RAIB

Rail Accident Investigation Branch

Rail Accident Report

Buffer stop collision at Kirkby, Merseyside 13 March 2021

Report 07/2022
August 2022

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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Buffer stop collision at Kirkby, Merseyside, 13 March 2021

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Summary

At around 18:53 hrs on Saturday 13 March 2021, a Merseyrail train hit the buffer stop at Kirkby station, Merseyside. The train was travelling at 41 mph (66 km/h) as it entered the platform. Soon afterwards, the driver applied the emergency brake, but there was insufficient distance remaining to prevent the collision, and the train struck the buffer stop at around 29 mph (47 km/h). The train came to rest under a bridge, around 28 metres beyond the original buffer stop position. The driver was taken to hospital as a precaution and was discharged the following day. There were no other reported injuries to the guard or to the 12 passengers on board. The collision caused significant damage to the station infrastructure and the front of the train, with the station remaining closed for eight days.

The accident occurred because the driver of the train did not apply the brakes in time, as he was distracted from the driving task by his mobile phone and by his bag falling onto the cab floor.

No engineered systems automatically applied the train's brakes, as the conditions for their intervention were not met. The driver continued to operate the controls for two of these systems (the Automatic Warning System and the Driver's Safety Device), preventing their activation, despite not being entirely engaged in the driving task. A third system (the Train Protection and Warning System) did not activate until after the driver had already applied the emergency brake. This system was installed in compliance with the relevant standards but it did not protect against the particular scenario of this accident.

The risk assessment processes used by Merseyrail and Network Rail did not identify the risk of the buffer stop being hit at relatively high speed. RAIB also observed that Merseyrail's fatigue risk management procedure did not follow current industry good practice.

This accident would almost certainly have had a worse outcome if there had been more passengers on the train or in the platform area behind the buffer stop. At the time, the COVID-19 pandemic had led to restrictions on social contact which resulted in a reduction in passenger numbers.

RAIB has made three recommendations. The first is addressed to RSSB and relates to research into devices to monitor the alertness and awareness of drivers. The second, addressed to Merseyrail and Network Rail, seeks to improve the risk assessment process for collisions with buffer stops at terminal platforms. The final recommendation asks Merseyrail to improve its fatigue management process to follow industry good practice.

RAIB also identified two learning points. The first reminds train drivers of the risks posed by using a mobile phone while driving a train. The second reminds train operating companies of the importance of understanding the limits of protection offered by the train protection and warning system when risks assessing terminal platforms.

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. These are explained in appendix A. Sources of evidence used in the investigation are listed in appendix B.

The accident

Summary of the accident

3 At around 18:53 hrs on Saturday 13 March 2021, a Merseyrail train hit the buffer stop at Kirkby station, Merseyside (figure 1). The train was travelling at 41 mph (66 km/h) as it entered the platform. Soon afterwards, the driver made an emergency brake application, but there was insufficient distance remaining to prevent the collision, and the train struck the buffer stop at around 29 mph (47 km/h). The train came to rest under a bridge, around 28 metres beyond the original buffer stop position (figure 2).

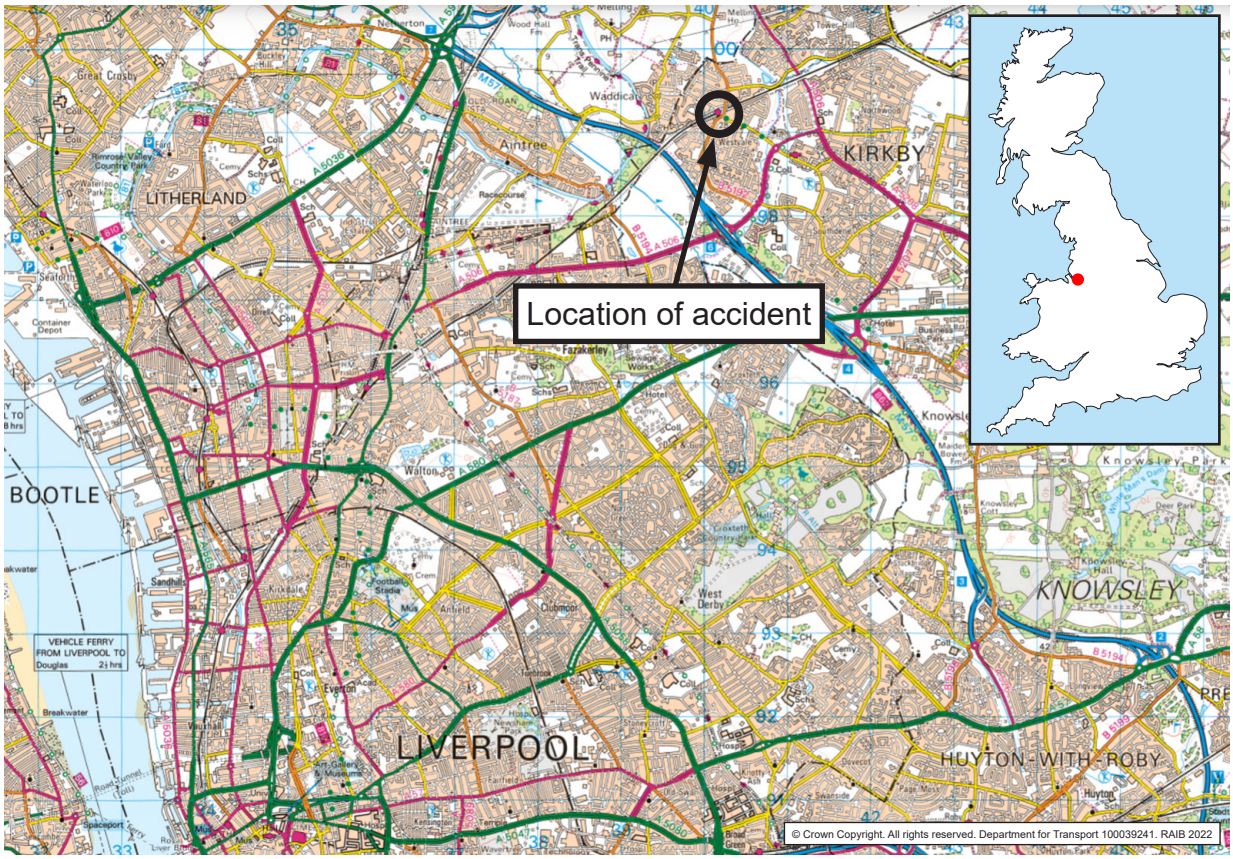

Figure 1: Extract from the Ordnance Survey map showing the location of the accident

4 There were 12 passengers, the guard and the driver on the train. The driver was admitted to hospital overnight and was discharged the following morning. There were no other reported injuries.

5 The train and the platform infrastructure behind the buffer stop were substantially damaged. The station remained closed for recovery and repair work until 21 March 2021.

Location

6 The accident occurred at Kirkby station, to the north-east of Liverpool. The station acts as an interchange between Merseyrail services that operate in and around the Liverpool area, and the Northern services between Kirkby and Manchester Victoria, via Wigan Wallgate.

Figure 2: Photograph of the train in its final position after the collision

7 Kirkby station has two terminal platforms, one for each service, both equipped with buffer stops (figure 3). Platform 1 serves Merseyrail trains and platform 2 serves Northern trains. The two platforms are in line with each other but separated by a gap of around 20 metres.[1] A road bridge and separate footbridge go over the railway between the platforms at this gap. The southern abutment of the road bridge is close to the line of the railway, requiring a platform extension to provide a walkway between the two platforms that projects into the gap between the tracks (figure 4). As a result, passengers walk behind both buffer stops to move between platforms.

