Rail Accident Investigation Branch

Rail Accident Report

Collision at Stainforth Road level crossing, 11 January 2018

Report 08/2018
July 2018

This investigation was carried out in accordance with:

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

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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.

The 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 the RAIB has described a factor as being linked to cause and the term is unqualified, this means that the RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident. However, where the RAIB is less confident about the existence of a factor, or its role in the causation of the accident, the RAIB will qualify its findings by use of the words 'probable' or 'possible', as appropriate. Where there is more than one potential explanation the 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 but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, the words '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 event 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 the RAIB, expressed with the sole purpose of improving railway safety.

The 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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Collision at Stainforth Road level crossing, 11 January 2018

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Summary

At around 05:50 hrs on 11 January 2018, a car collided with the rear-most wagon of a stationary freight train at Stainforth Road Automatic Half-Barrier level crossing, near Doncaster. The crossing's warning equipment was not operating and its half-barriers were raised when the car approached and entered the crossing. As a result of the accident, the driver of the car suffered scratches and bruises but their car was damaged beyond economic repair.

The train was at a stand because its brakes had been applied by the locomotive's vigilance device. This occurred because the driver of the train did not respond to the device's audible alarm in the time period permitted, probably due to the high level of ambient noise in the locomotive's cab.

The car driver was not alerted to the presence of the train by the crossing's warning devices because the design of the level crossing's control circuits had permitted it to re-open to road traffic while it was still occupied by the train. The car driver did not see the wagon with enough time to take effective avoiding action, given her speed of approach. This was because the train was unlit and unreflective and also because there was no ambient light near the crossing.

The crossing's control circuits dated back to its original installation in 1974. The control circuits had not been modified to incorporate later features which prove that trains are clear of a crossing before it re-opens. This was because a retrospective modification of this type was not mandated by relevant standards and guidance and also because the crossing's circuits had not required modification during the life of the crossing for other reasons. The crossing had not been renewed or replaced prior to the accident, because Network Rail had assessed it as still having useful working life left. The level crossing risk assessment process used by Network Rail did not identify and address the risk of the original design of control circuit remaining in service without it having later design features intended to improve safety.

The RAIB has made two recommendations, both addressed to Network Rail. The first recommendation relates to an assessment of the risk at other level crossings where there is the possibility of it re-opening to road users with a train still present on the crossing and the development and implementation of mitigation measures, where appropriate, to address this risk. The second recommendation concerns the revision of the current standard relating to the design of new remotely monitored level crossings so that this requires them not to open to road users while a train is present.

Introduction

Key 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.

The accident

Summary of the accident

3 At around 05:50 hrs on the morning of Thursday 11 January 2018, a car collided with the rear-most wagon of a stationary freight train at Stainforth Road Automatic Half-Barrier (AHB) level crossing, Doncaster, South Yorkshire (figure 1). The crossing's warning equipment was not operating and its half-barriers were raised when the car approached and entered the crossing.

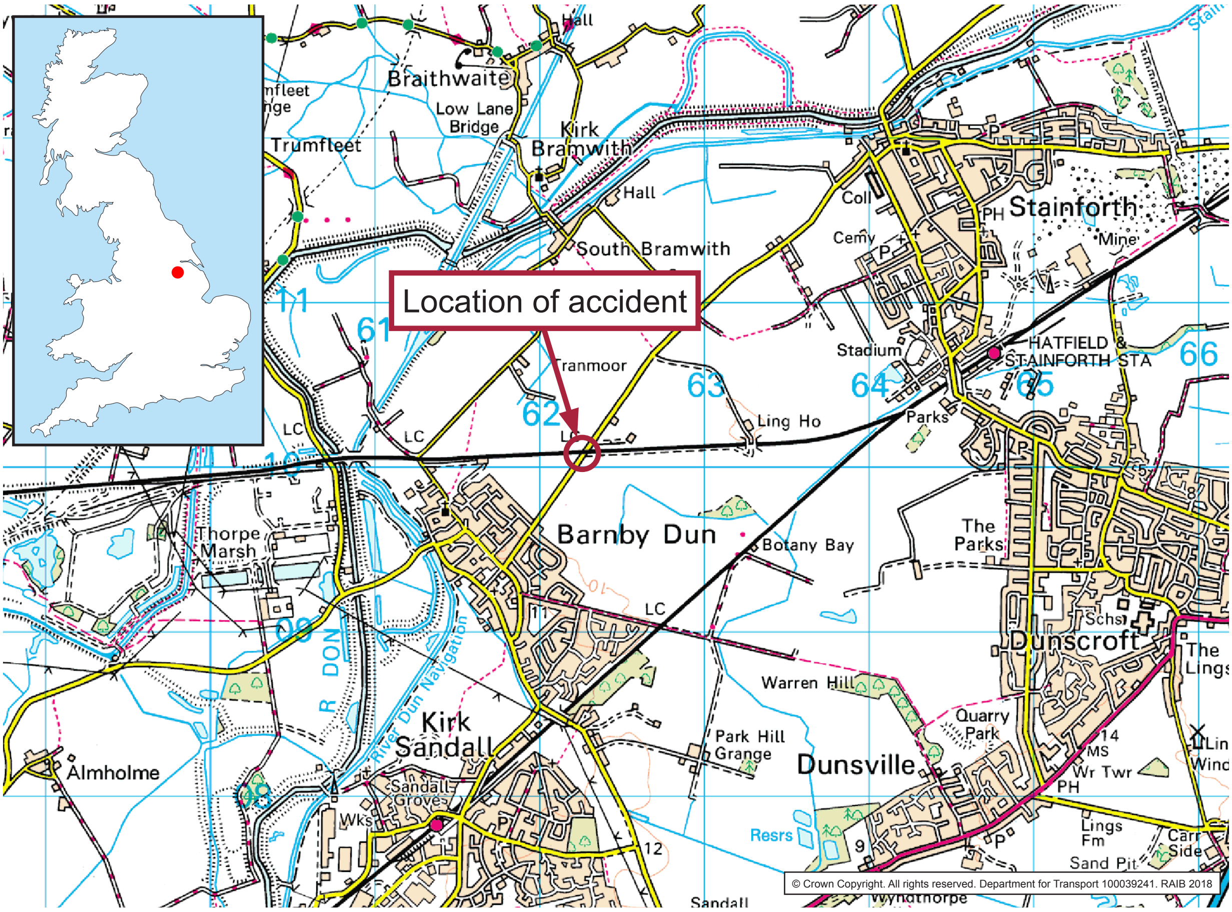

Figure 1: Extract from Ordnance Survey map showing location of accident

4 The driver of the car suffered scratches and bruises but her car was damaged beyond economic repair. The wagon sustained minor damage.

Context

Location

5 Stainforth Road AHB level crossing is located where Stainforth Road passes over the Up and Down Skellow lines, which run between Stainforth and Applehurst junctions. The railway at this location is on an east to west axis. Stainforth Road is a single carriageway road, subject to the national speed limit (60 mph (97 km/h) for cars). The road traverses the crossing from the south-west to the north-east, on a skew (figure 2).

