Rail Accident Investigation Branch

Rail Accident Report

Collision of a train with a demolished footbridge, Barrow upon Soar 1 February 2008

Department for Transport

Report 18/2008
September 2008

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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Contents

Introduction 5

Summary of the Report 6

Key facts about the accident 6

Immediate cause, causal and contributory factors, underlying causes 6

Severity of consequences 7

Recommendations 7

The Accident 8

Summary of the accident 8

The parties involved 8

Location 8

External circumstances 10

Events preceding the accident 10

Events during the accident 10

Consequences of the accident 12

Events following the accident 12

The Investigation 14

Investigation process 14

Sources of evidence 14

Key Information 15

The planning of the delivery operation 15

The lorry 16

The footbridge 16

The train 16

Key timings relating to the accident 18

Previous occurrences of a similar character 20

Analysis 21

Identification of the immediate cause 21

Identification of causal and contributory factors 21

The planning 21

Actions after lorry collided with bridge 21

Performance of the train 22

Conclusions 24
Immediate cause 24
Causal factors 24
Contributory factors 24
Underlying causes 24
Other factors affecting the consequences 24
Additional observations 25
Recommendations 26
Recommendations to address causal and contributory factors 26
Recommendations to address other matters observed during the investigation 26
Appendices 27
Appendix A - Glossary of abbreviations and acronyms 27
Appendix B - Glossary of terms 28

Introduction

1 The sole purpose of a Rail Accident Investigation Branch (RAIB) investigation is to prevent future accidents and incidents and improve railway safety.

2 The RAIB does not establish blame, liability or carry out prosecutions.

3 Access was freely given by Network Rail, East Midlands Trains, Midland Quarry Products and J & G Vesty Haulage to their staff, data and records in connection with the investigation.

4 Appendices at the rear of this report contain the following glossaries:

- acronyms and abbreviations are explained in Appendix A; and
- technical terms (shown in *italics* the first time they appear in the report) are explained in Appendix B.

5 All mileages in the report are from a zero datum at St Pancras International station.

6 All directions in the report are relative to the southbound direction of travel of the train.

Summary of the Report

Key facts about the accident

7 At 06:32 hrs on 1 February 2008 train 1L03, the 06:13 hrs Nottingham to Norwich train, collided with debris from a footbridge that had been knocked down by the raised body of a tipper lorry at Barrow upon Soar, Leicestershire (Figure 1). The train derailed.

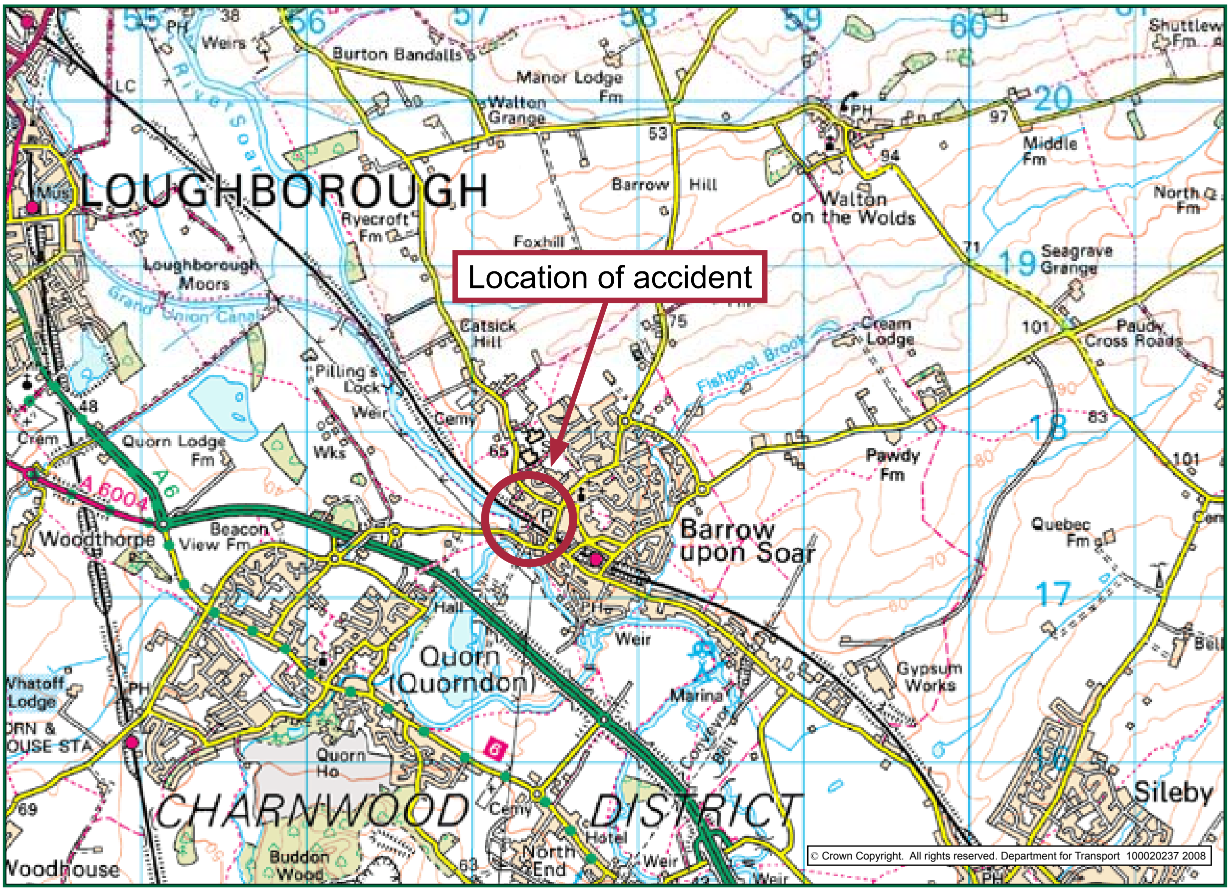

Figure 1: Extract from Ordnance Survey map showing location of accident

Immediate cause, causal and contributory factors, underlying causes

8 The immediate cause of the accident was that the train was unable to stop before it hit the debris from the footbridge that had been knocked down by the raised body of the tipper lorry.

