RAIB

Rail Accident Investigation Branch

Rail Accident Report

Collision between a stoneblower and ballast regulator near Arley, Warwickshire 10 August 2012

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August 2013

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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Collision between a stoneblower and ballast regulator near Arley, Warwickshire 10 August 2012

Contents

Summary

At around 04:21 hrs on Friday, 10 August 2012, an engineering machine used for maintaining track, known as a stoneblower, collided with a stationary engineering machine, at approximately 22 mph (35 km/h), near Arley, in Warwickshire. A member of staff on the stoneblower was treated in hospital for a minor injury. The stoneblower was badly damaged and deemed to be beyond economic repair.

The investigation found that when the stoneblower driver sighted the stationary machine he was driving too fast to avoid a collision. The driver's speed was probably influenced by a number of factors which led him to expect that the line was clear. It is also possible that the driver was distracted immediately prior to the collision which caused him to be driving faster than he realised.

If planned arrangements for the engineering work had been followed the collision would not have occurred.

An underlying cause of this accident is the tendency of long worksites, in the absence of controls to keep engineering trains (including machines) apart, to increase the risk of collision.

Although not a factor in this accident, it is observed that, for driving at night, the 40 mph (64 km/h) maximum speed of travel permitted in engineering worksites is incompatible with the braking and headlight capabilities of the type of engineering machine involved in the collision. The report observes a number of non-compliances with railway industry rules and company procedures during the management of the engineering work. There is also an observation on the difficulties of maintaining the necessary discipline in the driving cab, where mobile telephones are used for communications, to avoid distracting the driver.

The RAIB has made three recommendations to Network Rail. As part of its planned review of the management of engineering work, Network Rail should undertake a fundamental review of the fitness for purpose of the current arrangements and is pointed to a number of areas for potential inclusion in the review. Actions arising from the review should then be implemented. Measures to ensure that train drivers are given all the information they need to make movements safely and to address issues on the use of intermediaries when conveying information to drivers, are also recommended. In addition, Network Rail is recommended to address a recurrence of specific behavioural issues at its Saltley depot, which the RAIB noted in a previous investigation.

Introduction

Preface

1 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.

2 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.

3 The RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of all other investigations, including those carried out by the safety authority or railway industry.

Key definitions

4 All dimensions in this report are given in metric units, except speed and locations which are given in imperial units, in accordance with normal railway practice. Where appropriate the equivalent metric value is also given.

5 All mileages in this report are measured from a zero datum at Derby for the Derby to Birmingham line, or from a zero datum at Whitacre Junction, where the line from Nuneaton joins the Derby to Birmingham line.

6 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report). These are explained in appendices A and B.

The accident

Summary of the accident

7 At around 04:21 hrs on Friday, 10 August 2012, a collision occurred between two *on-track machines* on the *Down* Arley line, between Whitacre Junction and Nuneaton (figures 1 and 2). The machines were a *stoneblower* and an *automated finishing machine,* (often referred to as a regulator, the reference used in the remainder of this report).

