Colas calculated a fatigue index of 40.0 for the driver of the rail grinding train on the night of the incident. This meant that he was deemed to be not at risk of fatigue. Post-incident, Colas recalculated the fatigue index taking into account travel time, resulting in a revised score of 41.8. For the driver's night shift of 1-2 May 2021, his calculated fatigue index was 45.0. Colas informed RAIB that this resulted in a conversation with the driver about his fatigue risk and allocating a second driver on the shift as a stand-by, in case the driver did become fatigued.

70 Since February 2021, Colas has employed a fatigue manager and a fatigue co-ordinator who, among other activities, carry out the FRI assessments of shift schedules, produce regular fatigue reports based on actual hours worked and, from August 2021, issue monthly fatigue briefing documents. Some of these briefings referred to wider industry guidance which included advice on napping during breaks. Contrary to the driver's perceptions (paragraph 55), judicious use of napping is generally accepted as an effective short-term mitigation for fatigue. Prior to the incident on 5 May 2021, though, Colas had no policy on this topic and had not delivered any briefings to drivers on the use of napping.

71 While there is evidence that Colas supplied information to drivers about fatigue and hydration before the incident, there is no evidence that any guidance was issued to drivers specifically relating to the effects of nutrition on fatigue. The driver did not eat anything during the shift (paragraph 55) and did not believe that this affected his alertness.

Observations

System-wide risk assessment

72 There was no system-wide risk assessment process to control the risk of overruns arising from the operation of non-standard vehicles on the network.

73 The process for accepting rail grinding train C2101 onto Network Rail's infrastructure included a statement of its braking capability, quoting a rate of 0.48 ms^{-2} (4.9%g) against the requirements in Railway Group standard GMRT2045 (Issue 4, March 2016) approximating to 4.6%g (paragraph 17). The actual braking performance of the train observed during the incident on 5 May 2021 suggests that this rate was achieved, with the combination of the independent brake and the emergency braking as initiated by TPWS achieving an average 4.9%g (paragraph 60). Network Rail's TPWS effectiveness calculations, however, do not account for trains with lower braking rates than 7.5%g (paragraph 60).

74 The requirements of the Railway Group standard predict that the stopping point for trains with the required braking rate of 4.6%g would be 386 metres beyond the conflict point from 60 mph (97 km/h). On the day of the incident, the rail grinding train (which was travelling at a slower speed and with a higher braking rate than prescribed in the standard) stopped around 80 metres beyond the conflict point (from 53 mph (85 km/h)). While the rail grinding train was properly accepted onto Network Rail's infrastructure, this process only demonstrates technical compatibility and does not account for integration with the wider system. Consequently, this imported a risk of signal overruns that is not accounted for in TPWS risk assessments.

Management of safety-critical information

75 Colas did not obtain safety-critical information about the driver involved in the incident when he joined the company.

76 Colas' recruitment procedure[18] follows the rail industry standard[19] for transferring safety-critical information from one employer to another when staff move between companies. The information to be transferred encompasses the employee's safety record, including any previous operating or safety incidents.

77 The driver of the rail grinding train on 5 May 2021 had been involved in a previous similar incident in November 2012 when he worked for a different company (paragraphs 29 and 89). He was subsequently dismissed from this company, then re-joined the rail industry around a year later to work for Balfour Beatty. When Colas took over the rail grinding contract in July 2015, the driver transferred across along with other employees under the Transfer of Undertakings (Protection of Employment) (TUPE) regulations.

78 Although it appears that the records relating to his training and competence were transferred from Balfour Beatty to Colas when the driver moved between the two companies, RAIB has been unable to determine whether Balfour Beatty was aware of the driver's dismissal by his previous employer for the incident which occurred in 2012. This is because the associated files had not been retained beyond five years after his employment with them ended.

79 There is no evidence that Colas would have managed the driver differently had it been aware of the incident in 2012. Nevertheless, RAIB observes that potentially important safety-critical information about this driver was not available to them.