9 The causal factor was that the lorry driver forgot to fully lower the body of the lorry because he was distracted from his normal routine by having to unlock the cab passenger door to allow access for the *controller of site safety* (COSS).

10 The lack of effectiveness of the alarm system in the lorry cab indicating that the body was raised was a contributory factor.

11 The underlying factor was the lack of a formal Network Rail process to assess and manage the risks from road vehicle transit operations to and from worksites on their property.

Severity of consequences

12 The cab of the train was severely damaged due to the collision with the debris from the footbridge. The driver of the train, the guard and one of the passengers were taken to hospital. The guard and the passenger were released later that day and the driver early the next morning.

13 The cab of the tipper lorry was also severely damaged; however the driver escaped with no injuries.

14 The COSS was taken to hospital suffering from shock and was released later the same day.

Recommendations

15 Recommendations can be found in paragraph 105. They relate to the following areas:

- review of the adequacy of the arrangements for ensuring safety during road vehicle delivery operations and transit between worksites on Network Rail property;
- train design to mitigate the consequences of derailment; and
- review of arrangements to ensure that correct protections from the rule book (Railway Group Standard GE/RT8000) are used when undertaking work on or near the running line.

The Accident

Summary of the accident

16 At 06:32 hrs on 1 February 2008 train 1L03, the 06:13 hrs Nottingham to Norwich train, travelling at 65 mph (104 km/h) collided with debris from a collapsed footbridge at Barrow upon Soar, Leicestershire.

17 The collision with the debris caused both wheelsets of the leading bogie of the train to derail to the left. The train ran in this condition for 170 metres until it stopped partially under a road overbridge.

18 Shortly before the accident, a tipper lorry that had been delivering ballast to a worksite on Network Rail property using a vehicular access path alongside the running lines, struck a footbridge over the railway and the path to the north of Barrow upon Soar station. This caused the footbridge to collapse onto the path and the main Leicester to Nottingham/Derby railway line.

19 When the COSS for the tipping operation realised that the bridge had collapsed, he contacted the signaller and requested that all trains in the area be brought to a stop. The signaller replaced all *controlled signals* in the area to danger but was unable to stop train 1L03 in time to avoid the collision.

20 Train 1L03, which consisted of a two-car Class 158 diesel multiple unit (158856) sustained significant damage to the cab (Figure 2). All four lines of the railway through Barrow upon Soar were obstructed and a lineside equipment cabin was destroyed. Additionally, the cab of the lorry sustained serious damage (Figure 3).

21 The driver of the train, the guard and one of the passengers were taken to hospital. The guard and the passenger were released later that day and the driver early the next morning. The COSS was taken to hospital suffering from shock and was released later the same day. The driver of the tipper lorry escaped with no injuries.

The parties involved

22 The railway infrastructure is owned and maintained by Network Rail.

23 Train 1L03 was owned by Angel Trains Ltd and operated by East Midlands Trains.

24 Midland Quarry Products were the supplier of the ballast to the worksite, contracted to Network Rail.

25 The tipper lorry was owned and operated by J & G Vestey Haulage who was a franchised haulier to Midland Quarry Products.

Location

26 The accident occurred at 108 miles 75 *chains*, 450 metres north of Barrow upon Soar station. The footbridge was referred to as SPC5 60.

27 At this location the railway consists of four lines. Train 1L03 was travelling on the *up fast line* which has a maximum permissible speed of 110 mph (176 km/h).

Figure 2: View of the train following collision with the footbridge

Figure 3: View of the destroyed cab of the tipper lorry

External circumstances

28 It was dark at the time of the accident and the weather was dry, clear and mild. The weather had no effect on the accident.

Events preceding the accident

29 In October 2007 the *track asset manager* (TAM) identified the need to remove *wet beds* and clean drains on the *down slow line* between 109 miles 230 yards and 109 miles 300 yards. The work was later scheduled to take place on 2 February 2008. The ballast for the job was ordered and planned to be delivered by road on 30 and 31 January and 1 February 2008 between 06:00 hrs and 08:00 hrs each day.

30 A site visit by the *track section manager* (TSM) and the *track production manager* (TPM) identified that traffic on the *down fast line* of the railway would need protecting from any unexpected incursions during the delivery of the ballast, and that protections in accordance with Module T12 of the rule book, 'protecting personnel carrying out activities on the line that do not affect the safety of the line', would provide the required level of protection. An arrangement was made between the TPM and the signalling manager at Leicester signal box that the COSS would telephone the signaller when he required the *T12 protection*.

31 The TPM briefed the COSS on the supervision of the delivery of the ballast and the protection requirements on 29 January 2008.

32 All deliveries were successfully completed on both the 30 and 31 January 2008.

33 Prior to arrival of the first delivery on 1 February 2008, the COSS took a T12 line blockage from 06:02 hrs to 06:32 hrs. He had completed an RT9909 'COSS record of site safety arrangements and briefing form' and an RT3181 T12 line blockage form confirming that he was following the correct procedure. The first delivery was completed successfully.