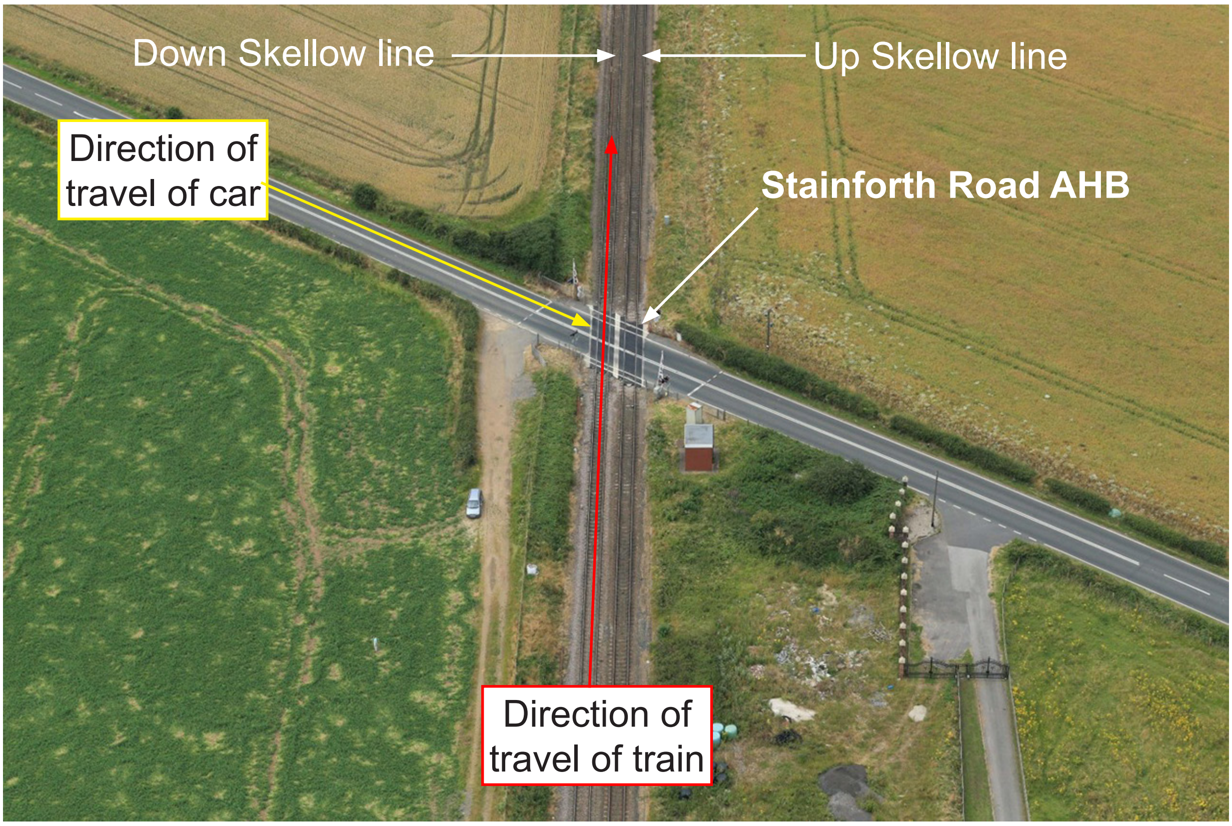

Figure 2: Stainforth Road AHB level crossing (image courtesy of Network Rail)

6 The Up and Down Skellow lines are used by freight trains and the maximum permitted linespeed at the crossing is 50 mph (80 km/h). There has been a level crossing at this location since the middle of the 19th century, with the current AHB crossing being installed in 1974. The variant of AHB level crossing in place is known as a 'Mark I' design.

7 The road surface of the crossing measures just over 11 metres wide. It includes a central two-lane carriageway which is around 8.5 metres wide, flanked on each side by a marked footpath (figure 3). The crossing is in a rural location and there are no ambient light sources which illuminate the crossing surface at the time of day that the accident occurred. There is vegetation growing to the side of the crossing. This blocks the view of car drivers along the railway in the western direction as they enter the crossing from the south-west (termed as 'northbound' road users in this report).

8 The approach to the crossing for northbound road users is straight and level, with a small dip in the road around 50 metres on the approach to the crossing. The presence of the crossing is indicated to road users by a series of statutory road-side signs and road markings. The carriageway on the immediate approach to the crossing and on the crossing surface itself is marked with solid double white lines in the centre of the road (figure 3).

Figure 3: Stainforth Road AHB level crossing, facing north on the approach from Barnby Dun (image courtesy of the British Transport Police)

9 The crossing is equipped with road traffic lights[1] (commonly referred to as 'wig-wags'). These operate when the crossing is activated to close the road for the passage of a train; an audible alarm also sounds to alert pedestrians. The road traffic lights at Stainforth Road AHB are fitted with LED lamps. A survey of the crossing undertaken by the RAIB in daylight and overcast and dry conditions indicated that the road traffic lights would be visible to northbound road users from at least 350 metres from the crossing. Witness evidence suggests that a similar or greater degree of visibility would typically have been present when it was dark. A short time after road traffic lights illuminate and the audible alarm sounds, half-barriers descend in order to block the left-hand side of the carriageway in both directions. Each of these half-barriers has two small boomlights mounted on it, one half-way along the barrier and one at its end, which illuminate once the half-barriers leave the vertical position. A failure of the crossing's equipment will result in an alert being given to the signaller via remote monitoring circuits.

The train involved

10 Train reporting number 6H58 consisted of Class 66 locomotive number 66158, hauling 25 loaded IIA Biomass wagons (figure 4). The train was 494 metres long and had a gross weight of 2382 tonnes.

[1] When operated, each road traffic light initially shows a steady amber light. After 3 seconds this extinguishes and two flashing red lights illuminate.

Figure 4: A library image of a type IIA Biomass wagon (image courtesy of Drax Group PLC)

Organisations involved

11 Network Rail is the infrastructure manager for the railway at this location. Network Rail's Doncaster Maintenance Delivery Unit is responsible for the maintenance of the Up and Down Skellow lines and Stainforth Road AHB. Network Rail's Doncaster Area Network Operations is responsible for the routine risk assessment of the crossing. Staff working for the Route Asset Manager within Network Rail's London North Eastern and East Midlands (LNE & EM) Route are responsible for decisions relating to replacing level crossings on the basis of their condition and for certain aspects of the routine risk assessments of crossings.

12 DB Cargo UK Ltd. (DB Cargo) employs the driver of the train 6H58. It is also the owners of locomotive 66158 and is responsible for its maintenance and inspection. Drax Group PLC owns the IIA Biomass wagons. The operation and maintenance of these wagons are not relevant to the investigation.

13 All parties freely co-operated with the investigation.

Staff involved

14 The driver of train 6H58 had around 10 years of experience as a train driver, four of which had been with DB Cargo. He drove the type of train involved in the accident frequently, and had passed over the Up and Down Skellow lines on numerous occasions.

External circumstances

15 The accident occurred in complete darkness (civil twilight was not until 07:33 hrs, about 90 minutes after the accident). The weather (as recorded at Doncaster Sheffield Airport, around 7.5 miles (12 km) south of the crossing) was overcast and dry, with an ambient temperature of 6°C.

The sequence of events

Events preceding the accident

16 The driver of train 6H58 arrived for work at Knottingley Traction Maintenance Depot at around 22:55 hrs on the night of Wednesday 10 January 2018. Locomotive 66158 had already been prepared for service and the driver stated that he could not recall it having any defects when he took it over. The On Train Data Recorder (OTDR) fitted to the locomotive recorded its departure from Knottingley for Milford (as a light locomotive) at 23:47 hrs[2].

17 At Milford, the locomotive was coupled to a rake of empty Biomass wagons. The train, once formed, then departed for Immingham. The OTDR recorded the train's arrival at Immingham at 02:30 hrs. The driver was relieved on arrival for a scheduled break while the wagons were loaded and he took this in the nearby driver's restroom. He stated that he fell asleep about 15 to 20 minutes after his break started and that this sleep lasted for around an hour. The driver woke up around 30 minutes before he took back control of the now-loaded train. The OTDR recorded train 6H58's departure from Immingham for Drax power station[3] at 04:12 hrs.

18 At 05:38 hrs, the OTDR recorded train 6H58 coming to a stand at a red 'danger' signal at Hatfield and Stainforth station. Once the signal cleared, the OTDR recorded the driver applying the locomotive's throttle progressively until it was in its highest setting, 'Notch 8'. The driver stated that using full power was necessary because there is an ascending gradient for trains entering the Down Skellow line from Hatfield and Stainforth.

19 At 05:43 hrs, the OTDR recorded the train passing the Automatic Warning System (AWS) track equipment fitted at D719 signal. This is the final stop signal passed on approach to Stainforth Road AHB level crossing and is located around 350 metres on approach to the crossing. The OTDR recorded that the train's speed at this point was 29 mph (47 km/h), that the locomotive's throttle remained in Notch 8 and that the signal was showing a green 'proceed' aspect.

20 Around a minute after this, and with the front of the train around 181 metres beyond the crossing, the OTDR recorded that a brake demand was made by the locomotive's Driver Safety Device (DSD) system (the demand was made by the vigilance device which forms part of the DSD system, see paragraph 48). This brought the train to a stand with its rearmost wagon partially foul of the carriageway at the crossing.

21 The OTDR recorded that the train took 313 metres and 33 seconds to stop from the start of the brake application. The driver of 6H58 stated that he was aware that he had passed Stainforth Road AHB prior to the brake application occurring. He stated that, once the train came to a stand, he was unsure if the rear of the train had cleared the crossing or not, but that he assumed that the crossing lights and barriers would continue to protect the crossing in the event that his train was foul of it.

[2] Analysis by the RAIB suggests that the times recorded by the OTDR are around 3 to 4 minutes behind GMT.

[3] The driver was due to be relieved at Knottingley and to book-off duty at 06:13 hrs, before the train reached Drax power station.

22 While the train was at a stand, a car driver approached the crossing in the southbound direction. He stated that, as he did so, the road was in darkness and that the crossing's warning equipment was not activated. As he got to the crossing and drove over it, he could see that the rear of a stationary train was blocking the opposite side of the carriageway. The southbound car driver did not feel that it was safe to stop because he was on an unlit single-carriageway road. He therefore drove on to Barnby Dun, where there was street lighting, and from there called the police to report the matter. This call was received by South Yorkshire Police, who in turn called Network Rail's Route Control at York. The call from the police was logged by Network Rail Route Control at 05:50 hrs.