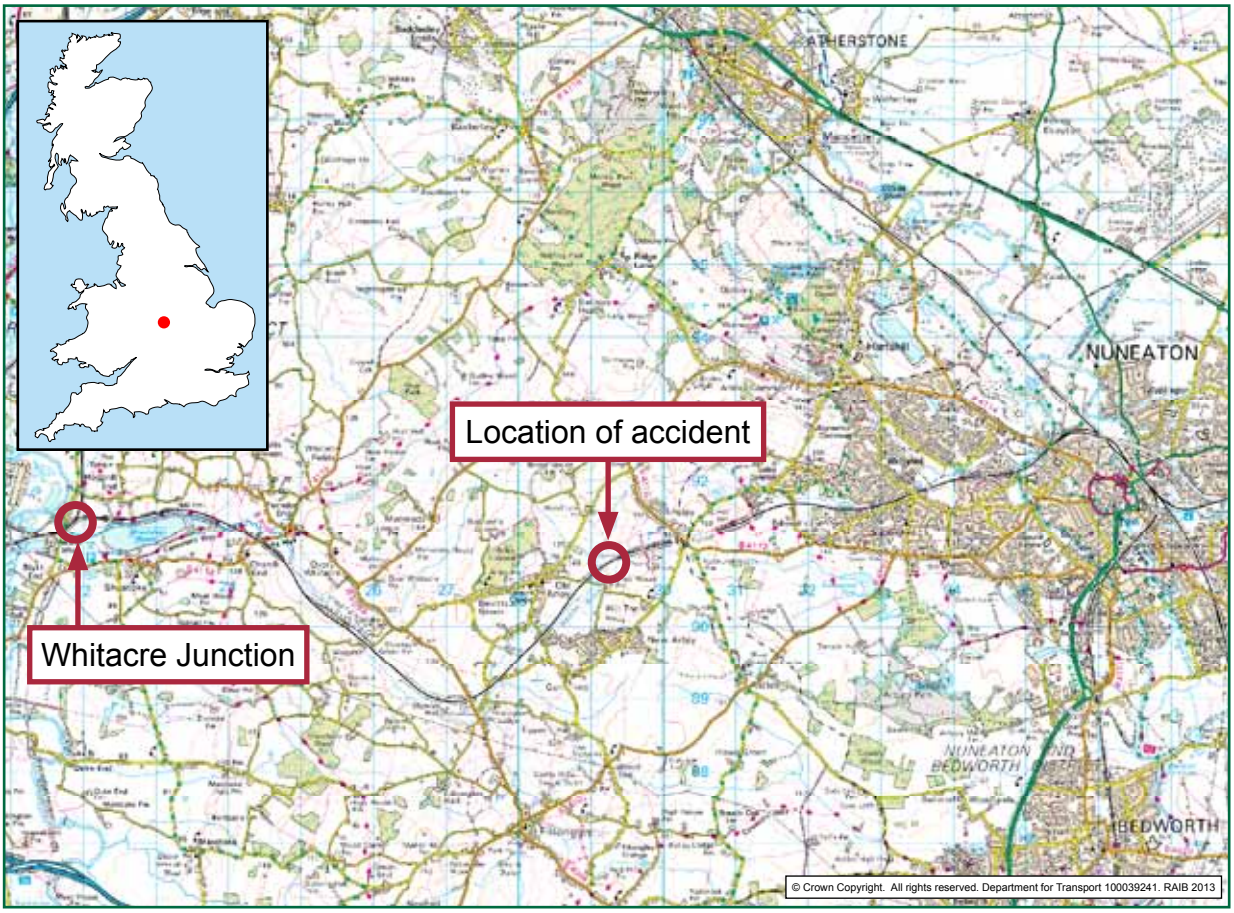

Figure 1: Extract from Ordnance Survey map showing location of accident

8 The stoneblower ran into the stationary regulator at approximately 22 mph (35 km/h), pushing the regulator forward by about 10 metres.

9 None of the four people on the regulator or the three people on the stoneblower was seriously injured. One person was treated in hospital for a minor injury but was not detained.

10 The stoneblower overrode the buffers of the regulator (figure 3) and the trailing wheels of its leading *bogie* were derailed. The stoneblower suffered significant damage to its underframe and was deemed beyond economic repair by its owner, Network Rail.

11 The rear cab of the regulator was deformed and partially displaced from its mountings (figure 3). The regulator was subsequently repaired and recommissioned for service.