34 On arrival of the second lorry (the lorry that would later be involved in the accident), the first lorry was still completing its delivery and therefore the driver waited in the car park at the entrance to the site. When the first lorry left the site the COSS briefed the driver of the second lorry, as it was his first visit to the site. He explained where the ballast was to be discharged and that he would highlight hazards as the driver reversed by illuminating them with his head torch; the lorry had to reverse 300 metres alongside the track. Figure 4 shows the layout of the site and key locations following the accident.

Events during the accident

35 On reaching the location where the ballast was to be discharged, the driver raised the body of the tipper lorry and watched the ballast discharge via the CCTV in the lorry's cab. While the discharge was in progress he moved the lorry forwards two to three metres to prevent the ballast spilling over onto the railway.

36 On completion of the discharge he lowered the body of the lorry until it was only elevated by the last of the four hydraulic rams in the body lifting mechanism. He alighted and cleared any remaining stone that might obstruct the tailgate closing at the back of the lorry, as was his normal practice. At this time the COSS requested a lift back to his vehicle which was parked just north of the footbridge, 250 metres from the discharge site and stated that he would sign the paperwork while in the lorry's cab.

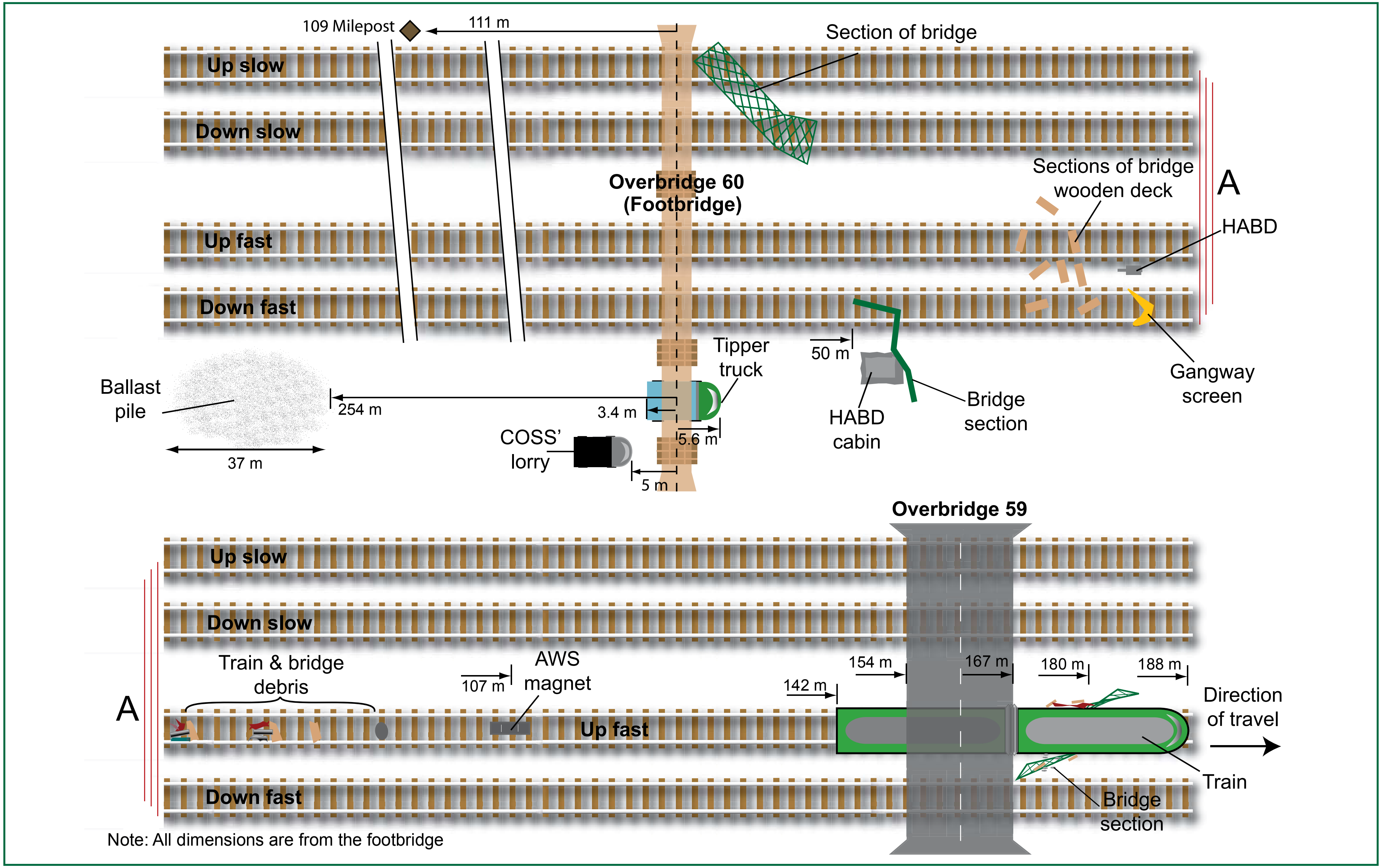

Figure 4: Plan of the accident site showing key locations

37 The driver pulled himself into the cab by his right arm and, instead of operating the controls to finally lower the body of the lorry with his left hand, as was his usual practice, he leant over and unlocked the passenger side door.

38 The COSS entered the cab, signed the paperwork and telephoned the signaller to hand back the T12 protection. By the completion of the call, they had arrived at the COSS's vehicle and he alighted. He went to his van as the lorry driver put the lorry into second gear and started to move off. The COSS turned and realised that the body of the lorry was still raised and started to run after the lorry, but before he could make much progress the hydraulic ram on the lorry collided with the bridge knocking it off its pillars and onto the railway track and on top of the lorry.