Events during the accident

23 After the southbound car driver had passed over the crossing, a second car driver approached the crossing, this time in the northbound direction. She stated that the road was very dark, that she could see that the level crossing's warning equipment was not activated and that she felt that the crossing was safe to use. The northbound car driver estimated that her speed of approach was between 40 and 50 mph (64 to 80 km/h).

24 As she approached the crossing, the northbound car driver saw the wagon standing in front of her on the crossing and swerved to try and avoid a collision. Despite this, the passenger side of her car struck the wagon and the car was spun around, eventually coming to a rest pointing westwards (figure 5). Photographs of the damage sustained to the car and to the wagon involved show that the passenger side of the car collided with the headstock and buffer of the wagon (figures 6 and 7). Once the car had stopped moving, the car driver got out. As she did so, she saw the train pull away. The OTDR recorded that the train had been at a stand for 1 minute and 52 seconds.

Figure 5: Photograph of the crossing taken following the accident (image courtesy of Network Rail)

Figure 6: The damage sustained by the car as a result of the accident (image courtesy of the British Transport Police)

Figure 7: The damage sustained by the rearmost wagon as a result of the accident (image courtesy of Network Rail)

Events following the accident

25 Two more cars arrived at the crossing just after the collision had occurred. They stopped to offer assistance and one of the drivers called the police to report the accident. This call was received by South Yorkshire Police during their ongoing call to Network Rail Route Control and was relayed to them. This second call was logged by Network Rail at 05:51 hrs. The other car driver, a former member of railway staff, reported the accident to Doncaster Power Signal Box (PSB) using one of the crossing telephones. Doncaster PSB subsequently contacted the driver of train 6H58 via the GSM-R system and asked him to examine his train. The driver was able to confirm that minor damage had been sustained to the rearmost wagon.

26 Stainforth Road AHB was closed for recovery, investigation and testing activities. Normal railway working resumed over the crossing at 08:20 hrs on 12 January 2018.

Key facts and analysis

Background information

How the crossing closes and re-opens to road traffic

27 With D719 signal showing a green (proceed) or yellow (caution) aspect, trains approaching Stainforth Road AHB on the Down Skellow line will 'strike-in'[4] when they occupy track circuit[5] 6543b, which is located on approach to the signal (figure 8). 'Striking-in' will cause the crossing's control circuits to initiate the road closure sequence. This means that the road traffic lights and audible alarms will activate and the half-barriers will drop (paragraph 9). Just beyond D719 signal, the wheels of an approaching train will operate treadle[6] 'C' (figure 9). This will register the presence of the train at this location within the level crossing's controls.

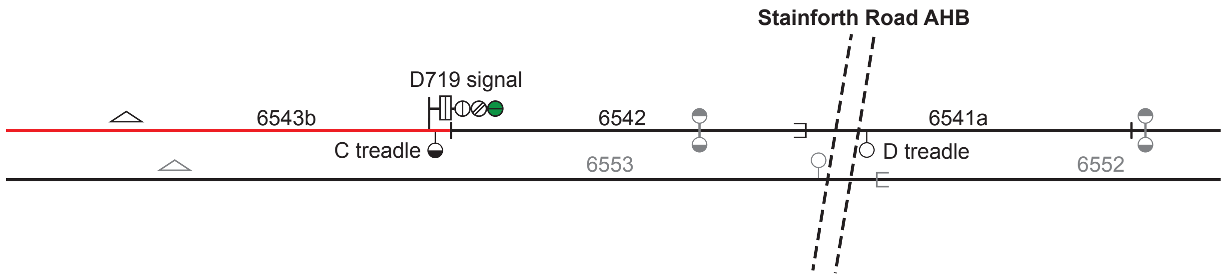

Figure 8: A train approaching on the Down Skellow line occupies track circuit 6543b

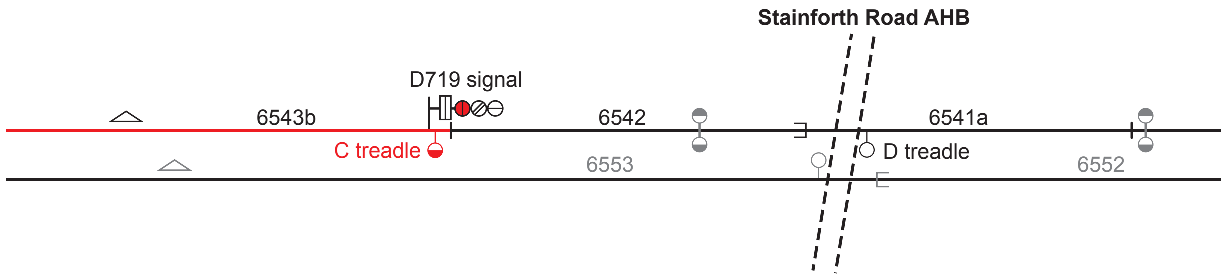

Figure 9: A train approaching on the Down Skellow line operates Treadle C

28 As the train continues to approach the crossing, track circuit 6542 will become occupied and track circuit 6543b will clear (figure 10). Occupying track circuit 6542 or operating treadle 'C' will also activate the road closure sequence if track circuit 6543b has not already done so (this would be the case if D719 signal is passed while showing a red (danger) aspect).

[4] The location on the approach to an automatic level crossing at which an approaching train triggers the operating sequence of the level crossing*. This and other definitions marked with an asterisk have been taken from Ellis's British Railway Engineering Encyclopaedia © Iain Ellis www.iainellis.com.

[5] An electrical or electronic device used to detect the absence of a train on a defined section of track using the running rails in an electric circuit*.

[6] An electrical switch mounted on the rail with an actuating lever which is operated by the wheel flanges of passing rail vehicles*.

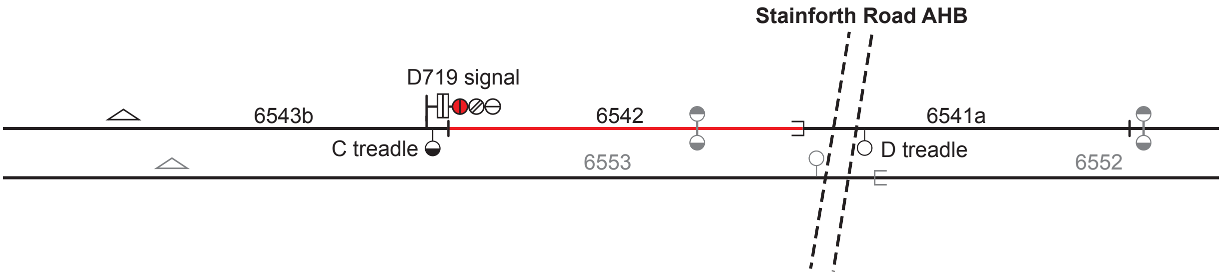

Figure 10: A train approaching on the Down Skellow line clears track circuit 6543b and occupies track circuit 6542

29 Track circuit 6542 terminates short of the crossing. The Down Skellow line immediately on approach to the crossing surface, the crossing surface itself and the track beyond it are monitored by track circuit 6541a. Occupation of this track circuit alone will not activate the road closure sequence. Network Rail stated that early designs of AHB had this arrangement so that the presence of tracked vehicles or salt in the crossing surface would not cause the crossing to close erroneously.

30 The track circuits in place at the crossing are of the audio-frequency type. This means there are no insulated block joints marking the boundary between circuits. Network Rail stated that the transformer unit located around 17 metres on approach to the crossing was used as the boundary between track circuits 6542 and 6541a (figure 11).