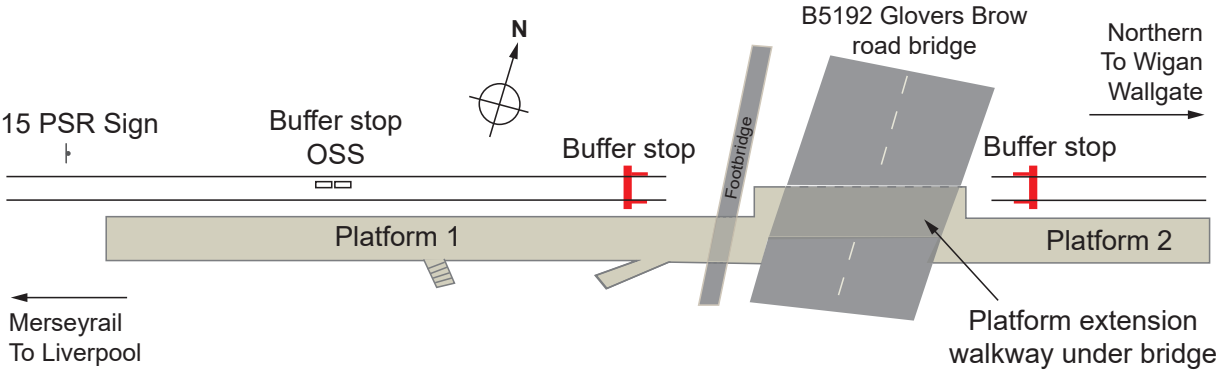

Figure 3: Diagram showing the track and station layout at Kirkby

[1] The tracks and platforms are in line as they were historically connected, with Kirkby station sitting on a through route.

Figure 4: Photograph showing the track and station layout at Kirkby (El Pollock, reused under Creative Commons License)

8 The station sits in a cutting. The only access to both platforms is down either steps or a ramp from the ticket office, which is at road level. These initially give access to platform 1, with access to platform 2 being via the platform extension walkway under the bridges.

9 Merseyrail trains from Liverpool Central to Kirkby call at five intermediate stations; the last one before Kirkby is Fazakerley. The route comprises two tracks from Liverpool, used respectively by trains running to and from the city, as far as Fazakerley station. Beyond Fazakerley, the tracks merge at a set of points, and a single line, used by trains travelling in both directions, continues to the buffer stop at Kirkby. The permissible speed leaving Fazakerley is 50 mph (80 km/h), rising to 60 mph (97 km/h) after the points, and dropping to 15 mph (24 km/h) at the start of the platform at Kirkby. The buffer stop at Kirkby was a fixed buffer stop made out of sections of rail. It had no specific energy absorbing features.

10 The entirety of the Merseyrail network is electrified with a 750V DC conductor rail.

Organisations involved

11 Merseyrail, a joint venture between Serco and Abellio, operated the train, managed the station and employed both the guard and the driver.

12 Network Rail owned, operated and maintained the infrastructure on both sides of Kirkby station.

13 All organisations freely co-operated with the investigation.

Train and railway systems involved

14 The train involved was a six-car class 507 electric multiple unit[2] (EMU). It was formed of two three-car EMUs coupled together, unit number 507006 leading and 507021 trailing. The train was operating as train reporting number 2K48,[3] the 18:53 hrs service from Liverpool Central to Kirkby.

15 The train was fitted with an on-train data recorder (OTDR) and internal CCTV cameras. It was not fitted with forward-facing CCTV.

16 Class 507 trains are fitted with a gangway at each cab end which is not accessed by the public, except in emergencies. As a result of this, the driving cab is located in a separated cubicle on the left-hand side in the direction of travel (figure 5). Access to and from the cubicle is through a door which opens up into the gangway space and can be held open by a floor bolt. On the right-hand side of the gangway area, under the front window is a small cabinet which holds the tripcock[4] equipment (figure 5). Between the tripcock cabinet and the cubicle, along the centreline of the train, is the gangway door which allows for emergency egress within tunnels.

Figure 5: Photograph showing gangway area of a class 507 train

17 Merseyrail's class 507 trains are fitted with a Driver's Safety Device (DSD, sometimes known as a 'dead man's handle') as well as a combined Automatic Warning System (AWS) and Train Protection and Warning System (TPWS).

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[2] An electric multiple unit is a train consisting of one or more vehicles permanently coupled together, operating as a single unit and powered by electricity supplied through overhead line equipment or, as in this case, conductor rails.

[3] An alphanumeric code, known as the 'train reporting number', is allocated to every train operating on Network Rail infrastructure.

[4] Merseyrail uses a tripcock system on its underground sections. This mechanical device interacts with lineside infrastructure to trigger a brake demand if a train passes a signal at danger.

18 The DSD system on the class 507 is intended to apply the emergency brakes should the driver become incapacitated. The driver must maintain downward pressure on either a foot pedal (located under the driver's right foot) or the traction control lever (figure 6). On the class 507, an emergency brake demand is triggered should both controls be released for more than 2.5 seconds. There is no requirement for the driver to release and reapply the DSD controls at set time intervals, which is a feature of more modern DSD systems. The DSD on the class 507 would not necessarily detect if a driver ceases to be vigilant in circumstances where pressure is still maintained on the relevant controls.

Figure 6: Photograph of the driving cab of a class 507, showing the position of the DSD and AWS controls

19 The AWS provides an audible and visual warning to a driver on the approach to certain infrastructure features, such as signals and selected speed restriction changes. It utilises track mounted magnets which interface with receivers fitted to 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 507, the driver has to acknowledge the warning within 2.5 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.

20 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.

21 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[5] that the brake demand has occurred and will be required to acknowledge the demand as part of resetting the system.

22 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.

23 OSS loops are set between 4 and 36 metres apart. 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 a TPWS brake demand. The driver will again receive a warning that this has occurred.

Staff involved

24 The driver of the train had been driving for Merseyrail for over 35 years. His traction and route knowledge assessments were up to date and he was deemed competent to drive the Liverpool Central to Kirkby route. The driver had driven over this route for almost all of his service with Merseyrail.

25 Merseyrail provided RAIB with the driver's employment record, which showed that he had been involved in three safety and six operational incidents between 1995 and 2019. The last two of these occurred within a six-month period in 2019, which triggered Merseyrail's 'Individual Development Programme' (IDP) process. Merseyrail placed the driver on an IDP, which included a post-incident in-cab assessment of the driver's behaviour, and the analysis of two OTDR downloads to check his driving techniques. The driver was signed off as having successfully completed this process on 20 October 2020.

26 During his last medical examination in February 2019, the driver had been assessed as medically fit to continue to drive trains. The driver had no medical conditions relevant to the accident.

[5] Newer versions of TPWS also include an audible alert.

27 The guard was in the cab at the rear of the train during the accident. After leaving Fazakerley, the guard made the appropriate passenger announcement en route to Kirkby. He did not realise that there was any issue with the approach to Kirkby until the driver made an emergency brake application (see paragraph 44). There was no operational rule requiring the guard to monitor the speed of the train.

External circumstances

28 It was dark at the time of the accident, and the weather was dry and overcast. There is no evidence that the weather played any part in the accident.

29 The ongoing COVID-19 pandemic resulted in fewer passengers using the railway network at the time of the accident than would normally have been the case. This almost certainly reduced the severity of the consequences of the accident (see paragraph 97).