39 The COSS went to the lorry driver to check how he was and then made an emergency call to the signaller at Leicester signal box. While he was explaining what had happened and requesting an all line blockage, he saw train 1L03 approaching. He shook his head-torch vigorously to alert the driver to stop the train. The driver sounded the horn in response to seeing the light and then appreciated that it was an emergency signal and applied the emergency brake.

40 When the train hit the debris from the bridge both wheelsets of the leading bogie of the train were derailed to the left, caused by riding over the bridge sections on the track. The derailed train ran for 170 metres until it came to rest partially under a road overbridge.

Consequences of the accident

41 The driver of the train, the guard and one of the passengers were taken to hospital. The guard and the passenger were released later that day and the driver early the next morning.

42 The cab of the tipper lorry was also severely damaged, however the driver escaped with no injuries.

43 The COSS was also taken to hospital suffering from shock and was released later the same day.

44 The cab of the train was severely damaged due to the collision with the debris from the footbridge. The trailing vehicle was not damaged. The train did not collide with any other structures or trains. All traffic was stopped in the area by a *National Radio Network* (NRN) emergency broadcast from the *Integrated Control Centre* (ICC) in Birmingham.

45 The derailed wheelsets caused damage to *rail fastenings*, *sleepers*, the *automatic warning system* (AWS) magnet relating to LR494 signal on the up fast line and *a hot axle box detector* (HABD). The debris from the bridge affected all four lines and destroyed a lineside HABD equipment cabin.

Events following the accident

46 During the emergency call made by the COSS, the signaller instructed his colleague to arrange an NRN emergency broadcast call to stop train 1L03, via the ICC. Additionally, the COSS requested that the signaller contact the emergency services.

47 On completion of the emergency call, the COSS called the emergency services directly, requesting all services attend the site of the accident. Following the instructions of the emergency services operator, the COSS went to the train to check on the passengers and crew; he then returned to the lorry to check on the driver.

48 Following the collision the guard walked to the front of the train checking passengers and found the driver trapped in the cab. He contacted the signaller using the *signal post telephone* on signal LR494, approximately 5 minutes after the accident. He had to use the signal post telephone because the NRN radio in the driving cab was damaged by the collision and he had lost his mobile phone during the accident. The signaller informed him that all lines were blocked and that there was no need for him to put down any additional protection and to go and wait with the driver.

The Investigation

Investigation process

49 The investigation covered the following elements:

- the sequence of events leading to the lorry striking the footbridge, including the planning of the work and the identification of hazards at the worksite;
- the actions taken to protect the railway after the bridge collapsed; and
- the crashworthiness and post-derailment performance of the Class 158 after it collided with the footbridge debris.

Sources of evidence

50 The primary sources of evidence were:

- voice recordings from the Leicester signal box;
- interviews;
- the data recorders from train 1L03;
- examination of unit 158856;
- Vehicle and Operator Services Agency (VOSA) reports on the state of the lorry; and
- bridge drawings and inspection report.

Key Information

The planning of the delivery operation

51 The ballast was required to repair a wet bed on the down slow line, due to be undertaken on 2 February 2008. The TPM decided that the ballast would be delivered by road and dropped by the access road adjacent to, and clear of, the down fast line. Network Rail's National Delivery Services (NDS) ordered the ballast and identified Midland Quarry Products as the appropriate approved supplier.

52 The TSM and TPM visited the site to undertake a site risk assessment to identify any hazards to the delivery operation. The only risks identified were trackside relay boxes and the proximity to the down fast line. It was decided that, as a precaution, any risk to trains on the down fast line would be managed by taking T12 blockages of it during the deliveries.

53 Footbridge SPC5 60 was not identified as a hazard because it was more than 250 metres from the tipping site.

54 Delivery of the ballast was arranged for 30 and 31 January and 1 February 2008 between 06:00 hrs and 08:00 hrs. The timing was chosen to avoid congestion in the old station car park through which access was required. Midland Quarry Products were advised of the delivery address and that the site could not accommodate articulated lorries, and that there was a narrow entrance and no turning circle. No other site specific information or hazards were identified by Network Rail. Midland Quarry Products passed the same information onto J & G Vesty Haulage. There is a generally held belief within NDS that any specific hazards would be communicated to the haulier by the nominated Network Rail representative on site, the COSS in this case. There is no formal procedure covering road deliveries, other than documentation such as the order forms.

55 Because the haulier was unable to give precise times for the deliveries, the T12 blockages could not be pre-booked through the *Green Zone Access Manager*. Instead the TPM visited the signalling manager at Leicester signal box and agreed that the COSS would telephone the signaller when he required the T12 protection. A note to this effect was left on the panel in the signal box.

56 The COSS was verbally briefed by the TPM on 29 January 2008. His duties were to take the T12 blockages, inform the lorry drivers what was required of them, ensure that the lorries did not hit the relay boxes (paragraph 52), show the drivers where to tip, and then escort them off site. He was given no responsibility for acting as a *banksman*; Network Rail does not have such a policy or related competence.

57 The COSS had completed a 'Record of site safety arrangements and briefing form' and the T12 line blockage form (paragraph 33). Because it was not possible to pre-book *green zones* (such as T12 protections) when the exact times were not known in advance (paragraph 55), the first form indicated that the work would be undertaken *red zone* – this was not the intention, only a limitation of the administrative system. The extract from the *National Hazard Directory* attached to the form stated that red zone working was prohibited at this site due to restricted warning times. The only specific hazards identified were slips and trips at the access location.

The lorry

58 The tipper lorry had satisfactorily undergone a safety inspection carried out by the operator's maintenance contractor on 24 January 2008.