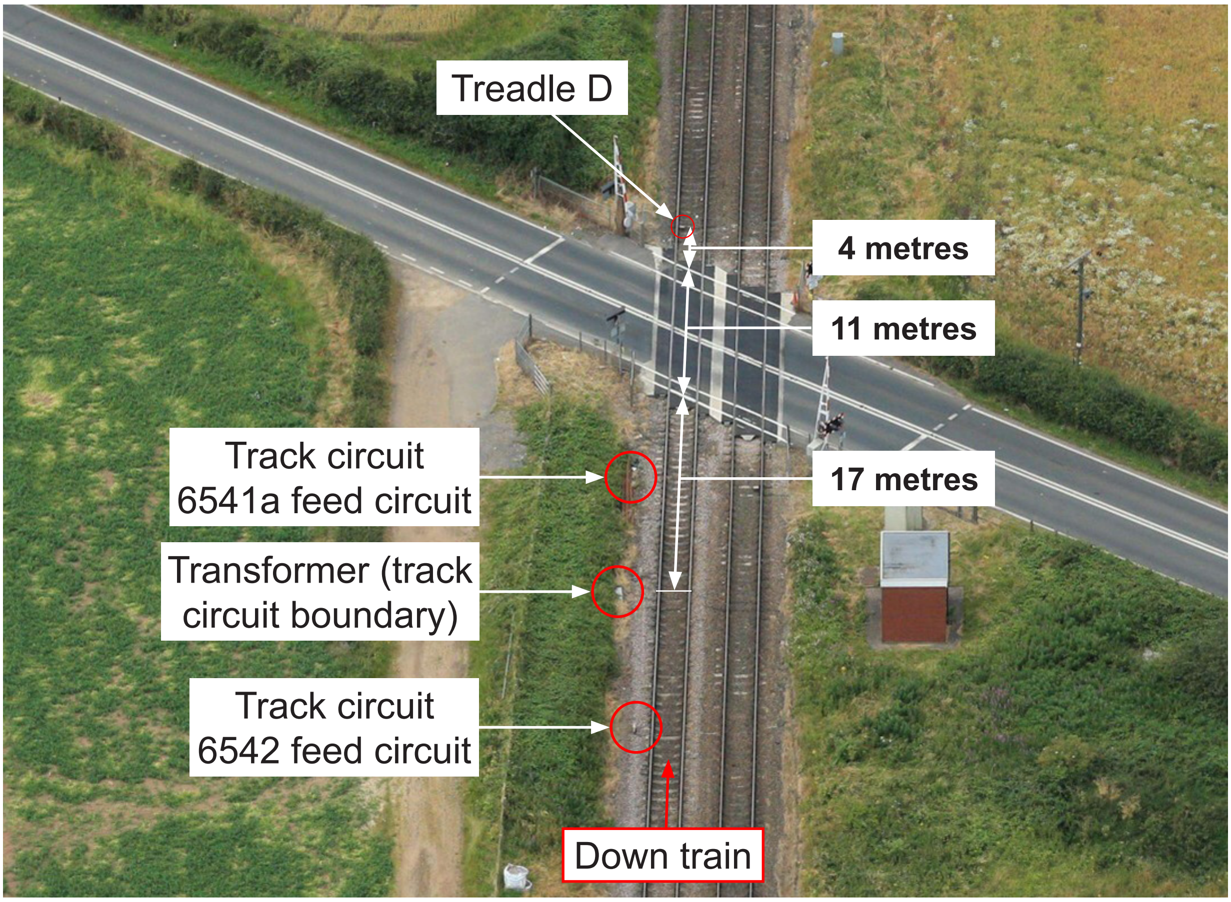

Figure 11: The track circuit and treadle arrangement at Stainforth Road AHB (underlying image courtesy of Network Rail)

31 Having entered track circuit 6541a, the front of the train passes over and leaves the crossing surface. About 4 metres beyond the crossing, the train's wheels will operate treadle 'D' (figure 12). Providing the control circuitry of the crossing has previously stored the operation of treadle C and can confirm that the road closure has been called and that the barriers remain down, the operation of treadle 'D' signifies to the controls that the crossing function and direction of the train has been proved. This information will again be stored by the control circuits.

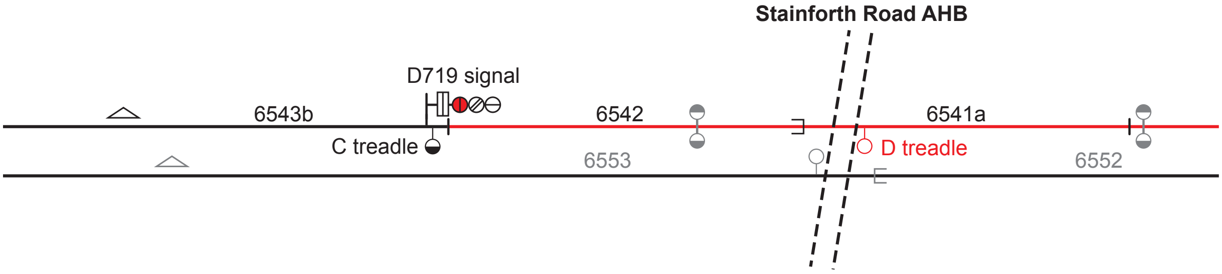

Figure 12: A train on the Down Skellow line operates Treadle D as it exits the crossing

32 The rear of the train will then clear track circuit 6542. Providing the crossing function and direction of the train has been stored, the clearance of this track circuit will cause the crossing re-opening sequence to start.

33 Stainforth Road AHB will therefore start to re-open to road traffic when the rearmost axle of an approaching train passes a point around 17 metres on approach to the crossing. Allowing a nominal 3 metres for the overhang of a wagon's body, and taking into account the 11 metre width of the crossing's surface, trains on the Down Skellow line will therefore have to travel around 31 metres after the crossing's re-opening sequence has started, before they completely clear the crossing's surface. For a train travelling at the maximum permitted linespeed of 50 mph (80 km/h) this will take about 1.4 seconds.

34 Network Rail's annual test plan requires that the half-barriers of an AHB crossing should take no more than 7 seconds to return to the fully raised position (80 to 85° from horizontal). The road traffic and boom lights should extinguish before the barriers rise past 45°, although the road traffic lights are required to re-activate should the barriers take longer than 6 seconds to become fully raised. In the case of Stainforth Road AHB, the data recorder fitted to the crossing showed that it took 6.5 seconds to fully reopen immediately before the accident occurred. This was within the 7 seconds permitted but would have caused the road traffic lights to re-activate for around 0.5 seconds (ie until the barriers were fully raised). Network Rail maintenance staff stated that the barriers took this long to rise because of the age of the hydraulic system which lifted them and because the crossing was fitted with relatively long booms.

35 Taking 6 seconds as the shortest expected time for the crossing to become fully re-opened, only trains travelling at around 11 mph (18 km/h) or below are at risk of not having fully cleared the crossing's surface when the half-barriers reach the fully raised position. The OTDR recorded that the front of train 6H58 passed over the crossing at 32 mph (51 km/h). However, the brake application subsequently caused it to slow down and for the rearmost wagon to come to a stop foul of the northbound carriageway.

Previous relevant incidents involving AHB crossings

36 Information drawn from Network Rail's level crossing file and other railway systems were examined by the RAIB. The file and systems contained no evidence that a similar accident or incident had previously occurred at Stainforth Road AHB. Data provided by RSSB from the railway industry's Safety Management Intelligence System ('SMIS' - the national database for recording safety-related events that occur on the rail network in Great Britain) was also analysed. This showed that there had been no similar accidents or near misses reported at AHB crossings during the five years preceding this accident.

37 Information provided by Network Rail's Doncaster Maintenance Delivery Unit showed that, between 2009 and 2012, there had been four reports of half-barriers rising while a train passed over an AHB crossing within their area of responsibility. These all occurred at Auckley AHB level crossing in Doncaster. Investigations by Network Rail staff found that the half-barriers had risen in each case due to the design of the crossing's control circuits combined with the unusually slow passage of a train. There was no suggestion of any accident or near-miss having resulted from these incidents. Auckley AHB has since been upgraded to a Manually Controlled Barriers with Obstacle Detection (MCB-OD) crossing.

38 There were also two further reported instances in the Doncaster area where two separate AHB crossings of the Mark I design raised their half-barriers during the passage of trains. Neither incident resulted in an accident or near miss. However, unlike Stainforth Road AHB, both of these crossings had approach track circuits which extended through the crossing surface. They were not, however, fitted with treadles and investigations by Network Rail found that the cause of the half-barriers lifting in each case was a wrong side failure of a track circuit. One of the crossings involved has since been modified to prevent this type of failure from re-occurring while the other has been replaced with a newer design of AHB.

Later designs of AHB crossing

39 Module X99[7] of Network Rail standard NR/L2/SIG/11201 states that bi-directional control circuits were introduced for double line crossings following a 1979 Ministry of Transport report[8]. Bi-directional control circuits allow trains to pass over the crossing on either line in both directions. This may be required where the line is bi-directionally signalled or where a train is making a 'wrong direction' movement[9]. Bi-directional controls incorporate an 'island track circuit' which monitors for the presence of trains on the railway lines directly at the crossing surface. Occupation of an island track circuit will not initiate a crossing closure but its clearance proves that a train is clear of the crossing before it is re-opened to road traffic.

40 Network Rail staff involved in the management of level crossing standards stated that island track circuits appeared in the typical circuits for level crossings from the mid-1980s onwards. Although a double line crossing, Stainforth Road AHB was not fitted with bi-directional controls and its design and installation in any case preceded the requirements relating to bi-directional controls by some years.

[7] NR/L2/SIG/11201/ Mod X99 'History of level crossings', Issue 1, September 2011.

[8] This is appears to be a reference to the 'Report on Level Crossing Protection including visits to the Netherlands, French, West German and Swiss Railways by officers of the Department of Transport and the British Railways Board' which was published in 1978 by the Department of Transport.

[9] In a direction opposite to the normal direction on the line concerned.

41 For new designs of level crossing, Module X02[10] of standard NR/L2/SIG/11201 requires bi-directional controls to be provided by default. It also continues to require new crossing designs with bi-directional controls to include island track circuits.