The sequence of events

Events preceding the accident

30 On Friday 12 March 2021, the day before the accident, the driver worked a late shift from 16:33 hrs until 00:38 hrs (on 13 March). He stated that he returned home (a short distance from the depot at Kirkdale) immediately after his shift ended and that he went to sleep shortly thereafter.

31 On Saturday 13 March 2021, the day of the accident, the driver was rostered to work from 13:10 hrs until 20:51 hrs, with a gap of around two hours in the middle, splitting the shift into two halves. The driver reported waking up between 08:00 hrs and 09:00 hrs. He drove to the depot and signed on ready for his allocated shift at around 12:30 hrs.

32 At 13:29 hrs, the driver started the first half of his shift, driving from Kirkdale depot towards Ormskirk. At Orrell Park station, the second stop after leaving the depot, the driver left the train to deliver something to a member of staff at the ticket office. The station CCTV footage shows the driver using his mobile phone while visiting the ticket office. Witness evidence and the driver's mobile phone records confirm that this call was to a member of staff at the depot and related to a personal matter. After the call, the driver reboarded the train, and continued his journey to Ormskirk. The train arrived at the terminal platform at Ormskirk station at 13:54 hrs. While there, the driver made a further call to the member of staff at the depot relating to the personal matter.

33 At 16:28 hrs, the driver completed the first half of his shift. Since he had a long break and lived locally, he went home for his break, as is permitted. He returned to the depot at around 17:50 hrs.

34 The driver started the second half of his shift driving the 18:22 hrs service from Kirkdale to Liverpool Central. The train arrived at Liverpool Central on time, where the driver swapped driving cabs for the trip back to Kirkby. As was his usual reported practice, he placed his bag on the tripcock cabinet and left the door between the driving cab and the gangway space open, held in place by the floor bolt (paragraph 16).

35 A report showing activity on the driver's mobile telephone, provided to RAIB by the British Transport Police, shows that the driver received a WhatsApp[6] message from a friend at 18:28 hrs, while the train was stationary at Liverpool Central station. The train left Liverpool Central on time at 18:35 hrs and proceeded without incident to Fazakerley.

[6] WhatsApp is an internet based social media application that allows messages and other media to be sent between users.

Events during the accident

36 The train departed on time from Fazakerley at 18:49:45 hrs.[7] The driver accelerated through the points and onto the single line (figure 7). Once the train reached 50 mph (80 km/h), the driver stopped applying power, allowing the train to coast. After passing the points, the permissible speed increased to 60 mph (97 km/h). The driver did not increase the train's speed further after the train passed into this higher permitted speed.

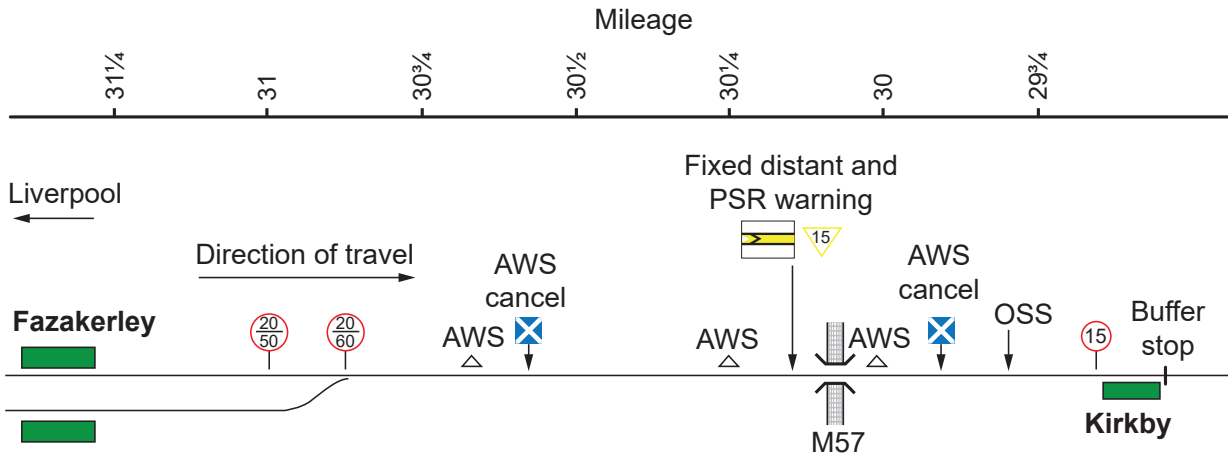

Figure 7: Schematic showing the track layout and associated infrastructure between Fazakerley and Kirkby

37 As the train coasted through the single-line section, it passed over three AWS magnets (as shown in figure 7) at the following times, all of which were recorded by the OTDR as sounding a warning horn in the cab:

a. 18:50:52 hrs – AWS warning at an unsuppressed[8] AWS magnet for signal ML308, a signal for trains travelling in the opposite direction.

b. 18:51:22 hrs – AWS warning at an AWS magnet alerting the driver to a fixed distant signal (a retroreflective sign showing an image of a cautionary yellow semaphore signal, see figure 8a), and a sign warning of the upcoming permanent speed restriction (PSR) at Kirkby station.

c. 18:51:42 hrs – AWS warning at an unsuppressed AWS magnet for signal ML308R, a repeater signal for trains travelling in the opposite direction.

38 The driver acknowledged each of these warnings within the required timeframe (paragraph 18).

39 At 18:51:34 hrs, mobile telephone records show a WhatsApp message being sent from the driver's phone, in reply to the one he received 23 minutes earlier (paragraph 35).

[7] The timings given in this section are based on data from the train's OTDR, CCTV systems and other electronic data sources. Timings from individual systems have been corrected where necessary to match the central timing recorded by the railway's signalling equipment.

[8] On lines signalled in both directions, trains will pass over AWS magnets intended for trains travelling in the opposite direction. These can either be suppressed, where a second magnetic field masks the AWS magnet from the train, or unsuppressed, where the train receives a warning as normal but the driver is informed by a lineside sign (figure 8c) that the warning does not apply to them.

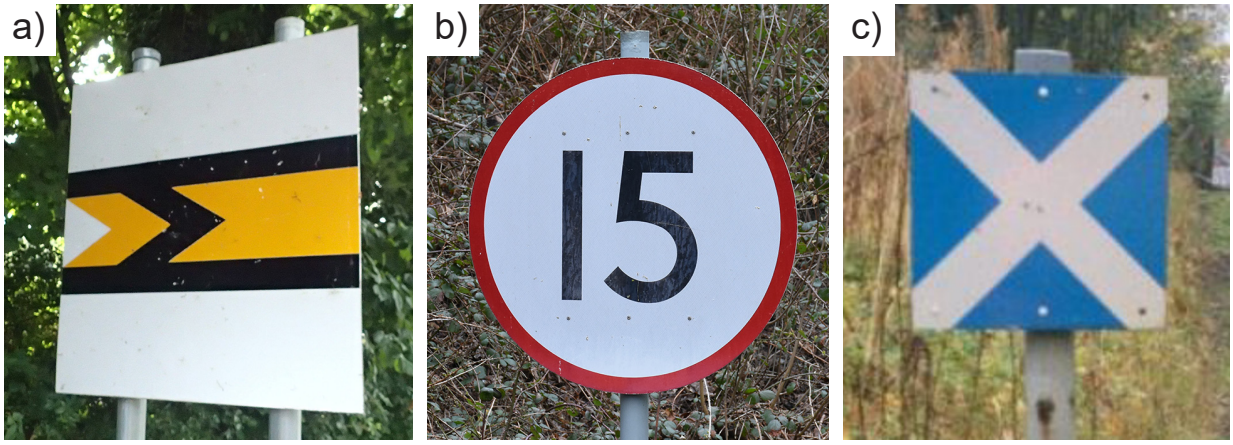

Figure 8: Photographs showing examples of a) a fixed distant signal, b) a 15 mph permanent speed restriction sign and c) an AWS cancel sign

40 At 18:51:35 hrs, shortly before the third AWS magnet (paragraph 37c), the train passed over the M57 motorway. Merseyrail driver training uses this landmark as the normal braking point for Kirkby station, around 900 metres further ahead. As the train passed over the motorway, it was still coasting and its speed had reduced to 46 mph (74 km/h). The driver did not apply the train's brakes at this point.