59 The VOSA post-accident investigation reports concluded that the vehicle appeared well maintained and that there was no evidence that the vehicle was in an unroadworthy condition prior to the collision.

60 The Road Vehicles (Construction and Use) Regulations (1986) mandate that there is a visual alarm in the cab of tipper lorries when the body is raised. Some suppliers of tipper mechanisms also provide audible alarms in addition to the visual alarms, but there is no legal requirement for this. Indeed, for applications where tipper lorries are required to move forward while discharging a load an audible alarm would not be effective because the driver would become used to hearing it.

61 The lorry was fitted with a visual alarm system in the cab, compliant with the Road Vehicles (Construction and Use) Regulations, indicating when the body was raised. The VOSA report identified that this was inoperative after the accident due to impact damage to a relay in the associated fuse board. When supplied with an alternative source of voltage from the fuse board the warning light functioned correctly. It is probable the warning light was functioning correctly before the accident.

The footbridge

62 Footbridge SPC5 60 was the subject of a detailed examination on 14 August 2005. With the exception of vegetation, the bridge was considered to be in a fair condition requiring some maintenance, none relevant to the accident. A site visit made on 15 November 2007 identified that the bridge was generally in a fair to good condition, and concluded that it was fit for purpose, although it required some painting.

63 The height of the underside of the footbridge was 5.1 metres, taken from the original drawings. This would not classify the footbridge as a low bridge; on the public highway; the limit is 5.03 metres.

The train

64 The Class 158 was built from 1989-92 by British Rail Engineering Ltd (BREL) and features an aluminium alloy bodyshell.

65 There was no evidence to suggest that the train or the way in which it was being driven contributed to the accident.

Damage to the vehicle body

66 The leading vehicle (158856) suffered severe damage to its body end structure as a direct result of the impact with the detached bridge section. The damage extended back to the drivers window and included the drivers cab and console as shown in Figure 5.

67 Indentations to the flexible gangway indicated that it had been struck, just above the floor level, by a 160 mm section bridge girder at an angle of 10 degrees to the horizontal.

Figure 5: Damage to the leading end of vehicle 1

Figure 6: Damage to superstructure (fairings and flexible gangway removed)

68 The principal structural members available to resist an impact above floor level were the two gangway pillars, which were located behind the uprights of the flexible gangway and the two corner pillars. Each of these pillars were connected to the underframe at the lower end and to a horizontal collision beam at the upper end. There are additional connections from the corner pillars to the bodyside.

69 Both gangway pillars sheared just above their welded attachments to the floor structure (Figure 6) and were pushed back 645 mm on the right-hand side and 635 mm on the left-hand side. Both pillars pivoted about their upper welded attachment to the collision beam and were inclined backwards 21 degrees to the vertical. The upper welded attachments to the collision beam fractured at the welds (Figure 6).

70 The deformation of the gangway pillars caused the driver's console to be pushed back towards the driver. Pipework located behind a fascia panel on the console came to within 130 mm of the forward edge of the seat. The extent of the intrusion on the left-hand side was just sufficient to trap the driver in his seat without causing serious injury. However on the right-hand side of the cab, there was no remaining survival space.

71 There was no damage to the interior of the passenger compartment.

72 The steel *obstacle deflector* remained vertical, although the structure was slightly damaged with areas of localised permanent deformation, indicating the deflector had been subject to loading during the impact. The glass reinforced plastic moulding in front of the obstacle deflector was damaged in several places, particularly along its bottom edge.

<u>Leading bogie</u>

73 The steel *lifeguards* attached to the leading bogie frame in front of both wheels (Figure 7) had been bent backwards permanently a distance of 240 mm into contact with the wheels.

Figure 7: Deformation of the lifeguard

74 Both wheelsets suffered damage to the wheel flanges from running derailed. In addition the outboard edges of the left-hand axle mounted brake discs were damaged around their circumference where they had come into contact with the left-hand running rail while the leading bogie was running derailed.

Key timings relating to the accident

75 The key elements in the timeline leading to the accident are presented in Figure 8.

76 The signal on the up fast line immediately to the north of the accident site was LR502, an *automatic signal*. Train 1L03 passed this signal at 06:31:23 hrs. The previous controlled signal on the up fast line which the signaller could replace to danger was LR516, located north of Loughborough station. The train had stopped at this station at 06:28:23 hrs.

77 The COSS called the signaller to hand back the T12 protection at 06:30:29 hrs. This call ended at 06:31:06 hrs. He was in the cab of the lorry for the duration of this call.

78 The COSS made the emergency call to the signaller at 06:32:08 hrs. He was on the access road when he made this call. The train horn can be heard 3 seconds into this call, followed by the sound of the train hitting the bridge 9 seconds later (06:32:20 hrs), and the HABD alarm in the signal box 3 seconds after that.

79 The train brakes were applied 2 seconds after the horn was sounded.

80 Leicester signal box called the ICC to request an NRN emergency broadcast call at 06:33:25 hrs, this was answered 11 seconds later and the call finished 27 seconds after that. The actual NRN emergency broadcast call was made at 06:34:16 hrs.