42 For new designs of AHB crossings, Module X10[11] specifically states:

4.1.4 The crossing shall not re-open to road unless the following has occurred:

- *All strike-in track circuits are now clear, and;*
- *The direction of the train has been established, and;*
- *The train has been proved to pass completely over the level crossing by two independent means. An example is track circuits and a treadle…*

OR

- *All strike-in track circuits are clear, and;*
- *A timed reset has occurred which has cancelled the operating sequence and disengaged the appropriate directional stick relay.*

43 Implementing the first half of clause 4.1.4 at Stainforth Road AHB would prevent this particular accident from occurring, as the crossing would not have reopened while the train remained on it. However, the second-half of clause 4.1.4 permits a timed reset to occur even if the crossing surface is not clear. Although the accident on 11 January occurred within the typical timed reset period of 2 minutes, this suggests that a similar accident could still take place were a train to be at a stand for only seconds longer than on the day of the accident.

44 An examination of the current typical circuits for AHB crossings used by Network Rail shows that a crossing built to these circuits would not undergo a timed reset if the island track circuit remained occupied by a train. These circuits are not mandated by the standard. However, an AHB level crossing built to the requirements of Clause 4.1.4 and in accordance with the typical circuits would therefore both have avoided this accident and also similar accidents which could potentially be caused by a timed reset.

Previous relevant incidents involving other crossing types

45 In September 2013, a car driver reported that they had had to brake sharply on approach to Lairg level crossing, Caithness, because the crossing's road traffic lights were not illuminated and its half-barriers were raised, despite a train standing on the crossing. An investigation by Network Rail confirmed that the train had been at a stand while the driver exchanged tokens[12] and that the crossing had undergone a timed reset after 3 minutes, in accordance with its design.

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[10] NR/L2/SIG/11201/ Mod X02 'Level Crossings: Common Design Requirements', Issue 2, June 2012.

[11] NR/L2/SIG/11201/ Mod X10 'Level Crossings: Automatic Half Barriers', Issue 1, September 2011.

[12] A token is a device carried by a driver on certain lines as authority to enter a section.

46 Lairg was originally an automatic open crossing locally monitored (AOCL) crossing. Locally monitored crossings are automatically activated by the approach of a train, with train drivers being required to observe the crossing as they approach it to ensure that the crossing is clear of users and that the road traffic lights are functioning. The status of the road traffic lights is shown to train drivers via a railway signal known as a driver's crossing indicator. Lairg AOCL was later retrofitted to include half-barriers, a type of crossing known as an AOCL+B. This did not change how it operated for approaching trains, but the addition of a half-barrier meant that it would look very similar to an AHB crossing for road users.

47 Government guidance[13] states that locally monitored level crossings should automatically re-open if they remain closed for longer than could be caused by passing trains (this is usually assumed as 3 minutes). This is because, unlike remotely monitored crossings (paragraph 9), locally monitored crossings do not alert the signaller to equipment failures and so could potentially remain closed to road users for prolonged periods following a failure[14]. Network Rail standards require new designs of locally controlled crossings to temporarily disable their automatic operation following a timed reset. Approaching trains are then required to stop short of the crossing and the train driver will use an emergency plunger to activate it.

The locomotive's DSD system and vigilance device

48 Locomotive 66158 is equipped with a DSD system, intended to stop the train if the driver has become incapacitated. The DSD requires the driver to keep a foot pedal depressed when the locomotive is being driven. Should the driver allow the foot pedal to rise, an alarm will sound. The driver will have between 5 and 7 seconds to cancel the alarm by depressing the pedal. If they do not, then a brake application will occur. This will vent the train's brake pipe to 0 bar at the full service brake venting rate and will also cut the locomotive's throttle. An alert stating 'DSD PENALTY BRAKE' will also appear on the locomotive's management computer. In addition, 30 seconds after the brake application has been demanded, the DSD system will trigger an emergency call to the signaller via the locomotive's GSM-R radio, unless this is first cancelled by the driver. The DSD system is reset by the driver via the locomotive's selector switch and DSD pedal, once the train is at a stand.

49 The DSD system also includes a vigilance device, intended to ensure that drivers remain alert. The vigilance device monitors the driving controls. If no controls are moved within a time window of between 55 to 65 seconds, then the DSD alarm will sound. The alarm is reset by raising and then depressing the DSD foot pedal. If the alarm is not reset within 5 to 7 seconds then a DSD penalty brake demand and GSM-R emergency call will occur (and be reset) in the same way as described for a DSD brake application. The locomotive's management computer will display a message stating 'VIGILANCE SYSTEM - PENALTY BRAKE APPLICATION'.

[13] Office of Rail and Road 'Level crossings: a guide for managers, designers and operators', December 2011 http://orr.gov.uk/__data/assets/pdf_file/0016/2158/level_crossings_guidance.pdf.

[14] The Level Crossing Risk Management Toolkit states 'Research conducted suggests that vehicle drivers are more likely to engage in risky behaviours the longer they are delayed'.

Network Rail’s level crossing risk assessment process

50 Network Rail standard[15] NR/L3/OPS/045/3.08 requires level crossings to be risk assessed at regular defined intervals, with higher risk crossings being assessed more often than lower risk ones. Risk assessments are also triggered by specific activities such as crossing renewals, changes to line speeds, expressions of concerns from stakeholders and accidents. An assessment is undertaken by Network Rail staff who have undergone the relevant training, usually the level crossing manager.

51 The assessor will visit the crossing to collect data and to conduct a census of crossing use. They will then use the All Level Crossing Risk Model (ALCRM) to undertake a quantitative assessment of risk. ALCRM is a computer-based application which uses data from the Safety Risk Model[16] (SRM). The SRM estimates the underlying risk which exists from railway activities by using historical accident data, modelling, expert judgement and statistical methods. ALCRM uses the risk precursors[17] in the SRM which relate to a particular type of crossing (known as a ‘core type’) to derive an average risk figure for each precursor for each core type. The relative risk for a particular crossing of a core type is then calculated using the data collected on site and from railway information systems to weight the risk associated with the relevant precursor.

52 The SRM is owned and managed by RSSB, a not-for-profit organisation owned by major rail industry stakeholders. RSSB stated that latest version of the SRM[18] contains two hazardous events which would account for this accident. These were:

- Hazardous event ‘HET-10E LAHB-BLETF RV struck by train - on AHB - equipment failure: lights/barriers fail to operate’. This event accounts for 0.58% of the total risk predicted within SRM of a passenger train colliding with a road vehicle on a level crossing. If only AHB crossings are considered then this event accounts for 1.43% of the total risk.
- Hazardous event ‘HET-11E LAHB-BLETF RV struck by train - on AHB - equipment failure: lights/barriers fail to operate’. This event accounts for 0.54% of the total risk predicted within SRM of a freight train colliding with a road vehicle on a level crossing. If only AHB crossings are considered then this event accounts for 1.45% of the total risk.

53 Both hazardous events account for all factors which could prevent a crossing from functioning ie they cover equipment malfunction as well as any design factors which may prevent the warning equipment from operating.

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[15] NR/L3/OPS/045/3.08 ‘National Operating Procedures: Risk Assessing Level Crossings’, Issue 1, September 2017.

[16] At the time of writing, ALCRM was using data drawn from SRM Version 7.0, issued in 2010.

[17] A risk precursor is a one of the events or situations necessary for an accident or incident to occur within a given set of circumstances.

[18] SRM Version 8.5, issued in 2018.

54 RSSB stated that no previous events had been observed for these precursors between March 1996 and Feb 2017. However as the risk was still considered credible, it was therefore estimated using professional judgement. Based on the information available to the RAIB, it has not been possible to determine what proportion of the risk predicted by the hazardous events is assigned to potential design issues or if the estimations accounted for the presence or absence of island track circuits.

55 ALCRM expresses the risk in terms of the predicted Fatalities and Weighted Injuries (FWI) per year at the crossing. This is translated into a risk score, made up of a letter representing the risk to an individual using the crossing and a number representing the collective risk to crossing users and those on board trains. These scores represent the range of risk across all types of crossings with an individual risk of A and a collective risk of 1 being the highest and M and 13 being the lowest. Once completed, the ALCRM assessment will be peer-reviewed by another person trained in crossing assessment.

56 The assessor will then identify and analyse the cost and benefit of potential safety improvements which could be undertaken at the crossing. This process is known as 'optioneering'. Potential improvements which have a significant cost associated with their implementation (such as the upgrade of a crossing to a type offering a higher level of protection) are analysed using Network Rail's cost-benefit analysis tool. Lower cost improvements (such as the fitting of red-light enforcement cameras) are analysed using Network Rail's minor mitigation calculation tool[19]. The cost-benefit analysis will support the assessor's judgement as to whether the safety and business benefit resulting from a change justify the associated expenditure. The options identified and the results of any analysis undertaken are recorded in ALCRM along with a recommendation as to which option, if any, is suitable for implementation.