41 The driver reported that, at some point in the journey from Fazakerley to Kirkby, his driving bag fell off the tripcock cabinet, spilling some of its contents onto the floor. This included a soft drink bottle, which began rolling around the gangway area floor. The driver stated that he wanted to retrieve the contents of the bag and, in order to do this, he left the driving seat. He retrieved the bag and its contents and placed it back onto the tripcock cabinet. This involved swapping feet on the DSD pedal (paragraph 17) to allow him to reach further across. The driver has not been able to confirm where in the journey from Fazakerley to Kirkby this occurred.

42 At 18:51:58 hrs, the train passed over a TPWS OSS placed to protect the 60 mph to 15 mph (97 km/h to 24 km/h) speed change. This was set to trigger a TPWS brake demand if a train passed over at greater than its set speed of 53 mph (85 km/h). By this point, the train's speed had reduced to 42 mph (68 km/h) as it was still coasting. As this was below the set speed, a TPWS brake demand was not triggered. At around this point, the station at Kirkby, and the 15 mph (24 km/h) PSR lineside sign (figure 8b) would have been around 300 metres ahead and visible from the driving position through the front windscreen.

43 At 18:52:14 hrs, the train passed the 15 mph (24 km/h) PSR sign and entered the platform at Kirkby station at 41 mph (66 km/h).

44 At 18:52:17 hrs, the driver engaged the emergency brake, with the train still travelling at 41 mph (66 km/h), and around 110 metres on approach to the buffer stop. OTDR data shows that the train's brakes began to slow the train down around two seconds later.

45 At 18:52:20 hrs and 65 metres on approach to the buffer stop, the train, now travelling at 39 mph (63 km/h), passed over the TPWS OSS associated with the buffer stop. This was set to trigger at speeds greater than 12.5 mph (20 km/h). The TPWS equipment on the train detected the excess speed and generated an emergency brake demand. However, as the driver had already made an emergency brake application, this had no additional braking effect on the train.

46 At 18:52:23 hrs, one second before the collision with the buffer stop, internal CCTV shows the driver vacating the driving cab and moving into the saloon of the first vehicle.

47 At 18:52:24 hrs, the train hit and demolished the buffer stop at a speed of around 29 mph (47 km/h). It then struck the platform extension walkway (paragraph 7). The train lost its electrical power supply during the collision, causing the internal CCTV and OTDR to cut out. A short circuit was created between the conductor rail and running rail, causing the traction supply circuit breakers to trip and an alarm to be sent to the Sandhills electrical control operator.

48 The front of the train came to rest around 28 metres beyond the original location of the buffer stop, 9 metres from the buffer stop on the line used by Northern trains on platform 2 (figure 2).

Events following the accident

49 The driver reported being initially disorientated following the collision. He reported trying to use his mobile phone to make an emergency call but struggling to use it. At some point he re-entered the cab to try and use the GSM-R[9] system to contact the signaller, but the equipment had been damaged in the collision. He also used this opportunity to retrieve his bag.

50 The guard attempted to use the on-train internal communication system to contact the driver, but it had been rendered inoperable by the collision, and the driver was, in any case, no longer in the cab (paragraph 46). He then used his company mobile phone to contact the Merseyrail control room, who immediately passed the message to the signaller, who is located in the same room. He then called a Merseyrail driver manager. While doing this, he made his way to the front of the train to check on the driver.

51 Merseyrail control relayed the details of the incident to Network Rail control immediately, and both controls alerted the emergency services. A controlled isolation of the conductor rails took place at 19:00 hrs and the emergency services arrived on site at around 19:07 hrs. The driver was admitted to hospital that night but was discharged the following morning. There were no reported injuries to any of the passengers or to the guard.

52 Investigation, recovery and infrastructure repair took place over the following week. Network Rail replaced the track, buffer stop and platform extension like-for-like. The line reopened for passenger service on 21 March 2021.

[9] Global System for Mobile Communications – Railway.

Analysis

Identification of the immediate cause

53 The train entered the platform at too great a speed and the driver did not apply the train's brakes in time to prevent the collision.

54 The train entered the platform at Kirkby station at 41 mph (66 km/h), well above the maximum permitted linespeed of 15 mph (24 km/h). The driver applied the emergency brake around 110 metres from the buffer stop, while the train was still travelling at 41 mph (66 km/h). This left insufficient time for the train to stop and for the collision to be avoided.

55 Post-incident inspection of the track and train found no evidence of anything that would have affected the braking performance of the train. Analysis of the OTDR showed that the train's braking rate, with allowance for brake build-up time, was around 12%g (1.2 m/s^2), which is typical for a class 507 train. There was also no evidence of the train's wheel slide protection system intervening due to wheel slide activity, nor any evidence of significant levels of railhead contamination on the approach to the station or through the platform.

Identification of causal factors

56 The accident occurred due to a combination of the following causal factors:

a. The driver was distracted from the driving task and did not apply the train's brakes until after it had entered the station at 41 mph (66 km/h) (paragraph 57).

b. None of the engineered systems fitted to the train intervened to apply the train's brakes in time to avoid a collision (paragraph 72).

Each of these factors is now considered in turn.

The actions of the driver

57 The driver was distracted from the driving task and did not apply the train's brakes until the train entered the station at 41 mph (66 km/h).

58 Merseyrail trains its drivers to begin applying the brakes on the approach to Kirkby station as the train passes over the M57 motorway (paragraph 40). Applying the lowest braking setting at this point typically results in a gradual reduction in a train's speed to around 10 mph (16 km/h) by the time the train reaches the 15 mph (24 km/h) permanent speed restriction sign located at the start of the platform.

59 The driver did not apply the brakes as he passed this normal braking point and made no further braking applications until the final emergency brake application which was made within the platform area of the station and on approach to the buffer stop (paragraph 44, figure 9).