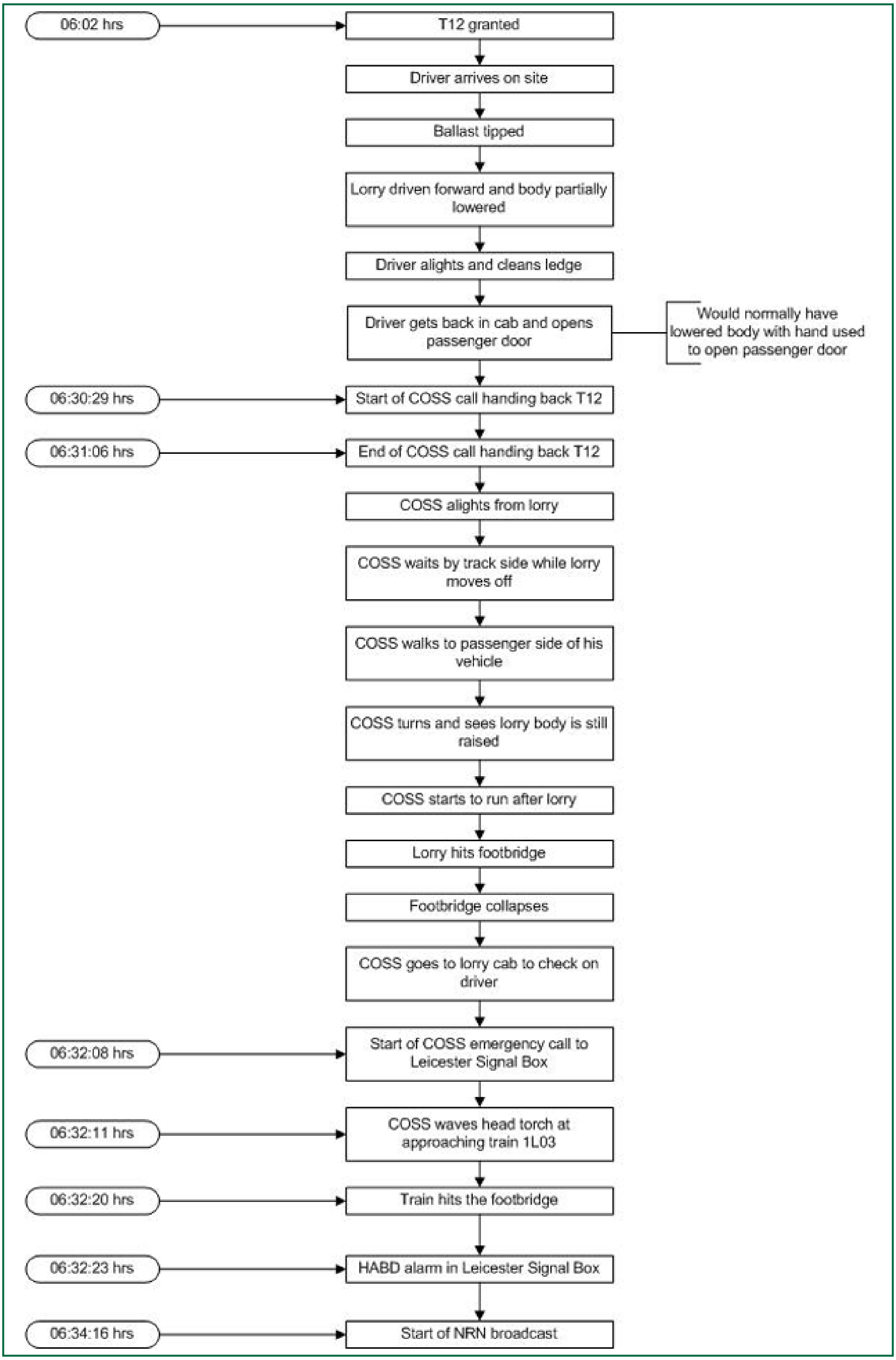

Figure 8: Diagram showing accident timeline

Previous occurrences of a similar character

81 A review of incidents where overbridges have been struck by vehicles operating on Network Rail property where debris had been deposited on or near the track showed that only one such incident had occurred in the last five years and that this was due to a road-rail machine and took place in a possession.

Analysis

Identification of the immediate cause

82 The immediate cause of the accident was that the train was unable to stop before it hit the footbridge that had been knocked down by the raised body of the tipper lorry.

Identification of causal and contributory factors

83 The lorry driver forgot to fully lower the body of his vehicle because he was distracted from his normal routine on entering his cab by having to unlock the cab passenger door to allow the COSS to gain access. This is the causal factor for the accident.

84 The design of the visual alarm in the cab of the lorry was such that it could easily be overlooked. The ineffectiveness of the alarm system provided was a contributory factor to the accident.

The planning

85 The site risk assessment identified that the only protection required was for traffic to be blocked on the down fast line during the tipping operation.

86 There was no consideration of ensuring safety for the haulier's movements from entry onto the Network Rail site to the location of the tipping, other than an informal arrangement between the COSS and the lorry driver that the former should identify any hazards as the lorry was reversed. Network Rail does not have any policy or competency for the provision of a 'banksman'. There was an inconsistency between the belief generally held within NDS that the nominated Network Rail representative on site was responsible for identifying specific site hazards to the haulier, and the COSS' sole duties to make sure workgroups are not put in danger by train movements and that, on completion of work, the line is clear for trains to proceed (Rule Book Sections T6 and T12).

87 Although the lorry driver believed that the COSS was acting as his 'banksman', he never asked the COSS for confirmation of the state or position of his vehicle body.

88 Witness evidence from NDS and those involved in the accident indicates that Network Rail does not have a process to assess and manage the risks from road vehicle transit operations to and from the worksites on their property. This is an underlying factor to the accident.

Actions after lorry collided with bridge

89 The total time from completion of the T12 protection hand back call (paragraph 77) to the start of the emergency call (paragraph 78) was 1:02 minutes. Considering the time that would have elapsed prior to the lorry hitting the bridge, the RAIB is satisfied that there are no issues relating to the COSS's speed of response and that it did not affected the outcome of the accident.