Post-incident management

80 Colas did not authorise the movement of train 6Z08 after the incident.

81 After the driver and the signaller had completed the necessary documentation immediately following the incident (paragraph 41), the driver declared himself fit to continue to the signaller. The driver then drove train 6Z08 back to Chaddesden sidings (paragraph 42), having been given a signalled route for the movement.

82 The railway Rule Book[20] states that following an incident of this nature, the signaller must not allow the train involved to proceed until authorised by operations control. A radio call between the driver and the signaller at 06:40 hrs indicated that the signaller's intent was to seek such authorisation. A subsequent call from Colas' operations control to train 6Z08 at 06:43 hrs, which took place after the train had begun its movement, indicated that Colas' operations control was unaware that the train was on the move and that the signaller had already authorised the movement. However, there is no clear evidence as to who ultimately instructed the driver to resume the journey to Chaddesden.

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[18] TO2-101 Recruitment and Selection of Train Drivers / Groundstaff and Operational Staff, Issue 10, December 2020.

[19] RIS-3751-TOM Rail Industry Standard for Train Driver Selection, Issue Three, March 2015.

[20] GERT8000-S5 Passing a signal at danger or an end of authority (EoA) without a movement authority (MA), Issue 9, September 2020 (withdrawn 4 December 2021 and replaced by Issue 10).

83 Colas' procedure[21] for managing accidents and incidents requires that a member of on-call staff must attend site as directed by Colas' operations control. They must establish the driver's fitness to continue and, if appropriate, authorise them to drive at caution to the nearest recess point.

84 Colas informed RAIB that its control was, however, unaware of the movement of train 6Z08 until after it was underway, meaning that it was unable to establish if the driver was fit to continue driving the train. The Colas investigation report also suggested that, based on the driver's initial report, its control was unaware of the severity of the near miss with train 5P01.

Post-incident brake testing

85 Loram's post-incident brake testing carried out on train 6Z08 did not adequately capture the necessary information to fully understand the effectiveness of the train's braking system.

86 Following the incident, the train completed its journey to Chaddesden sidings at around 07:33 hrs on the morning of 5 May 2021 (paragraph 42). Loram subsequently carried out a test of the brakes on the train according to its vehicle maintenance instruction[22] (paragraph 18). The brake test was signed off on 6 May 2021 in Wellingborough, although Loram has informed RAIB that the test itself was carried out on the night shift of 5-6 May 2021 before the train travelled to Wellingborough.

87 The Loram vehicle maintenance instruction covers functional tests of the independent brake, the automatic brake, the emergency brake plungers and the parking brake. These tests include checking brake pipe pressures and ensuring that the brake blocks apply and release at the wheels.

88 Although the tests included checks of brake pipe pressures, there was no test specified or recorded for brake cylinder pressures, or other measure of brake block force applied to the wheels. There was no allegation of malfunctioning brakes, or any evidence to suggest that the brakes on train 6Z08 were not fully effective at the time of the incident. However, the absence of post-incident test data regarding brake forces could have hampered any further investigation of the braking system, had this been necessary.

Previous occurrences of a similar character

89 At 15:10 hrs on 26 November 2012, train 3J87, a railhead treatment train operated by DB Schenker, passed a signal at danger at Fiskerton Junction and collided with the gates of Morton level crossing, which was open to road traffic. This incident involved the same driver as involved in the incident on 5 May 2021 (paragraphs 29 and 77). The railway industry's investigation, which RAIB reviewed at the time, concluded that the driver misread the distant (caution) signal and therefore did not control his train in anticipation of the subsequent signal at danger. It also concluded that the driver may have been distracted. The investigation made three recommendations covering the speed restrictions applicable to railhead treatment trains, and four local actions concerning the signalling design and sighting for the signal concerned.

[21] TO2-501 Managing Accidents and Incidents, Issue 9, October 2019.

[22] LORAM/C2101/VMI/001 BZ001 Brake – Test, Issue 5, December 2020.