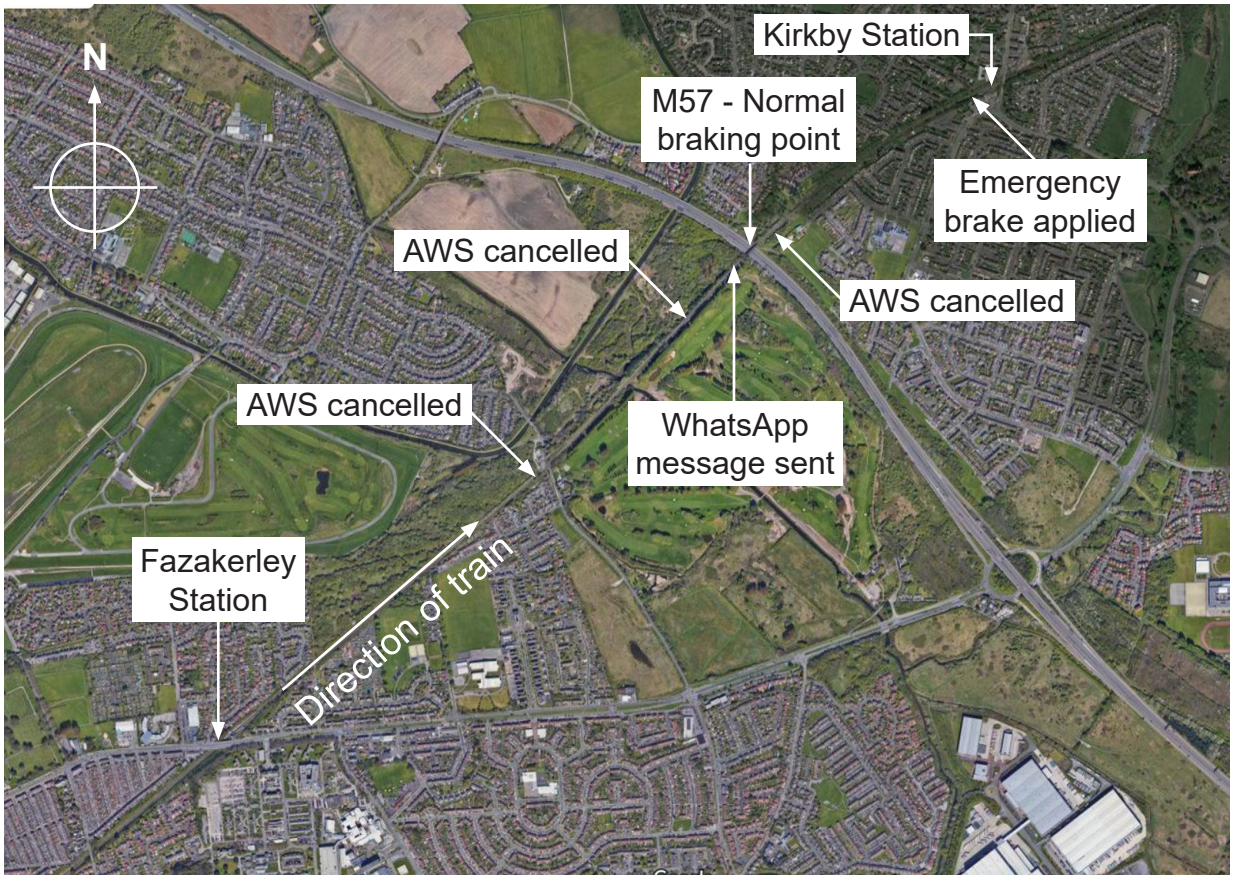

Figure 9: Google Earth image showing important points of the train's journey between Fazakerley and the collision with the buffer stop at Kirkby station

60 The driver did not apply the brakes because he was distracted from the driving task. This distraction was prolonged in nature. It appears that the driver's full attention was not brought back to the driving task despite cues from familiar lineside landmarks and the AWS system. The driver was distracted due to a combination of the following factors:

a. The driver was using his mobile telephone while driving the train (paragraph 61).

b. The driver left the driving seat to retrieve the contents of his bag, which had fallen on the cab floor (paragraph 66).

Each of these factors is now considered in turn.

Mobile telephone use

61 The driver was using his mobile telephone while driving the train.

62 In the days following the accident, the British Transport Police (BTP) seized the driver's mobile telephone. A report produced from examining the device was provided to RAIB. This showed that the driver sent a short message using WhatsApp at 18:51:34 hrs (paragraph 39). Although the message written by the driver was short, it would have taken a certain amount of time to compose, type and send it.

63 Research has found that using a mobile telephone can result in a decrease in situational awareness, slower reaction times and a reduction in hazard perception. This strongly suggests that the interaction with his mobile phone is likely to have distracted the driver from the task of driving the train.[10] It is also of note that a train driver being distracted by a mobile telephone was found to be one of the primary causes of a collision between two trains in Chatsworth, California in September 2008[11] which resulted in 25 fatalities and serious injuries to 28 other people.

64 The driver stated that his mobile telephone was placed in his top shirt pocket, and that this was his normal practice. Having the telephone switched on in the cab was contrary to Merseyrail's professional driving policy,[12] which states:

'Mobile phones and other electrical equipment must be switched off when driving a train.'

65 The driver stated that he was aware of this requirement.

The driver's bag

66 The driver left the driving seat to retrieve the contents of his bag, which had fallen on the cab floor.

67 On the right-hand side of the gangway area, under the front window, is the tripcock cabinet which holds the tripcock equipment and the windscreen washer reservoir (paragraph 16). The top of the cabinet slopes away from the window towards the inside of the train, and has a small lip which prevents objects placed on it from sliding off.

68 The driver stated that when he entered the cab at Liverpool Central station he placed the bag on the tripcock cabinet (paragraph 34). He also stated that, at some point between Fazakerley and Kirkby, his bag fell off the cabinet, with some of its contents falling out and rolling around the gangway area floor. The driver was not able to confirm exactly where in the journey this occurred.

69 The driver would have had time to repack the bag at Kirkby station, where he had around 15 minutes to change ends before the return service to Liverpool Central. However, the driver stated that he felt compelled to retrieve the contents of the bag, put them back into the bag, and put the bag back on the tripcock cabinet while the train was travelling towards the terminus at Kirkby.

70 To reach the fallen bag, the driver left the normal driving position and leaned out of the driving cab into the gangway area. In order to do this, he had to remove his right foot from the DSD pedal (paragraph 17) and instead placed his left foot on it. This allowed him to reach far further to the right, towards the bag, while preventing the automatic activation of the train's brakes that would occur should he release the DSD pedal for more than 2.5 seconds (see paragraph 19).

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[10] While research in this area primarily focuses on the risk to road users, such as that summarised by ROSPA at https://www.rospa.com/media/documents/road-safety/mobile-phones-and-driving-factsheet.pdf, RSSB projects T904 and T989 have sought to establish good practice for the education of train drivers regarding the risks involved.

[11] NTSB report NTSB/RAR-10/01, available at https://www.ntsb.gov/investigations/AccidentReports/Reports/RAR1001.pdf.

[12] Merseyrail Professional Driving Policy 2018.

71 BTP and RAIB undertook a reconstruction of this scenario following the accident with somebody of similar height and build to the driver. This showed that, while reaching for the bag, the driver would lose almost all visibility of the track ahead, as the internal driving cab door shrouded most of the view through the gangway door. It also showed that the driver could reach his bag, even if it fell on the floor close to the tripcock cabinet, while maintaining pressure on the DSD pedal with his left foot (figure 10).

Figure 10: Photograph of a reconstruction showing how the driver could have reached his bag while maintaining pressure on the DSD pedal with his left foot

Engineered systems on the train

72 None of the engineered systems fitted to the train intervened to apply the train's brakes in time to avoid a collision.

73 Class 507 trains are fitted with three individual systems which can trigger an emergency brake application should certain conditions be met (paragraphs 18 to 23). The tripcock system (paragraph 16) is only used in the underground sections of Merseyrail so is not relevant to this accident, which took place at a surface station. Because the trigger conditions for the remaining systems were not met during the journey, none of these systems intervened within the timeframe required to stop the train hitting the buffer stop.

74 This causal factor arose due to a combination of the following:

a. The driver continued to operate the DSD foot pedal and AWS reset button despite not being entirely focused on the driving task (paragraph 75).

b. TPWS, as installed on the approach to and at Kirkby station, did not prevent the collision (paragraph 82).