90 The train passed the last signal (an automatic signal) north of the footbridge at 06:31:23 hrs, ie 17 seconds after the COSS completed the T12 protection handback call. It is unlikely that the lorry had hit the bridge at this time and therefore even if the COSS had reacted faster, no action could have been taken to stop train 1L03 at the last signal before the footbridge, even if it had been able to be controlled from Leicester signal box.

91 The NRN emergency broadcast was started at 06:34:16 hrs, ie 2:08 minutes after the start of the COSS's emergency call. By this time the accident had happened. During this time the COSS needed to impart key personal, location and accident details and the signaller needed to call the ICC. The ICC controller had to study maps to ascertain the appropriate radio base station and then make the NRN emergency broadcast call. The RAIB is satisfied that there are no issues relating to the time taken to complete these tasks, given the complexity of the system to be followed, and that the time did not affected the outcome of the accident.

92 Additionally, the train hit the bridge at 06:32:20 hrs, ie 1:14 minutes after the COSS completed the T12 handback call. The train would have taken circa 30 seconds to stop on receipt of the NRN emergency broadcast. Even if the actions had been undertaken faster, it is highly unlikely that the NRN broadcast could have been made in time to prevent the accident. The introduction of *global system for mobile communications – railway* (GSM-R) radio system, scheduled for nationwide completion in 2013, will enable signallers to call trains directly and reduce any associated delay, although this would not have had any effect on this accident.

Performance of the train

Crashworthiness performance

93 When the Class 158 was designed in the late 1980s, there were no mandatory crashworthiness specifications for energy absorption or controlled structural deformation and consequently the Class 158 does not have any specific crashworthy features. However, its bodyshell structure was designed to be compliant with mandatory 'proof' and fatigue strength requirements specified by British Rail. The proof requirements included that the body end structure must be able to withstand a static load of 400 kN applied 350 mm above coupler level (or 150 mm above the structural floor level if higher) and 300 kN applied above this height, without permanent deformation.

94 The loading conditions at Barrow upon Soar were similar to those in a laboratory test undertaken on a Class 158 cab in 1991[1] to determine its collapse characteristics and energy absorption in a simulated *overriding collision*. The deformation mode exhibited in the accident was similar to that observed in the test. In particular the pillars were bent back in a similar manner to the laboratory test and the failures were predominantly at welded joints. Although the loads for the collision at Barrow upon Soar are unknown the similarity of the deformation modes indicate that the accident cab is likely to have been built to design.

[1] British Rail Research report RR VST 002 – Crushing Tests on Class 158 Cabs

95 In the laboratory test the cab resisted a force of approximately 800 kN before physical intrusion into the cab space commenced. Once the strength of a structure has been exceeded, its energy absorption characteristics determine the amount of intrusion into the cab space. The laboratory tests revealed that, over an intrusion distance of one metre the overall energy absorption was of 0.56 MJ. This is slightly above the minimum value specified in the current crashworthiness specification for the override case (0.5 MJ). Therefore, both in terms of static strength and energy absorption, the Class 158 cab structure would not have been lacking in the protection afforded to the driver, compared to the minimum requirements of current crashworthiness specifications. However, cab structures of more modern rolling stock, which often exceed the minimum specifications in similar laboratory tests, are likely to have performed better.

Post derailment behaviour of the train

96 Damage observed on the obstacle deflector and both lifeguards indicate that they had all been active in resisting bridge debris directly impacting the bogie and entering the wheel/rail interface. Despite this, both wheelsets of the leading bogie were lifted into derailment by the bridge debris.

97 It was observed that, following derailment, the leading bogie had run with the running rail between the wheel and left-hand brake discs on each wheelset. When running in a derailed condition with the wheels running on the sleeper ends, the Class 158 brake discs extend below the head of the running rail. The derailed bogie was therefore effectively guided by the running rails and did not deviate more than about 200 mm from the track. The guiding action provided by the brake discs probably prevented a secondary collision with a road bridge 34 metres behind the point where the train came to rest.

Conclusions

Immediate cause

98 The immediate cause of the accident was that the train was unable to stop before it hit the footbridge that had been knocked down by the elevated body of the tipper lorry.

Causal factors

99 The causal factor was that the lorry driver forgot to fully lower the body of the lorry because he was distracted from his normal routine by having to unlock the passenger door of his cab to allow access for the COSS (**Recommendation 1**).

Contributory factors

100 The lack of effectiveness of the alarm system in the lorry cab indicating that the body was raised was a contributory factor (**Recommendation 1**).

Underlying causes

101 The underlying cause was the lack of a formal Network Rail process to assess and manage the risks from transit operations to and from the worksites on their property (**Recommendation 2**).

Other factors affecting the consequences

102 The guiding action provided by the brake discs limited the lateral deviation of the derailed bogie and probably prevented a secondary collision with a road bridge.

103 The safety benefit of bogie mounted equipment acting to prevent significant lateral deviation of a derailed bogie has been noted by the RAIB in other derailments at Moy on 26 November 2005 (Reference 2)[2] and Duncraig on 15 January 2007. The RAIB has previously made a recommendation that the Rail Safety and Standards Board (RSSB) should investigate the practicability of design elements on the bogie that limit the degree of deviation from the track following derailments. The RSSB has rejected this recommendation on the grounds that any resultant solution may increase the risk in the case of a derailment at or in the vicinity of points or crossings. In this accident the degree of derailment was limited by existing equipment and therefore the RAIB believes that this is an area which needs to be reviewed in view of the safety lessons that could be learned for future rolling stock design (**Recommendation 3**).