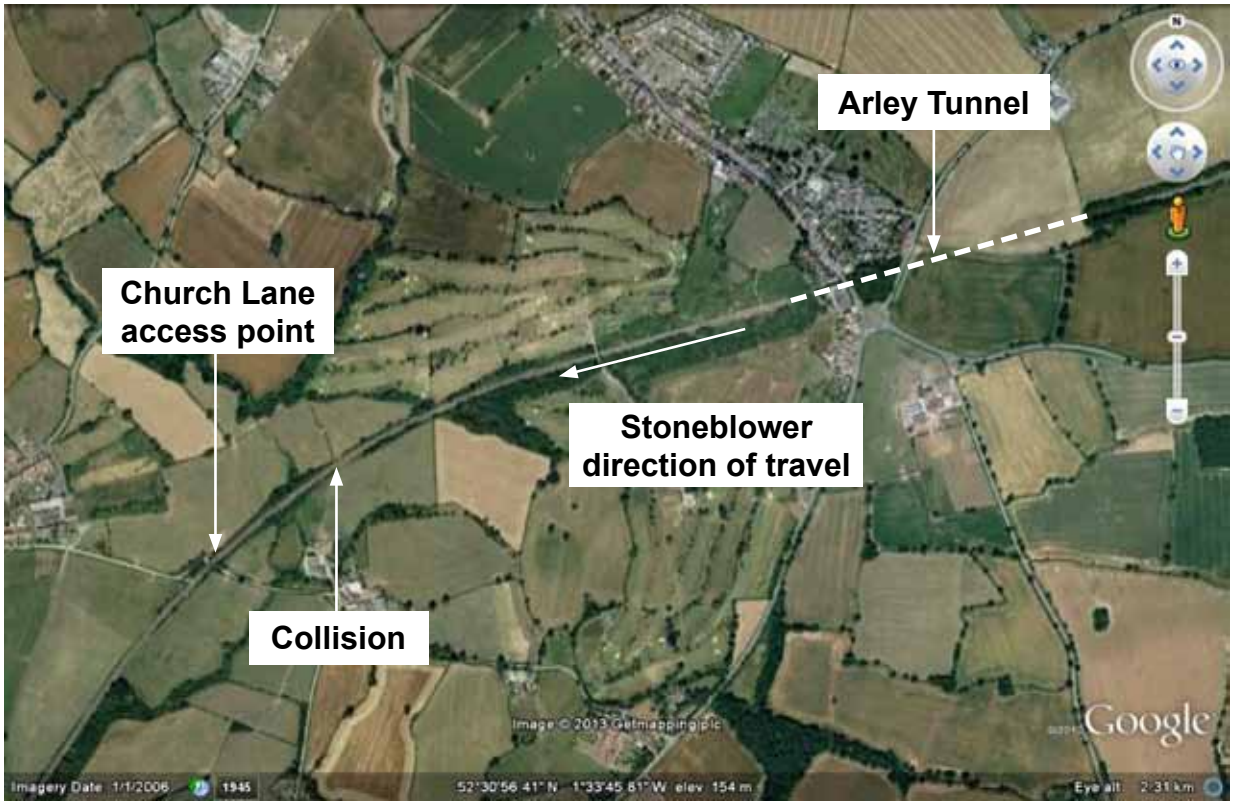

Figure 2: Google earth map showing location of collision

Figure 3: Damage to stoneblower and regulator caused by the collision

12 The line between Whitacre Junction and Nuneaton was closed to traffic until approximately 18:05 hrs on 10 August. There was minimal damage to the track.

Context

Location

13 The collision occurred on the Down Arley line at around 5 miles 55 chains, approximately 1 km west of the Arley tunnel (figure 4). The railway at that location comprises two tracks and has a maximum linespeed of 70 mph (113 km/h). The down line from Nuneaton follows a rising gradient of 1:120 and 1:135 and changes to a falling gradient of 1:125 approximately 300 metres before the point of collision. The collision occurred on a left-hand curve in the track (viewed facing the direction of travel).

Circumstances

14 The *Up* and Down Arley lines were under *possession* for engineering work planned by Network Rail, which meant that normal train services were not running. The stoneblower and regulator were within an area of the possession, known as a *worksite* (figure 4).

15 The possession was due to commence on Friday 10 August at 00.30 hrs and end at 05:30 hrs.

16 Mobile telephones were used for all communications by those managing and working in the possession. This is accepted custom and practice for on-track machine staff.

Organisations involved

17 Network Rail owns and maintains the railway infrastructure. Its Infrastructure Maintenance Delivery Unit based at Saltley depot was responsible for the maintenance of the Arley lines. Network Rail carried out the possession planning processes, and managed the logistics for getting the stoneblower and regulator to and from the possession. The stoneblower, one of a fleet of stoneblowers used on Network Rail's infrastructure, was owned by Network Rail.

18 Harsco Rail operated and maintained the stoneblower under a contract with Network Rail. Harsco Rail employed the two members of the stoneblower crew.

19 Swietelsky Babcock Rail owned, maintained and operated the regulator, which it supplied to Network Rail under a contract. Swietelsky Babcock Rail employed the three members of the regulator staff.

20 Network Rail, Harsco Rail and Swietelsky Babcock Rail freely co-operated with the investigation.

Machines involved

21 The stoneblower, machine number DR80212, was manufactured by Pandrol and Jackson, and entered service in 2000. It was the last of a series of 12 machines of its type to be built. The type had originally undergone a process of assessment and testing by an independent body, known as 'engineering acceptance', in 1996 and a certificate was issued to confirm its compliance with mandatory industry standards for use on the rail network.

22 The stoneblower was approximately 32 metres long, over three two-axle bogies. It had a tare weight of 92 tonnes and a fully laden weight of 113 tonnes. Its maximum design speed was 60 mph (97 km/h).

23 The regulator, an AFM 2000 RT machine, number DR77002, was manufactured in 2006 by Plasser and Theurer. It is approximately 47 metres long over five two-axle bogies. It has a tare weight of 108 tonnes and capacity to carry up to 18 tonnes of ballast.

Staff involved

24 The driver of the stoneblower was initially trained as a driver in 2005. In December 2011 he had undergone a routine two-yearly assessment of his driving and operation of a stoneblower and had been assessed as fully competent. His medical certificate of suitability and fitness to drive trains was valid until February 2015.

25 The stoneblower driver had not been involved in any incidents affecting the safety of the line in the previous four years.

26 The driver of the regulator had 28 years experience as an on-track machine driver. His last two-yearly assessment of on-track machine driving had been carried out by his employer in June 2012 and he had been assessed as fully competent.

27 The *assistant track section manager*, employed in the track maintenance function at Network Rail's Whitacre depot, was nominated by Network Rail as the *person in charge of possession* (PICOP). The PICOP has specific safety-critical duties relating to the supervision of the possession for engineering work (paragraphs 58 and 60 to 62). The assistant track section manager had 22 years experience of working on the railway. He had been qualified by Network Rail as a PICOP since 1997 and a senior PICOP (which qualified him to take control of possessions with multiple train movements) since 1999.

28 The PICOP was also carrying out role of *engineering supervisor* (ES), responsible for managing the safe conduct of work within a worksite. He had been qualified by Network Rail as an ES since 1997.