57 The assessor will then produce a narrative risk assessment. This summarises the ALCRM results for the crossing and includes a descriptive narrative about the risks and mitigations present. It also summarises the potential improvements which have been analysed. Within Network Rail's LNE & EM Route all narrative risk assessments are reviewed and signed-off by a Route Level Crossing Safety Specialist, who liaises with level crossing managers on behalf of the Route Asset Management team.

[19] Options costing less than £5,000 and any changes due to enforcement action are not subject to cost-benefit analysis.

Identification of the immediate cause

58 **A wagon was standing foul of the open northbound carriageway of Stainforth Road AHB level crossing when a car approached from the south.**

Identification of causal factors

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

a. train 6H58 was at a stand on the Down Skellow line, with its rearmost wagon foul of the northbound carriageway of Stainforth Road AHB, following a brake demand from the locomotive's vigilance device (paragraph 60); and

b. the car driver was unaware that the wagon was obstructing the northbound carriageway of Stainforth Road AHB until she was too close to avoid a collision (paragraph 68).

Each of these factors is now considered in turn.

The presence of train 6H58 on the crossing

60 **Train 6H58 was at a stand on the Down Skellow line, with its rearmost wagon foul of the northbound carriageway of Stainforth Road AHB, following a brake demand from the locomotive's vigilance device.**

61 Witness evidence and data from the locomotive's OTDR indicate that train 6H58 initially came to a stand because the locomotive's vigilance device demanded a brake application after its audible alarm was not cancelled in the permitted time window (paragraph 49). The train remained stationary while the driver reset the vigilance device and re-pressurised the brake pipe, in order to release the brakes. It was during this period that the accident occurred.

62 The driver of the train stated that he heard the audible alarm from the vigilance device and tried to cancel it by lifting his foot completely from the DSD foot pedal and then depressing it, but that this had been ineffective. He also stated that he may not have heard the audible alarm in enough time to cancel it, because of the high level of noise and vibration in the cab present when the locomotive's throttle was in Notch 8 (paragraph 18). There may also have been additional noise present because the driver had the cab window open.

63 The DSD pedal was subject to, and passed, routine functional testing both before and after the accident. The driver made no allegations of any malfunction in the vigilance device before or after this particular brake demand.

64 There was no evidence that the driver was distracted when the DSD alarm sounded or that he was impaired by drugs or alcohol. His medical certificate showed that he had no pre-existing conditions which could have reduced his alertness and he was not taking any medication which could have adversely affected his driving.

65 The driver was working his first night shift following two rest days and described himself as 'tired but not fatigued'. Analysis undertaken by the RAIB showed that his Fatigue Risk Index (FRI) score was well within the limits set by DB Cargo for night shift working[20]. The driver also had a nap while on his break at Immingham, which is likely to have been beneficial in reducing his fatigue. However, night shift work generally, and first night shifts in particular, are two of the fatigue risk factors identified in the Office of Rail and Road's (ORR) good practice guidelines[21]. The driver had also been awake for almost 13 hours when the vigilance device applied the brakes.

66 Based on the preceding evidence, the RAIB has concluded that the level of ambient noise in the cab probably prevented the driver from hearing the audible alarm in sufficient time to cancel it and that fatigue cannot be completely discounted as a factor which affected how he responded to the alarm.

67 Trains may come to a stand on operational railway lines for a number of reasons including service disruptions, the activation of safety devices and equipment failures. For this reason, the RAIB's investigation has been principally focused on how Stainforth Road AHB was able to reopen with a train still partly blocking the northbound carriageway.

The car driver's awareness of the train

68 The car driver was unaware that the wagon was obstructing the open northbound carriageway of Stainforth Road AHB until she was too close to avoid a collision.

69 The car driver stated that she frequently travelled over Stainforth Road AHB and that she was very familiar with the layout of the road and crossing. However she stated that, on the morning of 11 January, she was unaware that the rearmost wagon of train 6H58 was obstructing the crossing until it was too late to take successful avoiding action.

70 The car driver was unaware of the obstruction caused by the wagon because:

- she could not see the wagon at a distance necessary to avoid collision, given her speed of approach (paragraph 71); and
- she was not alerted to the presence of the wagon by the crossing's warning devices (paragraph 75).

Each of these is now considered in turn.

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[20] The use of the Fatigue Risk Index by DB Cargo during roster planning and its suitability for this task are discussed further in the RAIB's report into two signal passed at danger incidents at Reading Westbury Line Junction and Ruscombe Junction (RAIB report 18/2016).

[21] Office of Rail and Road 'Good practice guidelines - Fatigue Factors', December 2017 http://orr.gov.uk/__data/assets/pdf_file/0003/23682/good-practice-guidelines-fatigue-factors.pdf.

The car driver's visibility of the wagon

71 The car driver could not see the wagon at a distance necessary to avoid collision, given her speed of approach.

72 The car driver estimated that her speed of approach to Stainforth Road AHB was between 40 and 50 mph (64 to 80 km/h). She stated that the rearmost wagon was unlit and that she did not see it until she was too close to take effective avoiding action (paragraph 24). The fact that the wagon was only visible to car drivers once they were very close to or on the crossing was supported by the witness evidence of the southbound car driver who passed the crossing shortly before the accident occurred (paragraph 22).

73 There are a number of possible reasons why the car driver would have been unable to see the rearmost wagon until she was very close to or on the crossing. These include:

- It was very dark and there were no ambient light sources nearby which could have illuminated the crossing's surface (paragraph 7).
- The weather was overcast (paragraph 15).
- While the locomotive was equipped with lights, it was situated just under 500 metres from the crossing and the rest of the train was formed of unlit wagons. The bodies of these wagons are not intentionally reflective and the headstock and buffers (which would have been the elements of the wagon most likely to be struck by a car, paragraph 24) are painted black. It is of note that the railway rule book already acknowledges the dangers of unlit trains passing over other types of crossing in darkness during degraded working[22].
- Given the skewed orientation of the road and railway it is not likely the tail lamp mounted on the rear wagon would have been visible.

74 It is also the case that the crossing's warning devices not being activated would have caused the car driver to assume that the crossing was clear and safe to drive across.

The crossing's warning equipment

75 The car driver was not alerted to the presence of the wagon by the crossing's warning devices.

76 Witness accounts (paragraphs 22 and 24) and the crossing data recorder fitted to Stainforth Road AHB showed that, when the accident occurred, the crossing's road traffic lights were not illuminated and that its half-barriers were raised.

77 The crossing's warning devices were not activated because:

- The original design of the control circuitry of Stainforth Road AHB had permitted the crossing to re-open while it was still occupied by a train (this has been discussed between paragraphs 27 and 35).

[22] For example, GE/RT 8000 Module TS9 does not allow unlit trains to pass over Automatic Open Crossing Locally monitored (AOCL) and Automatic Barrier Crossing Locally monitored (ABCL) crossings where the road traffic lights have failed.

- The original control circuitry of Stainforth Road AHB was not retrospectively modified to meet later requirements that trains must be proved clear of a crossing before it is re-opened to road traffic. The crossing was also not renewed with a newer design of AHB or replaced with another type of crossing whose control circuits incorporated this principle (paragraph 78).

The lack of modification or renewal of the original control circuitry

78 **The original control circuitry of Stainforth Road AHB was not retrospectively modified to meet later requirements that trains must be proved clear of a crossing before it is re-opened to road traffic. The crossing was also not renewed with a newer design of AHB or replaced with another type of crossing whose control circuits incorporated this principle.**

79 The original control circuitry installed at Stainforth Road AHB was not modified, renewed or replaced to incorporate the principle that trains must be proved clear of a crossing before it is re-opened to road traffic for the following reasons:

- following its initial installation in 1974, there was no requirement for the control circuitry of Stainforth Road AHB to be retrospectively redesigned to incorporate island track circuits (paragraph 80); and
- the operational risk assessment process used by Network Rail did not identify and address the risk of the original design of control circuitry remaining in service (paragraph 83).

Each of these topics is now considered in turn.

The retrospective installation of island track circuits

80 The RAIB was unable to find any evidence of a requirement to retrospectively fit island track circuits to existing level crossings within relevant government requirements and guidance. Network Rail staff stated that, as far as they were aware, no similar requirement had existed within the internal standards issued by Network Rail or its predecessor organisations. Later design standards which required the installation of island track circuits, would only have been incorporated into the control circuits of Stainforth Road AHB had a new design been created for the crossing which post-dated the requirement. A new design would only have been needed had the crossing undergone major modifications or repairs, or if it had been renewed with a more modern AHB design or replaced with a crossing type offering a higher level of protection.