[2] Derailment near Moy, Inverness-shire on 26 November 2005, RAIB report 22/2006, November 2006

Additional observations

104 The rule book states that T12 protection arrangements are only to be used for ‘protecting personnel carrying out activities on the line that do not affect the safety of the line’ and must not be used if the activity ‘affects, or might affect, the safety of trains’. Protection was required for the work being undertaken at Barrow upon Soar due to the risk of ballast spilling onto the railway line; the use of a T12 protection was therefore contrary to the rule book. The correct protection was a T2 protection, which required using a track circuit operating device, disconnection of the signalling system or a hand-signaller (**Recommendation 4**).

Recommendations

105 The following safety recommendations are made[3]:

Recommendations to address causal and contributory factors

1 Network Rail should assess the risks to the safety of workers and the infrastructure which may arise from the transit and operation of road vehicles onto land near the running line, for the purpose of delivering materials. This should include consideration of:

a. the alarm systems that Network Rail require to be fitted to tipper lorries delivering to their sites indicating when the body is raised (paragraph 100); and

b. how road vehicles are to be controlled when operating on Network Rail land near the running line (paragraph 87).

2 Network Rail should then revise and implement procedures to manage those risks including emphasising the appropriate means of protection of the line (paragraph 101).

Recommendations to address other matters observed during the investigation

3 RSSB should consider the practicability of design elements on the bogie that limit the degree of deviation from the track following derailments and, where appropriate, proposals should be made to the relevant bodies to make changes to appropriate standards (paragraph 103).

4 Network Rail should review the arrangements for ensuring that their staff and contractors understand the differences between the purposes of T2 and T12 protections and the applicability of each (paragraph 104).

[3] 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 Regulation to enable them to carry out their 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 167 to 171) can be found on RAIB's web site at www.raib.gov.uk.

Appendices

Appendix A - Glossary of abbreviations and acronyms

AWS	Automatic Warning System
CCTV	Closed Circuit Television
COSS	Controller Of Site Safety
GSM-R	Global System for Mobile Communications – Railway
HABD	Hot Axle Box Detector
ICC	Integrated Control Centre
NDS	National Delivery Service
NRN	National Radio Network
TAM	Track Asset Manager
TPM	Track Production Manager
TSM	Track Section Manager
VOSA	Vehicle and Operator Services Agency

Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (*), have been taken from Ellis' British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com

Automatic signal	A colour light signal that changes its aspect automatically based on occupation and clearance of certain track circuits beyond it without intervention by a signaller.*
Automatic warning system	A fail-safe arrangement of permanent magnets and electro-magnets placed in the four-foot that convey information about the aspect of the associated signal to the train driver.*
Banksman	A skilled person who directs the operation of a vehicle from a point near the vehicle.
Chain	A unit of length, being 66 feet or 22 yards. There are 80 chains in one standard mile. Chains are the standard subdivision of miles used in the national railway network.*
Controlled signal	A signal which can be made to display a stop aspect by a signal box or ground frame during normal operations.*
Controller of site safety	A safety critical qualification demonstrating the holder's competency to arrange a safe system of work, ie protecting staff working on the line from approaching trains.*
Down fast line	The name generally given to the nominally more important of the two lines used by trains travelling in the direction away from London (northbound).
Down slow line	The name generally given to the nominally less important of the two lines used by trains travelling in the direction away from London (northbound).
Green zone	A site of work on or near the line within which there are no train movements.
Green zone access manager	An organisation within Network Rail responsible for processing requests for T1, T2 and T12 opportunities.*
Hot axle box detector	A device comprising axle counters, processing equipment and infra-red detectors mounted close to the rail which monitor passing trains and alert the controlling signal box if they sense an overheating or hot axle box. If a train activates a detector it is brought safety to a stand for examination or remedial action.*
Integrated Control Centre	The co-location of Network Rail and train operating control centres.
Lifeguards	Heavy metal brackets fitted vertically immediately in front of the leading end wheels of a rail vehicle, one over each rail. Their purpose is to deflect small objects away from the path of the wheels.*
National hazard directory	A database maintained by Network Rail which contains details of the health, safety and environmental hazards known to exist on Network Rail controlled infrastructure.

National Radio Network	A scheme developed by British Rail to provide a two way radiotelephone service for the National Railway Network. It was based on Band III VHF technology and following the Clapham Accident all driving cabs were equipped with the radios.*
Obstacle deflector	A device fitted to the front of trains to encourage any large obstacles on the track to move sideways in the event of a collision.
Overriding collision	A collision where the striking object impact and penetrates the front of a train above its structural underframe; the striking object may be another train.
Rail fastenings	Any device used to secure rails into chairs, onto baseplates or directly to sleepers or bearers.*
Red zone	A site of work on or near the line, which is not protected from train movements.
Signal post telephone	A telephone located on or near a signal that allows a driver or other member of staff to communicate only with the controlling signal box.*
Sleeper	A beam made of wood, reinforced concrete or steel placed at regular intervals at right angles to and under the rails. Their purpose is to support the rails and to ensure that the correct gauge is maintained between rails.*
T12 protection	A method of blocking the line for periods of less than 30 minutes where the safety of trains will not be affected.
Track asset manager	A member of the permanent way staff at supervisory level responsible for track inspection and safety of the line.
Track production manager	A member of the permanent way staff at supervisory level responsible for track maintenance.
Track section manager	A member of the permanent way staff to whom the TPM and TAM report, with responsibility for safety of the line.
Up fast line	The name generally given to the nominally more important of the two lines used by trains travelling in the direction of London (southbound).
Wet bed	An area of ballast contaminated with slurry.

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