90 At around 10:57 hrs on 26 March 2020, a train formed of two locomotives and an empty, un-braked passenger multiple unit passed a signal at danger about 0.75 miles (1.2 km) south of Loughborough station, stopping around 200 metres beyond the signal (RAIB report 10/2020). The signal was at danger to protect the movement of a passenger service which was just about to leave Loughborough station. The incident, which occurred about 4.2 miles (6.7 km) from signal LR477, was caused because the train was travelling too fast for its braking capability, and because the braking applied by the driver was insufficient to stop the train from that speed within the available distance. RAIB's investigation recommended that the train operator review its management assurance processes relating to operational safety.

91 At 05:19 hrs on 1 March 2021, train 6M39 operated by DB Cargo passed signal LR459 at danger by 200 metres. The signal, at Syston East Junction, is approximately 2.6 miles (4.2 km) from signal LR477 at Sileby Junction. These two incidents, occurring in close proximity and about two months apart, were the catalyst for Network Rail's review of TPWS effectiveness in the area (paragraphs 63 and 107).

Summary of conclusions

Immediate cause

92 The train passed signal LR477 at danger and did not stop before the conflict point (paragraph 43).

Causal factors

93 The causal factors were:

a. The driver did not control the speed of train 6Z08 on the approach to signal LR477 to enable it to stop at the signal. This was due to a loss of awareness of the driving task probably caused by fatigue (paragraph 46, **Learning point 1**).

b. The TPWS emergency brake demand did not stop the train before it reached the conflict point at Sileby Junction (paragraph 58).

Underlying factor

94 Fatigue risk management processes at Colas did not prevent the driver from being affected by fatigue. This is a probable underlying factor (paragraph 64, **Recommendation 1 and Learning point 1**).

Additional observations

95 Although not linked to the accident on 5 May 2021, RAIB observes that:

a. There was no system-wide risk assessment process to control the risk of overruns arising from the operation of non-standard vehicles on the network (paragraph 72, **Recommendation 2**).

b. Colas did not obtain safety-critical information about the driver involved in the incident when he joined the company (paragraph 75, **Learning point 2**).

c. Colas did not authorise the movement of train 6Z08 after the incident (paragraph 80, see paragraph 105 and **Learning point 3**).

d. Loram's post-incident brake testing carried out on train 6Z08 did not adequately capture the necessary information to fully understand the effectiveness of the train's braking system (paragraph 85, see paragraph 108).

Previous RAIB recommendations relevant to this investigation

96 The following recommendations, which were made by RAIB as a result of its previous investigations, have relevance to this investigation.

Previous recommendations that had the potential to address one or more factors identified in this report

Signal passed at danger and subsequent near miss at Didcot North junction, 22 August 2007, RAIB report 23/2008, Recommendations 2, 3 and 9

97 The investigation into the incident at Didcot North Junction identified that trains were operating on the network with levels of braking performance below those assumed for the design of the TPWS installation at the signal concerned. It also highlighted the limitations of the signalling risk assessment tool used by Network Rail at the time in only considering a limited number of braking rates between 7%g and 12%g.

98 The recommendations read as follows:

Recommendation 2

Network Rail should, in consultation with train operators, review its existing risk assessments for all existing junction signals in order to verify that:

- *the actual braking performance of trains signalled by that route has been correctly taken into account; and*
- *proper consideration has been given to any reasonably practicable measures identified.*

When addressing this recommendation Network Rail should ensure that risk assessors are competent and have access to accurate input data.

Recommendation 3

In support of Network Rail's assessment of risk at junction signals (see Recommendation 2), RSSB should make a 'proposal', in accordance with the Railway Group Standards Code, to amend Railway Group Standards to require train operators, in consultation with rolling stock owners, to publish and disseminate to Network Rail any detailed data they may possess relating to the actual braking performance of the trains they operate on the national network (for a range of typical train formations). This should include the distance to stop from a range of speeds (or the duration of any freewheel time and the subsequent rate of deceleration).