81 Following its introduction into service in 1974, Stainforth Road AHB underwent various minor modifications. These included alterations in road and rail signage, an increase in linespeed, the addition of a footpath to the western side of the crossing surface and the installation of LED road traffic lights as part of a national programme of upgrades following a fatal accident at Beech Hill (RAIB report 17/2013). The nature of the modifications undertaken to the crossing meant that none of them required a redesign of the control circuits. Network Rail staff stated that there was no indication of any other repairs being needed which would have provided a similar opportunity.

82 The crossing was also not renewed or replaced prior to the accident. This was because, in 2015, Network Rail assessed the crossing as having sufficient remaining working life left not to need renewal or replacement before 2021. The way in which the remaining working life of a crossing is assessed and the planned replacement of the crossing during the upcoming Control Period 6[23] are discussed in paragraph 109.

Network Rail's operational risk assessment process

83 The last narrative risk assessment of Stainforth AHB undertaken before the accident was completed by the Doncaster level crossing manager in March 2017. The ALCRM results included in the assessment showed that it had a risk equivalent to 0.012673097 FWI per year and a risk score of E2. This placed it in the 'red' category of crossing, which require assessment every 1.25 years. Based on the one hour traffic census undertaken for the assessment, ALCRM calculated that an average of 6858 road vehicles and 14 pedestrians and cyclists would use the crossing every day.

84 The main risk factors discussed in the narrative risk assessment relating to road traffic were the volume of road users and the possibility of road vehicles achieving high speeds and overtaking on approach to the crossing. Low lying sun and fog during certain times of the year were also highlighted as risk factors for crossing users. The main railway related risk factors were that freight trains operated 24 hours a day over the line and that they were not timetabled[24]. Risk mitigations in place at the crossing included LED road traffic lights, visits from a camera enforcement van operated by the British Transport Police and meetings with stakeholders. The original design of the crossing control's circuitry was not mentioned in the narrative risk assessment.

85 Three options were discussed in the narrative risk assessment to improve safety at the crossing. The first two options were to upgrade it from an AHB to an MCB-OD or Manually Controlled Barriers with CCTV (MCB-CCTV) type of crossing. Both MCB-OD and MCB-CCTV crossings use barriers which, when lowered, extend across the whole width of the carriageway. Trains cannot pass the railway signal protecting the crossing until the barriers have been proved down and the crossing surface checked to ensure that there are no persons or obstructions present, by CCTV or obstacle detection equipment respectively. Both types are regarded as offering higher protection to crossing users and the railway and would reduce the crossing's risk in ALCRM to a risk score of K6.

[23] Control Periods are five year periods which Network Rail uses for budgeting and planning purposes.

[24] The Level Crossing Risk Management Toolkit states that 'Level crossing users might base their decision to cross on their prior experience of train movements at that time of day. If the user is familiar with the crossing and has experience of a train passing at a specific time, they might believe that the crossing is safe to use at other times. However, users might fail to consider variations in train schedules and that many trains, such as freight, are not scheduled under standard passenger timetables'.

86 The third option was to close the crossing and replace it with a road bridge. For the purposes of an ALCRM assessment, this option would have effectively removed all of the risk at the crossing. While all three options were submitted within ALCRM, none were subject to cost-benefit analysis. The level crossing manager who undertook the assessment stated that this was because he did not have the information available which would allow him to cost options of this nature accurately, given that crossing replacements would be considered at route level as part of wider asset management decisions. This is discussed in more detail in paragraph 109.

87 Network Rail's LNE & EM Route Asset Management team stated to the RAIB that for Stainforth Road AHB to be upgraded to an MCB-OD crossing, it would typically cost between £2.1 million and £3.1 million. An upgrade to MCB-CCTV would have a similar cost and a bridge a much greater cost. Network Rail's cost-benefit criteria suggests that, given these costs, any cost-benefit analysis would have probably shown a weak safety and business benefit for all three options.

88 Previous narrative risk assessments which covered the period back to 2014 suggest that the risk score and the risk and mitigation factors at the crossing remained broadly similar over that period and that decisions around crossing replacement funding were again being passed to route level. ALCRM records show that the fitting of LED road traffic lights was recorded as a safety benefit in 2016 and that an option to remove redundant red-light enforcement cameras, which were potentially affecting road traffic light visibility, was progressed and implemented in 2014. None of the previous narrative risk assessments mentioned the absence of island track circuits at the crossing.

89 In summary, the evidence shows that, even though the ALCRM and narrative risk assessments were both undertaken in accordance with the required procedures and processes, neither highlighted the absence of island track circuits or the risk their omission may pose. This also meant that options to address the risk presented by their absence were not developed or analysed.

90 RSSB stated that the SRM base data used by ALCRM (paragraph 54) did not distinguish between crossings equipped with different types of track circuit. This means that an older design without island track circuits would not be highlighted as a greater risk (for this particular reason) than a newer AHB equipped with them. The latest SRM predicts the non-operation of warning equipment to have only a very low contribution to the overall risk of a collision between a road vehicle and a train at an AHB (paragraph 52). The absence or presence of island track circuits at an AHB probably would not, therefore, have made a significant difference to the risk scores generated by ALCRM. The installation of island track circuits in isolation would also not have shown any predicted improvement in FWI, meaning that it would be unlikely to be proposed as a safety improvement during the optioneering phase.

91 Narrative risk assessments are not confined to the same SRM base data as ALCRM and the risk posed by the absence of island track circuits could potentially be discussed by the assessor. However this would rely on the assessor having a detailed understanding of the function of the control circuitry of the crossing, how this varies from later designs and the potential risks that later design features were intended to address. The available records (paragraphs 36 and 37) suggest that incidents of this nature are infrequent and that those which previously occurred have resulted in low consequence outcomes. This means that, even were an assessor to be aware of the absence of island track circuits at an AHB, then it would probably be seen as a low contribution to the overall risk posed by the crossing's operation and one which would be unlikely to warrant safety improvements.

Underlying factor

92 **Network Rail's processes do not include a mechanism which could identify and address the increased relative risk at existing level crossings that are not provided with modern safety features. This is possibly an underlying factor.**

93 Where a crossing is renewed or replaced, the risk of the new design not incorporating later safety features is addressed in several ways. Firstly, Network Rail requires a detailed risk assessment to be undertaken before the exact nature of a renewal or replacement crossing project is decided upon (ie prior to Network Rail's GRIP[25] Stage 3 'Option Selection'). An example of one of these assessments was provided to RAIB by LNE & EM Route. This showed that the assessment looked in much greater detail at the risk factors considered by ALCRM and narrative risk assessments. It also showed that options for future improvements were considered within cross-functional workshops attended by network operations staff and external signalling and risk consultants.

94 In addition, once a decision to proceed has been taken, detailed crossing designs are required to observe the current signalling standards which incorporate later safety features, such as the current Modules X02 and X10 of standard NR/L2/SIG/11201 (paragraphs 41 and 42). Crossing designers are also able to consult typical circuits which incorporate safety features. Further scrutiny of designs is also undertaken as a project proceeds towards implementation.

95 These processes mean that a new level crossing should incorporate any later design features which were introduced to improve safety. However, the RAIB has been unable to identify any mechanism which would identify and address the risk presented by the absence of later design safety features within level crossings currently in service. Had such a mechanism existed, then it is possible that the risks of there not being an island track circuit at Stainforth Road AHB would have been identified and action taken which would have prevented the accident from occurring.

[25] The Governance for Railway Investment Projects (GRIP) process describes how Network Rail manages and controls projects.

Observation

96 For new designs of Automatic Half-Barrier level crossing, Clause 4.1.4 of Network Rail standard NR/L2/SIG/11201 Module X10 permits a timed reset to occur even if the crossing surface is not proved clear (paragraph 42). Although this would not occur at crossings built in accordance with the current typical circuits for AHB crossings (paragraph 43), these circuits are not mandated by the standard.

Summary of conclusions

Immediate cause

97 A wagon was standing foul of the open northbound carriageway of Stainforth Road Automatic Half-Barrier level crossing when a car approached from the south (paragraph 58).

Causal factors

98 The causal factors were:

a. train 6H58 was at a stand on the Down Skellow line, with its rearmost wagon foul of the northbound carriageway of Stainforth Road Automatic Half-Barrier level crossing, following a brake demand from the locomotive's vigilance device (paragraph 60); and

b. the car driver was unaware that the wagon was obstructing the open northbound carriageway of Stainforth Road Automatic Half-Barrier level crossing until she was too close to avoid a collision (paragraph 68).

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

i. The car driver could not see the wagon at a distance necessary to avoid collision, given her speed of approach (paragraph 71).

ii. The car driver was not alerted to the presence of the wagon by the crossing's warning devices (paragraph 75).

iii. The original design of the control circuitry of Stainforth Road Automatic Half-Barrier level crossing had permitted the crossing to re-open while it was still occupied by a train (paragraph 27).

iv. The original control circuitry of Stainforth Road Automatic Half-Barrier level crossing was not retrospectively modified to meet later requirements that trains must be proved clear of a crossing before it is re-opened to road traffic. The crossing was also not renewed with a newer design of Automatic Half-Barrier level crossing or replaced with another type of crossing whose control circuits incorporated this principle (paragraph 78, **Recommendation 1**).