Each of these factors is now considered in turn.

DSD and AWS

75 The driver continued to operate the DSD foot pedal and AWS reset button despite not being entirely focused on the driving task.

76 The OTDR system on the train does not record which of the two DSD controls is used (paragraph 19), or individual applications or release of the controls. It only records when the cab is switched on and when the emergency brake demand is triggered after the 2.5 seconds delay.

77 The usual practice of the driver of the train involved in the accident was to use the foot pedal for DSD operation, in preference to the traction control lever. This was also the most common practice among Merseyrail drivers. When his bag fell from the tripcock cupboard (paragraph 68), he removed his right foot from the DSD pedal, swapping to his left foot. This swap must have taken less than 2.5 seconds (as no brake demand was made, and no event was logged on the OTDR) and it enabled him to stand up and reach out into the gangway area, away from the controls of the train.

78 During the journey on the single line between Fazakerley and Kirkby, the driver received three AWS warnings. The driver pressed the AWS reset button for all three warnings. Only one of these warnings applied to the train directly (paragraph 37). The driver would have always received these three horn warnings on this journey, as they relate to either the fixed distant signal or signals that would always be displaying a red aspect for trains travelling in the opposite direction. It is possible that the driver was not looking at the track ahead when he cancelled these warnings as he was aware that no action was required in any of these cases other than to press the AWS reset button.

79 The driver may also have been habituated to pressing the AWS reset upon the sounding of the AWS horn. Previous RAIB investigations, such as the investigation into a signal passed at danger at Didcot North (RAIB report 23/2008), and academic research[13] have shown that drivers can become habituated to cancelling AWS warnings without it drawing their attention to the intended trackside landmark, or the driving task as a whole.

80 Merseyrail and Network Rail, as part of the industry's investigation, used OTDR downloads to compare the reaction time of the driver on the incident journey to three previous sample journeys made by the same driver (table 1).

	AWS reaction time (seconds) from the OTDR download			
	Incident Journey	Sample Journey 1	Sample Journey 2	Sample Journey 3
AWS 1	1.7	1.2	1.1	0.6
AWS 2	0.8	0.2	0.1	0.2
AWS 3	1.5	0.6	0.3	0.2

Table 1: Driver's AWS reset reaction time on the incident journey and three previous sample journeys

[13] McLeod, R. W., Walker, G. H. & Moray, N. (2005). Analysing and modelling train driver performance. Applied Ergonomics, 36(6), 671-680.

81 These results show that the driver's reaction times, while still within with the 2.5 seconds window, were slower on the approach to Kirkby during the incident journey than in any of the sample journeys. This could also suggest that he was not entirely focused on the driving task at that time.

TPWS

82 TPWS, as installed on the approach to and at Kirkby station, did not prevent the collision.

83 On the approach to the buffer stop at Kirkby, two pairs of OSS loops are installed:

a. Permanent speed restriction OSS – Loops set for an intervention speed of 53 mph (85 km/h) and installed 295 metres from the 15 mph PSR sign.

b. Buffer stop OSS – Loops set for an intervention speed of 12.5 mph (20 km/h) and installed 65 metres from the buffer stop.

84 Both installations are compliant with the relevant Network Rail company standard for TPWS loop positioning and trigger speed (NR/SP/SIG/10138, issue 3).

85 The PSR OSS as installed at Kirkby is designed to mitigate against a train not slowing from close to the full permitted speed of 60 mph (97 km/h), for the 15 mph (24 km/h) PSR as it enters the platform. As such, it is set to intervene should a train pass the loops at a speed equal to or greater than 53 mph (85 km/h). When the incident train passed these loops, it was travelling at 42 mph (68 km/h), so no TPWS brake demand was triggered (paragraph 21).

86 The buffer stop OSS is installed to mitigate against a slow speed misjudgement by a driver and assumes that a defensive driving approach is used. As such, it is designed to minimise the consequences of a buffer stop collision for trains approaching at speeds of up to 20 mph (32 km/h). The train involved in this accident, however, passed the OSS at 39 mph (63 km/h). While this triggered a TPWS brake demand, this had no effect as the driver had already made an emergency brake application (paragraph 44). If the driver had not applied the emergency brake, an emergency brake application triggered by the TPWS system at this point would still have resulted in a collision with the buffer stop due to the speed at which the train passed the OSS and the available braking distance.

87 The two functionally separate OSS systems fitted on approach to and within Kirkby station are designed to different sections of standard NR/SP/SIG/10138 and mitigate against different risks. TPWS is not designed to avoid a buffer stop collision if a train is moving within the two set speeds while travelling between the two systems, as in this accident, that is to say between 53 mph and 20 mph (85 km/h and 32 km/h).

Identification of underlying factors

Risk of buffer stop collisions at Kirkby

88 Merseyrail and Network Rail's risk assessment process did not consider the risk of a train entering the platform at speeds greater than 20 mph (32 km/h). This is a possible underlying factor.

89 In the 35 years before this accident, there had been at least three previous buffer stop collisions at Kirkby station with photographs and news articles showing collisions in 1987, 1991 and 1997 (figure 11), before the installation of TPWS. The photographs of the aftermath of these collisions suggest that the speed of impact in each accident was likely to have been similar to the speed of impact of the 2021 accident. Witness evidence from some long-serving Merseyrail staff suggests that low adhesion was a causal factor in the 1997 accident.

Figure 11: Photographs of buffer stop collisions at Kirkby in a) 1987 and b) 1997 (courtesy of Network Rail)

Merseyrail Process

90 Merseyrail uses a task-based risk assessment process to manage the risks associated with its driving operations. At the time of the accident, the risk of hitting a buffer stop (or another train already in the platform) when driving a train into a terminal station was included in the risk assessment entitled 'Merseyrail train driver', under the section titled 'Drive trains in stations'[14] (see extract in appendix C). This was a generic risk assessment, which was not location specific. The risk assessment process identified the risk of a buffer stop collision as being low, based on control measures which included:

a. driver training, assessment and route knowledge

b. driver rule book knowledge

c. staff knowledge of TPWS location and intervention speeds

d. Merseyrail's professional driving procedure.

[14] Merseyrail drivers task-based risk assessment, Feb 2020.

91 The risk assessment shows the hazard of entering a platform at excessive speed as having the consequence of either a TPWS intervention or a low speed collision. However, TPWS is not included as a control measure. While TPWS cannot mitigate against all eventualities (paragraph 20), it does reduce the risk of a buffer stop collision so should have been considered within the control measures. All the control measures identified in the risk assessment are, in contrast, reliant on the actions of the train driver.

92 Other relevant hazards in the risk assessment also assume that any buffer stop collision will be at low speed and the scenario of a train entering the platform at speeds greater than 20 mph (32 km/h) is not identified by the risk assessment (paragraph 86 and appendix C).

93 Witness evidence suggests that the capability and limitations of the TPWS arrangement at Kirkby, and the possible need for further risk control measures, was not fully understood by Merseyrail. This is a possible explanation for the deficiencies in its risk assessment. It may also explain why the three previous similar accidents which occurred before the installation of TPWS did not prompt a better appreciation of the risk, or the inclusion of more effective risk control measures.