29 The PICOP ES had undergone his last routine computer-based assessment of his underpinning knowledge for the competence of ES in March 2011. He did not reach the required standard in his assessment but his line manager subsequently deemed him competent to act as an ES (subject to him undertaking certain private study of the Rule Book), as is permitted by Network Rail procedures.

30 The PICOP ES was involved in a previous safety-related incident in March 2010 which was investigated by the RAIB (paragraph 155). The incident involved unauthorised changes being made to a safe system of work which resulted in a passing train being struck by a suspended length of rail.

31 The person undertaking the role of *controller of site safety* for the stoneblower (COSS (stoneblower)) was employed by Network Rail as a track quality supervisor at Saltley depot. He had 10 years experience of working on the railway and had been qualified by Network Rail as a COSS since 2006.

32 As COSS, he was responsible for the safety of the stoneblower crew from other rail traffic, while the stoneblower was in the worksite. The COSS (stoneblower) was acting as a *competent person* for the PICOP ES to relay safety-critical instructions from the PICOP ES to the stoneblower driver.

33 The COSS (stoneblower) was involved in a previous safety-related incident in September 2011 in which he was working as an ES for a worksite. The incident, which was not investigated by the RAIB, involved irregularities in the authorisation for the movement of an on-track machine, which brought the machine in close proximity with a worker on the track (paragraph 158).

34 The COSS for the regulator (COSS (regulator)) was employed by Network Rail as a senior technical officer, at Saltley depot. He had six years railway experience and had been qualified by Network Rail as a COSS since 2010. The COSS (regulator) was also acting as a competent person for the PICOP ES to relay safety-critical instructions to the regulator driver.

35 All of the staff involved were routinely tested for drugs and alcohol after the accident. All tests were found to be clear.

External circumstances

36 The accident occurred on a fine, dry, clear summer night, approximately one hour before sunrise. The area is rural (figure 2) and there were no external lights or noise. The environmental conditions played no part in this occurrence.

Events preceding the accident

37 At 23:30 hrs on Thursday 9 August the stoneblower left the Kings Norton depot in Birmingham and was routed towards Whitacre Junction. On its approach to the junction the stoneblower was signalled into the Down Arley goods loop (figure 4). It arrived at the signal protecting the exit from the loop at 00:10 hrs, where it was held to await the start of the possession.