Recommendation 9

Network Rail should ensure that its methodology and computer systems for assessing the risk associated with signal overruns correctly take into account the actual braking performance of all trains scheduled to pass a signal. This should allow for freewheel time and the subsequent average deceleration.

99 Taken together, the industry's response to these recommendations was to replace the then existing signalling risk assessment with the new SORAT process, which contains braking capability data for all known trains on the network and includes freewheel time in its calculations. Recommendations 3 and 9 were considered by ORR to be implemented on 18 February 2013 and the formal status of recommendation 2 as reported by ORR is still 'ongoing'. However, in January 2022, ORR advised RAIB that the recommendation has been implemented following a long-term period of monitoring and review of the SORAT process.

100 Notwithstanding the implementation of these recommendations, the current investigation found that the SORAT evaluation for signal LR477 still did not take account of trains with lower braking rates than 7.5%g, such as the rail grinding train involved in the incident (paragraph 60).

Recommendations that are currently being implemented

Two signal passed at danger incidents, at Reading Westbury Line Junction, 28 March 2015, and Ruscombe Junction, 3 November 2015, RAIB report 18/2016, Recommendations 2 and 3

101 The above recommendations addressed the underlying factor associated with fatigue that was identified in this investigation (paragraph 64). Since these recommendations have not yet been fully implemented (see paragraph 102) and did not prevent the incident on 5 May 2021, a similar recommendation is made specifically on Colas in the present report (paragraph 109, Recommendation 1).

Recommendation 2

Freight operating companies should expedite a review of their fatigue risk management systems to ensure that they have sufficient controls (eg policies, company standards) in place which are consistent with published good practice (such as that from ORR and RSSB), including:

- *rostering rules and associated staffing levels (such as limits on working hours, overtime and consecutive shifts), especially for night shifts;*
- *appropriate use of biomathematical fatigue models (such as the FRI);*
- *training and education on fatigue for safety-critical workers and controllers of safety-critical work;*
- *fitness for duty checks when booking-on for duty;*
- *processes for gathering and using feedback, in an open and timely manner, from safety-critical workers on fatigue-inducing shift patterns;*
- *in consultation with their occupational health advisers, screening and treatment for sleep disorders as part of medical assessments, both routinely and particularly where a worker has been involved in a suspected fatigue-related incident, and requirements on individuals to declare any known sleep disorders to their employer.*

Recommendation 3

DB Cargo (UK) Ltd, in cooperation with other freight operating companies, should submit a research proposal to RSSB with the aim of conducting more detailed analysis on incident patterns using normalised data (eg long shifts, consecutive shifts), revisiting previous research in this area and building on recent advances in SPAD data analysis.

102 The status of both of these recommendations is ‘progressing’, as at the last update from ORR on 28 September 2017. In response to recommendation 2, a number of freight operating companies (including Colas) reported taking suitable actions to address the recommendation, although progress was still being monitored by ORR. The actions reported by Colas included strengthening the section responsible for rostering with a view to developing more efficient rostering practices and incorporating the FRI calculator into its rostering programme. As explained at paragraph 64, RAIB considers that Colas’ fatigue risk management system includes features which are not consistent with current good practice guidance promulgated by ORR.

103 The response to recommendation 3 did not clarify whether a research proposal had been submitted to RSSB, and further information was awaited at the time of the last update. RAIB is aware of related research[23] exploring the use of OTDR parameters for long-term trending and prediction of human performance, but it is not clear if this research resulted from recommendation 3.

104 The investigation report also identified a learning point on the role of napping as a fatigue mitigation, which is reinforced in the current investigation (see paragraph 110, Learning point 1).

[23] Walker, G. & Strathie, A. (2015). Leading indicators of operational risk on the railway: A novel use for underutilised data recordings. Safety Science, 74, 93-101.

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

105 Since the incident, Colas has briefed all its drivers about the incident and, in January 2022, commissioned an external consultant to implement a programme of non-technical skills training for all its drivers, based on RSSB's framework.[24] Colas has also issued fatigue briefing documents since the incident which include advice on healthy eating.