Network Rail process

94 Network Rail's relevant risk assessment process, while considering the likelihood of a buffer stop being struck, is primarily focused on the harm caused by a collision and any overrun beyond the buffer stop. This process is based on the Railway Group standard GC/RT5033[15] and the associated recommendations for risk assessment contained in GC/RC5633.[16] The process considers a large number of factors and calculates a numerical fatalities and weighted injuries (FWI) score.[17]

95 Following the buffer stop collision at Chester in 2013 (RAIB report 26/2014) and its associated recommendations, Network Rail's London North Western route used the GC/RT5033 process to evaluate the buffer stops at Kirkby station and at other locations on its route. At that time, the process included guidance on the actions to be taken based on the calculated FWI score. The buffer stop at Kirkby station did not reach the threshold for these actions, hence no changes were proposed. The standard[18] and guidance[19] were re-issued in 2018, after the assessment at Kirkby was done, removing the suggested actions based on FWI. The standard and guidance instead offer some general suggestions of possible mitigation measures and allow duty holders to decide on the appropriate course of action based on their knowledge of their assets.

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[15] GC/RT5033: 'Terminal tracks – Requirements for buffer stops, arresting devices and end impact walls', Issue 2, December 2007.

[16] GC/RC5633: 'Recommendations for the risk assessment of buffer stops, arresting devices and end impact walls', Issue 2, December 2007.

[17] Fatalities and weighted injuries (FWI) is a composite measure of risk of harm that combines fatalities with physical injuries and cases of shock/trauma, which are weighted according to their relative severity.

[18] RIS-7016-INS: 'Interface between station platforms, track and buffer stops'. Issue 1 was published in June 2018, and subsequently issue 1.1, published in June 2019.

[19] GIGN5633: 'Recommendations for the risk assessment of buffer stops and end impact walls', issue 1, June 2018.

96 One factor in the process was to consider whether there was any history of buffer stop collisions at the location within the last five years. This timeframe meant that the three previous accidents at Kirkby (paragraph 89) were not considered and did not have any impact on the resulting FWI score. If they had, it is possible that improvements may have been made at Kirkby to better control the risk of a train overrunning the buffer stop.

Factors affecting the severity of consequences

97 At the time of the accident, the UK government had placed restrictions in England on social contact, as part of the ongoing response to the COVID-19 pandemic.[20] These restrictions meant that fewer people were travelling for work or leisure purposes, reducing passenger numbers across the rail network. Witness evidence provided to RAIB indicated that before the pandemic, a train to Kirkby station at an equivalent day and time would have been carrying a significantly higher number of passengers.

98 Given the speed of collision, if this accident had occurred with more passengers on board, it is likely that it would have resulted in more injuries, some of which could have been serious.

99 Due to the impact speed and design of the buffer stop, the train demolished the buffer stop and much of the platform extension walkway (figure 12). This walkway was open to pedestrians at the time of the accident. However, most of the footfall over this walkway occurs immediately before and after the arrival of a Northern service into platform 2. As no such service was present at the time of the accident, nobody was on the platform extension walkway when the collision occurred. If passengers had been present on the walkway it is likely that the consequences of the accident could have been much more serious.

Figure 12: Photograph of the platform extension walkway the day after the accident

[20] A summary of the UK COVID-19 restrictions around the time of the accident is available at https://www.gov.uk/government/publications/covid-19-response-spring-2021.

Observations

Fatigue risk management

100 Merseyrail's fatigue risk management system did not follow current industry guidance and good practice.

101 As part of the investigation, RAIB reviewed the driver's roster in the weeks before the accident, and Merseyrail's relevant fatigue risk management policies and procedures. While there was no evidence that fatigue of the driver was causal to this accident, RAIB observed that those parts of Merseyrail's fatigue risk management system examined during the investigation do not follow current industry guidance and good practice.

102 Merseyrail's fatigue risk management procedure primarily uses fatigue and risk index (FRI), a measure developed by the Health and Safety Executive (HSE) in 2006 to compare different shift schedules. HSE states that '*Whilst the FRI is a useful tool, which can be used to help assess the risks of fatigue and injury, it should not be relied upon as the sole or primary means of assessing these risks*'.[21] HSE removed the FRI calculator from its website in June 2021, in part due to concerns about how it is understood and implemented by users.

103 The Office of Rail and Road (ORR) maintains industry guidance on 'Managing rail staff fatigue'.[22] This builds on the more general guidance on managing shift workers available from the HSE.[23] The guidance states that fatigue assessment scores (such as FRI) 'should not be used in isolation but should be complemented by building-in good fatigue management principles from the outset, and by seeking feedback from staff on how tiring they find the working patterns in practice'.

104 As well as its use of the FRI in isolation, RAIB observed that Merseyrail's fatigue risk management system did not require the comparison of work patterns against ORR's 'Good practice guidelines - Fatigue factors'[24] to identify potentially fatiguing features.

Previous occurrences of a similar character

105 There have been at least three previous buffer stop collisions at Kirkby station, in 1987, 1991 and 1997 (paragraph 89). In addition, RAIB identified the following investigation which contained factors of a similar nature.

[21] Fatigue/risk index for shiftworkers - https://www.hse.gov.uk/research/rrhtm/rr446.htm.

[22] Managing rail staff fatigue - https://www.orr.gov.uk/media/10934.

[23] Managing shift work: Health and safety guidance - https://www.hse.gov.uk/pubns/books/hsg256.htm.

[24] Office of Rail and Road 'Good practice guidelines - Fatigue Factors', December 2017 – https://www.orr.gov.uk/media/10935.

Passenger train collision with a derailed locomotive at Bromsgrove (RAIB report 14/2020)

106 At about 22:44 hrs on Monday 23 March 2020, the 21:05 hrs Cardiff Central to Birmingham New Street service collided with a class 66 locomotive that had derailed at the end of a siding, south of Bromsgrove station. The passenger train suffered significant damage along one side of all three vehicles, although it did not derail. There were four passengers and two crew on board the passenger train and none reported any injuries.

107 The locomotive had just arrived in the siding and was to act as a 'banking' locomotive, assisting heavy freight trains up the 1 in 37 Lickey incline, to the north of Bromsgrove station. It derailed after running through the buffer stop at the end of the siding and came to rest fouling the main line. The driver of the locomotive had alighted from it and was not injured in the collision, although the locomotive and the passenger train both suffered damage.

108 The driver did not stop the locomotive before it reached the buffer stop because he became distracted from the driving task by personal issues arising from the national COVID-19 lockdown, which had been announced earlier that evening. While he was not using a mobile telephone in the moments before the accident, the driver remained distracted following an extended interaction with his mobile telephone a few minutes earlier in the journey.

109 The collision between the two trains occurred because there was insufficient time between the locomotive derailment and the passenger train's arrival for the alarm to be raised and the passenger train to be stopped.

110 The investigation included three learning points, one of which stressed the importance of train drivers complying with their employer's mobile phone usage policy so as to avoid unnecessary distractions while driving.

Other buffer stop collisions

111 It is of note that the serious accidents at Moorgate (1975) and Cannon Street (1991) both resulted in multiple passenger fatalities and injuries due to trains not stopping at terminal end platforms.

112 RAIB has investigated a number of buffer stop collisions including Sudbury (RAIB report 26/2006), Chester (RAIB report 26/2014) and King's Cross (RAIB report 15/2016). The causes and circumstances of these accidents differ from those of the Kirkby accident, and so the recommendations made are not directly relevant.

Summary of conclusions

Immediate cause

113 The train entered the platform at too great a speed and the driver did not apply the train's brakes in time to prevent the collision (paragraph 53).