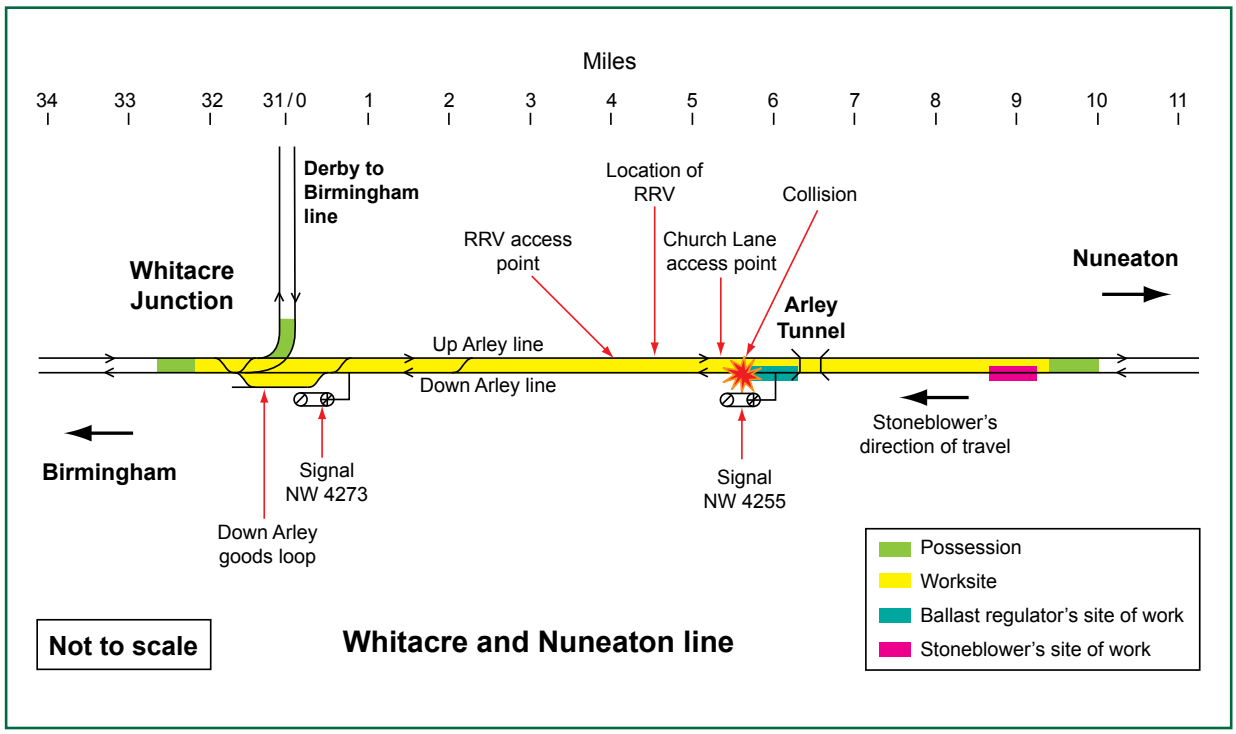

Figure 4: Schematic layout of possession and worksite

38 At 00:06 hrs on Friday 10 August the regulator departed the Washwood Heath depot in Birmingham and on its approach to Whitacre Junction was also signalled[1] into the Down Arley goods loop. It was brought to a stand close behind the stoneblower at 00:37 hrs. The COSS (regulator) joined the regulator while it was standing in the loop.

39 At 00:49 hrs the signaller at the West Midlands Signalling Centre granted the possession to the PICOP ES and at 00:54 hrs the PICOP ES recorded on the relevant form in his documentation for the possession that the worksite had been set up. The Down Arley goods loop was included within the area of possession and the worksite, which meant that the stoneblower and regulator had the possession and worksite established around them.

40 At 00:54 hrs the PICOP ES telephoned the driver of the stoneblower to authorise him to drive on the Down Arley line to his site of work and, on the way, to pick up the COSS (stoneblower) who was waiting at Church Lane access point (figure 4). The regulator driver was then similarly instructed to proceed to his site of work on the Down Arley line (figure 4) and departed shortly after the stoneblower.

41 On arriving at the stoneblower's site of work (figure 4), the COSS (stoneblower) put out *worksite marker boards* at the Nuneaton end of the worksite and the stoneblower commenced work. At some point later, a *road-rail vehicle* (RRV), working on the Up Arley line, took extra ballast to the area where the stoneblower was working by rail.

42 At 04:00 hrs the COSS (stoneblower) telephoned the PICOP ES to advise that the stoneblower's work was complete and was told by the PICOP ES to await further instructions. The stoneblower was then standing at about 9 miles 17 chains (figure 4). Around this time the RRV, which was in the vicinity of the stoneblower, set off on the Up Arley line for an access point around the 4 mile post, where it was to leave the track and revert to being a road vehicle (figure 4).

43 At 04:05 hrs the PICOP ES telephoned the COSS (regulator) for an update on progress and was told that the regulator was nearing the end of its work. The PICOP ES gave instructions to the COSS (regulator) to be passed to the driver, authorising the driver to return on the Down Arley line to signal NW4273, which is the signal protecting the Down Arley goods loop (figure 4). The COSS (regulator) stated that the regulator was not ready to depart at that stage because it had to be cleaned and made ready for travel. He reportedly advised the PICOP ES that he would telephone him when the regulator was ready to travel to the signal. In the meantime, the regulator remained stationary at about 5 miles 55 chains.

44 At 04:09 hrs the PICOP ES telephoned the COSS (stoneblower) with instructions for the driver to proceed to the same signal. He also authorised the COSS (stoneblower) to remove the worksite marker boards he had put out earlier.

45 At 04:14 hrs the stoneblower set off towards signal NW4273, which was approximately 8.5 miles (13.7 km) away. The COSS (stoneblower) was travelling in the rear cab with the other member of stoneblower crew.

[1] The regulator was signalled into the Down Arley goods loop using a subsidiary signal, a type of signal which permits a train to enter a line already occupied by another train.

46 At 04:17 hrs the PICOP ES telephoned the COSS (regulator) with a revised instruction for the driver to continue beyond signal NW4273 to the exit of the worksite. At this stage, the regulator had finished being prepared for travel but had not yet moved. The COSS (regulator) reported that while he did not explicitly advise the PICOP ES that the regulator was still stationary, he did not say anything that would have given the impression that it had begun its journey back towards Whitacre Junction.

47 At 04:19 hrs the PICOP ES telephoned the COSS (stoneblower) and, on learning that the COSS was not with the driver, the PICOP ES rang the driver's mobile phone shortly afterwards to try to speak to him directly.

48 At 04:21 hrs the stoneblower was rounding a left-hand bend in the track. The driver saw tail lights ahead and initially thought they were on the RRV on the up line, but on realising that the tail lights were on the regulator, he applied the emergency brake and sounded the horn.

Events during the accident

49 The regulator driver was in the leading cab (facing the intended direction of travel towards Whitacre Junction) and was in the process of releasing the brakes when he heard a horn being sounded. He put his head out of the driver's window and saw the stoneblower approaching. The collision occurred as he was pulling his head back in. The driver struck his head but was not badly injured.

50 The two other regulator staff members and the COSS (regulator) who were also in the leading cab were thrown forward by the impact and suffered minor injuries.