106 In relation to incident management (paragraph 80), Colas has completed a review of its process for managing accidents and incidents. In addition, its safety-critical staff have undertaken e-learning for safety-critical communications, and staff have been briefed about the importance of real-time reporting.

107 As a result of this incident and the similar incident at Syston East Junction on 1 March 2021 (paragraph 91), Network Rail commissioned a review of TPWS effectiveness at signal LR477 and other signals in the area (paragraph 63). The review considered a number of options to reduce the risk of signals passed at danger and to achieve full TPWS effectiveness for 'all current trains' (although this still excludes those trains, such as rail grinding trains, which have lower braking rates). The options were discussed at a meeting on 8 February 2022, with the preferred solution being to reposition the OSS loops on the approach to the signal. However, there were concerns over the time it would take to properly implement this solution, including a review of its impact on passenger services. In the meantime, the meeting agreed to impose a temporary speed restriction to mitigate the risk of an overrun.

108 Loram has reviewed and updated its procedures for post-incident brake testing to include more detail about brake forces and brake cylinder pressures.

[24] See https://www.rssb.co.uk/safety-and-health/improving-safety-health-and-wellbeing/understanding-human-factors/non-technical-skills/introduction-to-non-technical-skills.

Recommendations and learning points

Recommendations

109 The following recommendations are made:[25]

1 *The intent of this recommendation is to reduce the risk of fatigue affecting the performance of safety-critical staff at Colas*.

Colas Rail UK should review and update its current fatigue risk management system for staff who undertake safety-critical tasks, making any changes as necessary to confirm that it meets relevant industry guidance and good practice. This review should be based on an assessment of work activities and their associated risks and available risk controls. The review should consider relevant law, guidance and current good practice (paragraph 94).

2 *The intent of this recommendation is to address weaknesses in the rail industry's existing control of overrun risks associated with operating non-standard trains on Network Rail managed infrastructure.*

Network Rail, working together with relevant transport undertakings, should develop and implement a process which identifies and accounts for the residual overrun risk associated with the operation of vehicles (such as some freight trains and on-track machines) which have braking rates lower than those assumed when the effectiveness of TPWS is assessed (paragraph 95a).

[25] 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

110 RAIB has identified the following important learning points:[26]

1 This investigation serves as a reminder that, under appropriate circumstances, front-line staff may use napping as a mitigation where they have been unavoidably affected by fatigue. While napping should never be relied upon to control fatigue in lieu of preventative measures, train operators should ensure that their employees are aware of the role of napping within their wider fatigue risk management systems, including its relative merits as a fatigue countermeasure.

2 This investigation highlights the importance of the requirements in RIS-3751-TOM for organisations to pass on safety-critical information when employees move between companies, and to carry out due diligence checks on prospective employees returning to the rail industry after a period of absence.

3 The events following this incident emphasise the importance of the Rule Book requirements and associated organisational procedures for post-incident management, particularly regarding clarity of communications for authorising any onward movement of the vehicles and people involved.

[26] '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
CCTV	Closed-circuit television
DSD	Driver's Safety Device
FRI	Fatigue and Risk Index
HSE	Health and Safety Executive
ORR	Office of Rail and Road
OSS	Overspeed sensor system
OTDR	On-train data recorder
SORAT	Signal Overrun Risk Assessment Tool
TPWS	Train Protection and Warning System
TSS	Train stop system

Appendix B - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- information taken from the train's on-train data recorder (OTDR)
- closed-circuit television (CCTV) recordings taken from train 5P01
- digital geographic information about the site
- weather reports and observations at the site
- rosters, competence and medical records
- industry reports of post-incident brake testing and the industry's investigation report
- documentary evidence relating to train planning, processes and procedures, briefing and training, and signalling plans
- a review of relevant research literature
- a review of previous RAIB investigations that had relevance to this accident.

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