Causal factors

114 The causal factors were:

a. The driver was distracted from the driving task and did not apply the train's brakes until after it had entered the station at 41 mph (66 km/h) (paragraph 57). This causal factor arose due to a combination of the following:

   i. the driver was using his mobile telephone while driving the train (paragraph 61, **Recommendation 1, Learning point 1**)

   ii. the driver left the driving seat to retrieve the contents of his bag, which had fallen on the cab floor (paragraph 66, **Recommendation 1**).

b. None of the engineered systems fitted to the train intervened to apply the train's brakes in time to avoid a collision (paragraph 72). This causal factor arose due to a combination of the following:

   i. the driver continued to operate the DSD foot pedal and AWS reset button despite not being entirely focused on the driving task (paragraph 75, **Recommendation 1**)

   ii. TPWS, as installed on the approach to and at Kirkby station, did not prevent the collision (paragraph 82, no recommendation).

Underlying factor

115 The underlying factor was:

a. Merseyrail and Network Rail's risk assessment process did not consider the risk of a train entering the platform at speeds greater than 20 mph (32 km/h). This is a possible underlying factor (paragraph 88, **Recommendation 2, Learning point 2**).

Additional observation

116 Although not linked to the accident on 13 March, RAIB observes that:

a. Merseyrail's fatigue risk management system does not follow industry guidance and good practice (paragraph 100, **Recommendation 3**).

Actions reported that address factors which otherwise would have resulted in an RAIB recommendation

117 A new station at Headbolt Lane, one mile to the east of Kirkby station, is due to open to the public in Spring 2023. The interchange between Merseyrail and Northern services to Wigan Wallgate (paragraph 6) will transfer from Kirkby to this new station. This will change Kirkby station from a terminal to a through station, including the removal of the buffer stops and the platform walkway extension, and the closure of platform 2.

Other reported actions

118 Due to the damage to the cab and plans to retire Merseyrail's class 507 fleet in the near future, it was decided that repairing unit 507006 was not economically viable. It was permanently removed from service and later disposed of.

119 In the week after the accident, Network Rail undertook a like-for-like replacement of the buffer stop and platform walkway extension at Kirkby station.

120 The train driver involved was subject to disciplinary action by Merseyrail and prosecuted following a BTP investigation into the accident.

Background to RAIB's recommendations

121 Following the fatal tram accident at Sandilands junction on 9 November 2016 (RAIB report 18/2017), driver monitoring technology has been trialled within the UK tram industry. These trials have led to a better understanding of tram driver loss of alertness and attention.

122 The Office of Rail and Road (ORR) asked the railway sector to determine how technology could be used to improve the understanding of alertness and awareness on the mainline railway. In 2019 RSSB commissioned a research project, T1193,[25] which aimed to understand the science and evidence behind driver monitoring devices and to look at the lessons learned from their deployment in other areas.

123 This research was completed in 2021 and showed that an industry trial would be needed to measure the benefits of such systems against the cost of adoption. The project also created functional requirements and a report of learning from operational experience, which could assist the industry to prepare for the adoption of such devices.

[25] T1193 – Understanding the functional requirements for train driver attention and alertness monitoring devices: https://www.rssb.co.uk/research-catalogue/CatalogueItem/T1193.

Recommendations and learning points

Recommendations

124 The following recommendations are made:[26]

1 *The intent of this recommendation is that additional research be undertaken into systems which can detect and monitor driver alertness and awareness, and how these could be trialled in the industry.*

RSSB, in consultation with relevant stakeholders and bodies representing staff, should undertake further research into how the detection and mitigation of a loss of alertness or attention in train drivers can be improved. This research should specifically consider the effectiveness of systems currently in operation and build on work already completed, such as the functional specification and proposed trials set out in the T1193 research report. It should also take into account relevant practice from other transport systems (paragraphs 114a and 114b.i).

2 *The intent of this recommendation is that the risk of buffer stop collision on the Merseyrail network is appropriately understood and controlled.*

Merseyrail, working with Network Rail, should review the process of risk assessing buffer stop collisions to ensure that it identifies all foreseeable situations which could lead to a collision, and applies appropriate risk control measures. The review should include consideration of historic accidents (paragraph 115a).

3 *The intent of this recommendation is that Merseyrail should appropriately and effectively address the risk of fatigue.*

Merseyrail should review and improve its current fatigue risk management system for safety critical staff 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 practice (paragraph 116a).

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[26] 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

125 RAIB has identified the following important learning points:[27]

1 Train drivers are reminded that using a mobile phone while in control of a train in situations other than where this is permitted by the relevant operating rules carries a significant risk of distraction from the driving task and could lead to a serious accident or incident occurring.

2 Train operating companies assessing risks at terminal platforms are reminded that TPWS will not intervene at all train speeds, and is not failsafe, and cannot totally eliminate the risk of over-speeding in such platforms.

[27] '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
BTP	British Transport Police
CCTV	Closed-circuit television
DSD	Driver's Safety Device
EMU	Electric multiple unit
FRI	Fatigue and Risk Index
GSM-R	Global System for Mobile communications – Railway
HSE	Health and Safety Executive
IDP	Individual Development Programme
ORR	Office of Rail and Road
OSS	Overspeed sensor system
OTDR	On-train data recorder
PSR	Permanent speed restriction
RAIB	Rail Accident Investigation Branch
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 from the train and stations
- site photographs and measurements
- an examination of the train involved
- weather reports and observations at the site
- a report detailing relevant activity on the driver's mobile phone
- a review of relevant railway standards, procedures and guidance
- a review of previous RAIB investigations that had relevance to this accident.

Appendix C - Extract from Merseyrail Task Based Risk Assessment

(1) Unit	(2) Element	(3) Title	(4) Task	(5) Hazard	(6) Consequence	(7) Who can be harmed	(8) Current Controls	(9) Likelihood	(10) Severity	(11) Risk	(12) Risk associated with task	(13) Frequency of task undertaken
3	3.7	Drive Trains in Stations	a When entering terminal end stations or when entering a station under permissive arrangements, train speed must be reduced to no more than 10 mph at the start of the platform and a maximum of 5 mph 1 coach length from the buffer stop	Excessive speed when entering the platform.	TPWS intervenes or potential for a low speed collision with the rear of another train, RIDDOR Reportable injury, delay disruption. cancelation.	Driver other member of staff or customer	Driver training, assessment, Rule book route knowledge route risk. TPWS location sheet plus speed settings TPWS reminder boards	1	5	5	L	Daily
3	3.7	Drive Trains in Stations	b. Appropriate adjustment of speed and control of train is observed when entering an open platform.	Inappropriate speed and control of train when entering a platform.	Station overrun, delay, service disruption ,	NA	Driver training, assessment, Rule book route knowledge. PDP	3	2	6	L	Daily
3	3.7	Drive Trains in Stations	c. When approaching buffer stops or another train, speed is reduced progressively along the platform with a maximum speed of 5 mph 1 coach length, from the rear of a train bringing train to a stand 2 meters/ from the train.	Speed not progressively reduced stops short or collides with buffer.	Low speed Collision with buffers, damage to unit RIDDOR Reportable injury, delay disruption. cancelation,	Driver other member of staff or customer	Driver training, assessment, Rule book route knowledge. Route risk assessment OTDR PDP	2	3	6	L	Daily
3	3.7	Drive Trains in Stations	d.All movements are stopped 6 ft / 2 meters from the rear of another train (or buffers) and all passengers are detrained before coupling up is undertaken.	Trains not stopped at appropriate location/ distance.	Low speed Collision with another unit or buffers, damage to units RIDDOR Reportable injury, delay disruption. cancelation	Driver other member of staff or customer	Driver training, assessment, Rule book traction manual OTDR PDP	1	3	3	L	Daily

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