51 The COSS (stoneblower) and the stoneblower crew member in the trailing cab of the stoneblower were unaware of unfolding events and were thrown from their seats. The COSS (stoneblower) struck his head and suffered a cut to his face.

52 The stoneblower driver was dazed but otherwise uninjured.

Events following the accident

53 The COSS (regulator) reported the accident to the PICOP ES, who notified the signaller and operations control. A request for an ambulance was not made. However, when the regulator driver notified Babcock control in Glasgow of the accident, Babcock control decided to telephone the ambulance services at 04:35 hrs. The COSS (stoneblower) was subsequently taken by ambulance to hospital for treatment but not detained. Others were treated by paramedics on site.

54 The Arley lines remained under possession to allow investigation by the RAIB and by Network Rail, and recovery of the on-track machines. The machines were locked together and had to be separated before the stoneblower could be rerailed. The regulator was later hauled by a locomotive to a holding point at Whitacre. The stoneblower was able to travel under its own power to Nuneaton.

55 The possession was given up at 17:18 hrs and at 18:05 hrs normal traffic was resumed.

The investigation

Sources of evidence

56 The following sources of evidence were used:

- examination of the machines and collision scene;
- witness statements;
- *on-train data recorder* (OTDR) data;
- site photographs and measurements;
- signalling data records;
- recordings of voice communications;
- engineering acceptance records for the stoneblower;
- maintenance records for the stoneblower and regulator;
- post-accident testing results for the stoneblower;
- mobile telephone records;
- possession planning and management records;
- training and assessment records;
- the Rule Book (Railway Group Standard GE/RT8000);
- company standards and procedures;
- a review of similar previous reported occurrences of collisions in worksites; and
- a review of previous RAIB investigations that had relevance to this accident.

Key facts and analysis

Background information

Rule Book requirements[2]

57 The Railway Group standard GE/RT8000 Rule Book applies to possessions and worksites and to train movements within them. Paragraphs 58 to 73 set out requirements relevant to this report:

Demarcation of a possession and worksites within a possession

58 The limits of a possession are normally identified by three detonators[3] placed on the rail and marked by a *possession limit board* placed on the track. The PICOP is required to authorise the removal of the detonators and possession limit board to allow trains to enter the possession. The detonators and possession limit boards are placed at both ends of the possession and on any lines that give access to the area under possession.

59 A worksite within a possession in which an engineering train (which includes an on-track machine) is to work, must be identified at each end by worksite marker boards. These are required by the Rule Book to be placed on the track at least 100 metres from the actual site of work and at least 100 metres from the detonators at the ends of the possession. There can be one or more worksites in a possession, each within its own worksite marker boards.

60 Once a possession has been established, the PICOP authorises the setting up of worksites within it, and once satisfied that the worksite marker boards for each worksite are in place, gives the ES permission for work to start. At the end of work, when a worksite is clear of engineering trains, the PICOP authorises the removal of the worksite marker boards and the worksite is then 'given up'.

Train movements in a possession – duties of the PICOP

61 Train movements within a possession are not made under the control of the signalling system. The PICOP is therefore responsible for authorising train drivers to enter the possession at the detonator protection and for any train movements within areas of the possession that fall outside of worksites.

62 The PICOP is required to instruct the train driver to make each movement 'at caution' (paragraph 73) and to be prepared to stop within the distance that can be seen to be clear[4]. The PICOP is also required to check that the driver clearly understands the location (such as the mileage point of a worksite marker board) that the movement is to proceed to. The PICOP is only permitted to authorise one movement at a time and must check that any previously authorised movement has come to a stop at the worksite marker board or has passed into the worksite before authorising the movement of another train. The PICOP is not required to give a speed for the movement to the driver.

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[2] Railway Group standard GE/RT8000 Rule Book, published by the RSSB, details the procedures to be used for operating and working on the railway. It is available at www.rssb.co.uk.

[3] Detonators are devices attached to the rail which explode when a train passes over to provide a warning to the driver.

[4] The Rule Book does not specify what is meant by the 'distance seen to be clear', but is taken to mean the extent of track ahead that the driver can see is clear of anything that could obstruct the path of the train. The distance that the driver can see at any time will vary depending on such factors as curvature of the line, weather conditions etc.

Train movements in a possession – duties of a train driver

63 The driver has a duty to reach a clear understanding with the PICOP on what the driver has to do and on how far the movement is to proceed. During the movement the driver must make the movement 'at caution' (paragraph 73) and not exceed 40 mph (64 km/h) at any point.

Train movements in a worksite – duties of the ES

64 The ES is responsible for authorising trains to enter a worksite at the worksite marker boards and for the movement of trains within the worksite.

65 The ES is also required to instruct the driver to make movements 'at caution' (paragraph 73) and be prepared to stop within the distance that the driver can see is clear. The driver must be given the exact location the movement is to proceed to (for example, a signal identified by its number, or fixed point on the infrastructure, such as a bridge), and the ES must check that the driver clearly understands.