Underlying factor

99 Network Rail's processes do not include a mechanism which could identify and address the increased relative risk at existing level crossings that are not provided with modern safety features. This is possibly an underlying factor (paragraph 92, Recommendation 2 of RAIB report 04/2011).

Observation

100 For new designs of Automatic Half-Barrier level crossing, Clause 4.1.4 of Network Rail standard NR/L2/SIG/11201 Module X10 permits a timed reset to occur even if the crossing surface is not proved clear (paragraph 96, **Recommendation 2**).

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

Fatal accident at Moreton-on-Lugg, RAIB report 04/2011, Recommendation 2

101 **The RAIB considers that with more effective implementation of Recommendation 2 in RAIB report 04/2011, Network Rail may have developed processes that could identify and address the increased relative risk at existing level crossings that are not provided with modern safety features, which was a possible underlying factor in this accident.**

102 The RAIB has previously reported on a number of accidents where a factor in the accident was safety features of later level crossing designs not being present at existing level crossings. These reports included the fatal accident at Moreton-on-Lugg, which made the following recommendation:

'The intention of this recommendation is that implementation of Network Rail's level crossing risk management process will identify and assess the risks from all aspects of the design, operation and maintenance of equipment and systems, including signalling, so that mitigation measures can be identified and implemented.

Network Rail should enhance its level crossing risk management process to include identification, assessment and management of the risk associated with:

- *human error by signallers and crossing keepers;*
- *operational arrangements, in particular with regard to the ability of operators to cope with interruptions, such as telephone calls, and other out-of-course events;*
- *equipment design, in particular where it is not compliant with latest design standards; and*
- *maintenance and inspection arrangements, particularly where these are used to identify and remedy any equipment functional and performance deficiency.*

The process should allow for sufficient liaison between the relevant engineering and operational departments. When addressing risks identified by the implementation of the revised process, Network Rail should prioritise the implementation of required mitigation measures to level crossings where consequences of operator error are severe and not protected by engineered safeguards'.

103 Of particular relevance to the possible underlying factor discussed in paragraph 92 is the third bullet point, which addresses crossing equipment design not being compliant with latest standards.

104 In February 2012 the ORR (the safety authority for the national rail network in Great Britain) informed the RAIB that Network Rail had reported the following actions had been taken relevant to this bullet point within the recommendation:

- Network Rail had established a programme to improve level crossing risk management, as it was recognised that the scope of the existing process was too narrow. This process was to be expanded to cover local and bespoke factors specific to the environment, type and functionality of the crossing.
- Network Rail was planning to hold a crossing functional workshop to assess issues relating to equipment design within level crossings.

The proposed completion date for these actions was 31 May 2012.

105 In December 2013, the ORR informed the RAIB that Network Rail had reported the completion of the cross-functional workshops. The ORR asked Network Rail for further information as to how specific parts of the recommendation were being addressed and stated that it expected to update the RAIB again by 31 March 2014. In March 2018, the ORR stated to the RAIB that it was awaiting further progress on these matters and that it regarded the recommendation as still being open.

106 In April 2018, Network Rail's Group Safety, Technical and Engineering (STE) organisation stated to RAIB that it had undertaken the following actions relevant to level crossing equipment design risk:

- a large scale 'bow-tie' analysis of level crossing risk had been completed, which analyses the causes and consequences of crossing accidents and considers whether crossings are fit for purpose and safe;
- a review of the signalling design modules within Network Rail standard NR/L2/SIG/11201 and the protection principles which underlie them, in order to ensure that they are fit for purpose, consider maintenance and interface risk and are more consistent between crossing types;
- STE was also advising Major Scheme Review Panels, including asking them to specifically consider 'standage' (ie locations where trains should not routinely stop or slow) when they were reviewing and endorsing scheme plans; and
- the STE team was undertaking specific activities relating to incidents and accidents in order to understand and address risk promptly, such as the special inspection notices issued after this and other incidents/accidents (paragraph 108).

107 Although actions have clearly been taken as a result of the earlier recommendation, none of them appear to have provided a robust process which would identify and address the risk presented by the absence of later design safety features within level crossings currently in service. Had they done so, then it is possible that the risks presented by the absence of an island track circuit at Stainforth Road AHB would have been identified and addressed.

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

Special Inspection Notice 180

108 As a result of this accident, Network Rail issued Special Inspection Notice 180 'Level Crossing Detection Configuration' on 12 March 2018. This notice requires Route Asset Management teams to review all active level crossings equipped with train detection[26] and to report by 31/03/2019 any crossing of any type where there is a risk of a crossing being open to road users with the crossing surface occupied by a train. Network Rail stated that this notice was intended to assess the level of risk presented by this issue.

The planned replacement of Stainforth Road AHB

109 As part of managing level crossing assets, the Route Asset Management team at LNE & EM maintain an asset workbank. This is used to create a base business plan for the renewal or replacement of crossings during the next control period. The workbank contains information relating to the condition of level crossings within the route, including the FWI risk calculated by ALCRM (paragraph 55) and when the crossing is expected to need renewal or replacement due to its condition. Both the risk score and the remaining asset life are taken into account when renewals and replacements are planned.

110 The renewal or replacement date is based on the professional judgment of the Route Asset Management team, supported by information from a signalling infrastructure condition assessment (SICA) report. A SICA report looks at the actual condition of various crossing components and uses a scoring system to calculate the likely remaining working life of the crossing. Stainforth Road AHB has an asset workbank replacement date of 2021. Network Rail staff stated that this replacement date reflects the conclusions of its last SICA report, which was undertaken in 2015, but would also take into account their knowledge of the age and older design of some of the equipment at the crossing (such as the barriers) which is typically more difficult to maintain. The amount of working life remaining was the reason why the crossing was not replaced before the accident (paragraph 82).

111 For the upcoming Control Period 6, the Route Asset Management team within LNE & EM Route used Network Rail standard NR/L1/XNG/100[27] to guide their crossing renewal and replacement decisions. This standard required business plans to include provision for a percentage of crossing renewals to be upgrades to a crossing type offering a higher level of protection, even where specific sites had not been identified. In response to this requirement, LNE & EM Route decided that any AHB with an ALCRM collective risk score of between 1 and 3 would be upgraded to a more protective type.

112 Stainforth Road AHB has an ALCRM collective risk score of 2 (paragraph 83). This, combined with its expiring working life, means that Network Rail is planning to replace it with an MCB-OD type crossing, with a planned commissioning date of November 2021 (ie in Control Period 6).

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[26] With the exception of User Worked Crossings with Miniature Stop Lights which use overlay track circuits and so would not be affected by the same potential risk.

[27] NR/L1/XNG/100 'Level Crossing Asset Management Policy', Issue 1, June 2016.

Recommendations

113 The following recommendations are made[28]:

1 *The intention of this recommendation is to ensure that the risk of existing level crossings being open to road users during the passage of trains is recognised and actively managed on Network Rail managed infrastructure.*

Network Rail should:

- review the responses provided to Special Inspection Notice 180 in order to identify those locations where it is possible for a level crossing to be open to road users while it is occupied by a train;
- review the risks associated with such scenarios at the identified locations and identify suitable risk mitigation measures to address them; and
- draw up a time-bound plan to improve the crossings as appropriate, with those presenting the higher risk improved ahead of those presenting the lower risk (paragraph 98b iv).

2 *The intention of this recommendation is to prevent new designs of automatic level crossings which cross public roads, that are remotely monitored by the signaller and which are intended for use on Network Rail managed infrastructure, from being open to road users during the passage of trains.*

Network Rail should revise its level crossing design standards so that they do not permit new designs of remotely monitored level crossing to undergo a timed reset unless all strike-in track circuits are clear and the train has been proved to have passed completely over the level crossing by suitable means.

This may be undertaken as part of its current review of level crossing design standards and their underlying protection principles (paragraphs 100 and 106).

[28] 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 or 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.

Appendices

Appendix A - Glossary of abbreviations and acronyms

AHB	Automatic Half-barrier level crossing
ALCRM	All Level Crossing Risk Model
DSD	Driver's Safety Device
FWI	Fatalities and Weighted Injuries
LED	Light Emitting Diode
LNE & EM	London North Eastern and East Midlands Route
MCB-CCTV	Manually Closed Barriers with CCTV level crossing
MCB-OD	Manually Closed Barriers with Obstacle Detection level crossing
OTDR	On Train Data Recorder
SICA	Signalling Infrastructure Condition Assessment
SRM	Safety Risk Model
STE	Network Rail's Group Safety, Technical and Engineering organisation

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