66 The Rule Book states that movements within the worksite may run at any speed up to 40 mph (64 km/h) but the actual speed will depend on how far the driver can see to be clear, the distance needed to stop short of an obstruction or handsignal, and the instructions given to the driver by the ES, which must include the maximum speed to make the movement.

67 The Rule Book gives the ES three options for instructing the maximum speed of movements in a worksite:

- 5 mph (8 km/h) where this has been agreed as part of a safe system of work with the COSS for each workgroup working in the worksite;
- 20 mph (32 km/h) where, as part of a safe system of work for a workgroup, the ES has agreed with the COSS that a lookout warning may be used during darkness, poor visibility, or when in or near a tunnel; and
- 40 mph (64 km/h), if neither of the above applies.

68 The Rule Book does not prohibit the ES from authorising two or more simultaneous movements of trains within a worksite. It also does not expressly forbid the ES from instructing a train driver to drive to a location which is beyond another train or vehicle already occupying the line.

Train movements in a worksite – duties of the driver

69 Train drivers have a duty to make movements 'at caution' (paragraph 73) and at no greater than 5 mph (8 km/h) unless given specific instructions by the ES on the maximum speed to be applied.

70 The driver must not exceed the speed specified by the ES, or the speed which allows the driver to stop within the distance seen to be clear, whichever is the lower (paragraph 66).

Use of an intermediary to convey instructions to drivers

71 The rules permit the PICOP and ES to use a third party acting as a competent person to pass on their instructions to the driver. If using a third party in this way, the PICOP and ES have a duty to make sure that the person is competent to pass on their instructions, fully understands the instructions to pass on, and does not travel in the cab with the driver[5].

72 There is no defined qualification or process for assuring competence to act as a competent person to pass on instructions.

'At caution'

73 The instruction to drive 'at caution' is routinely given to drivers by signallers, PICOPs and ESs. The meaning of 'at caution' and how drivers should drive to comply with the instruction, was not defined by the Rule Book at the time of the accident. In September 2012[6] a clarification of the Rule Book was published in Amendments Module issue 15. This states that when a driver is instructed to proceed 'at caution' the driver must, in addition to obeying any specified speed, proceed at such a speed that will allow the train to be stopped within the distance they can see to be clear on the line ahead.

Possession and worksite information related to this accident

Possession arrangements

74 Network Rail publishes the arrangements for engineering work planned for the forthcoming week in the Weekly Operating Notice (WON). The arrangements include the signals which protect the limits of the possession and any special arrangements relating to trains or machines that are to work in the possession.

75 The planned arrangements for the engineering work on the Up and Down Arley lines for Friday 10 August were published by Network Rail in WON 19. These indicate that Network Rail had planned engineering work, involving both the stoneblower and regulator, to take place on mid-week nights from Monday 6 August to Thursday 9 August, finishing at 05:30 hrs on Friday morning. WON 19, item 113, sets out the specific arrangements for the work on the night of the accident. The possession was arranged to take place on Friday 10 August from 00:30 hrs to 05:30 hrs and to extend from around 32 miles 50 chains on the Derby to Birmingham line to around 7 miles 50 chains on the Whitacre to Nuneaton line, making the possession roughly 8 miles 31 chains (13.5 km) long[7].

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[5] The requirement of the Rule Book that the competent person does not travel in the cab with the driver first appeared in June 2011, and arose from industry concerns about the presence of a third party in the driving cab in a number of collisions, and notably at Leigh-on-Sea in 2008 (paragraph 152). One concern was that drivers may rely on the competent person to advise them of, for example, potential obstructions or trains ahead and relax their vigilance when travelling within possessions.

[6] The amendment previously appeared in the Periodical Operating Notice as amendment 07/10.

[7] The datum point for mileages changes at 31 miles 69 chains, which is where the Arley lines join the Derby to Birmingham line at Whitacre Junction (figure 4).

76 However, due to the cancellation of a possession earlier in the week and the need to complete the outstanding work from that possession, Network Rail changed the published arrangements in a late amendment issued on 8 August. The amendment, which was issued in accordance with Network Rail's company procedures, joined together the adjacent mileages covered by WON 19, item 113 and item 112 into a single possession. The resulting mileage of the amended possession extended from around 32 miles 50 chains on the Derby to Birmingham line, to around 9 miles 70 chains on the Whitacre to Nuneaton line, making the possession approximately 10 miles 51 chains (17 km) long (figure 4).

77 The late amendment changed the mileages of the possession only; it did not change the published arrangements for the stoneblower (paragraph 111).

Worksite arrangements

78 WON item 113 detailed a number of work activities or 'sites of work' which Network Rail planned to take place in one worksite, approximately 8 miles (13 km) long, within the possession. When the possession was extended to encompass item 112 (paragraph 76) the single worksite was also lengthened to enable the outstanding work to be completed. The resulting single worksite extended from 32 miles 25 chains to 9 miles 20 chains, making the worksite 9 miles 56 chains (15.6 km) long (figure 4).

Relevant on-track machine design standards

Stoneblower - headlights

79 The Railway Group standard GM/RT2180, issue 1, January 1995, 'Visibility and audibility of trains on the track' applied to the headlights of stoneblower DR80212 at the time it was built. The standard specified the intensity and alignment of headlights, which were primarily to ensure that the train was visible to persons on the track in sufficient time to move to a position of safety, and to avoid glare to on-coming drivers. The standard also introduced a requirement for headlamps to provide sufficient illumination of potential obstructions on the line during night time running, but without defining the type and size of the obstruction or the performance parameters to be met.

Stoneblower - braking performance

80 Braking performance tests on the first stoneblower in the series (No DR80200), for engineering acceptance purposes (paragraph 21), were conducted to Railway Group standard GM/TT0170 'Braking system and performance for traction units'[8]. The test results showed that the stoneblower was able to stop within specified stopping distances, which ensure that trains can comply with signal spacings on the main line. The test results indicated that the stoneblower (when laden) would stop from an initial speed of 40 mph (64 km/h) in approximately 300 metres, compared with the maximum allowable stopping distance of 582 metres.

81 Calculations by the RAIB confirmed that when stoneblower DR80212 braked on the approach to the regulator, the average deceleration rate achieved (0.5 ms^{-2})[9] was similar to the average rate achieved in the tests of stopping performance for its engineering acceptance (0.54 ms^{-2}).

[8] This mandatory standard, applying to on-track machines, specified the performance requirements of braking systems for safe operation on the rail infrastructure.

[9] Rate of deceleration was corrected for the 1:125 falling gradient.

Regulator – tail lights

82 Design standards, including the current standard, GM/RT2483, have consistently required the tail lights of a stationary train to be visible to an approaching driver for 400 metres on straight and level track, under defined visibility conditions.

Identification of the immediate cause[10]

83 **The driver was unable to stop the stoneblower to avoid a collision with the stationary regulator on the same line.**

84 The stoneblower's on-train data recorder (OTDR) indicated that the stoneblower was travelling at 33 mph (53 km/h) when the driver made a full brake application, 12 seconds before the collision. The stoneblower was calculated to be between 150 and 155 metres from the regulator when braking began[11].

85 The stoneblower's speed had slowed to around 22 mph (35 km/h) at the point of collision.

Identification of causal factors[12]

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

87 **The driver did not control the stoneblower to a speed such that, on sighting the regulator, he was able to stop short of it.**

88 The regulator was stationary beyond a left-hand bend in the track, which restricted the stoneblower driver's sighting distance of its tail lights to approximately 200 metres. By the time braking was applied the stoneblower was unable to stop in the distance available.

89 The maximum speed from which the stoneblower would have been able to stop short of the regulator was approximately 26 mph (42 km/h), 7 mph (11 km/h) less than the actual speed of the stoneblower prior to the collision. This figure for maximum speed assumes a similar delay between the driver sighting the regulator and applying the brakes, calculated to be 3 seconds, and that the stoneblower decelerated at the same rate (at 0.5 ms^{-2}) as in the accident.

[10] The condition, event or behaviour that directly resulted in the occurrence.

[11] The OTDR did not record distance.

[12] Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

90 **The stoneblower driver's speed of travel was probably influenced by his belief that the line was clear to his authorised stopping point. This was because:**

- **his instructions misled him as to the location of the regulator (paragraphs 91 to 94);**
- **he had no previous experience of being authorised to travel to a location which was beyond a vehicle already occupying the line or of travelling out of a worksite with another machine in front of him (paragraph 95); and/or**
- **he had reason to believe that he was travelling in a possession (paragraphs 96 to 99).**

Each of these factors is now considered in turn.

Location of regulator

91 The PICOP ES stated that when he authorised the stoneblower to proceed to the signal protecting the Down Arley goods loop, his instructions to the COSS (stoneblower) included information about the regulator being in front of the stoneblower and that the driver should travel 'steady', keeping a distance behind.

92 According to the COSS (stoneblower), the instructions he received were that the stoneblower should travel to the signal protecting the Down Arley goods loop but to stop two chains before the signal until the PICOP ES had authorised the regulator to proceed into the Down Arley goods loop. His account of the instructions he received from the PICOP ES did not include information about the driver needing to look out for the regulator on route to the signal or about how the stoneblower should be driven.

93 The driver reported that his instructions from the COSS (stoneblower) were to travel to the signal for the Down Arley goods loop but if the regulator was still at the signal, to stay two lengths clear of the signal. The driver stated that he took this to mean that the regulator was already at the signal but may have moved beyond the signal by the time the stoneblower reached it. He was, therefore, only expecting to encounter the regulator when he approached the signal for the Down Arley goods loop, at around the 0 miles 43 chains point.

94 When the PICOP ES and the COSS (stoneblower) delivered their respective instructions neither used the required protocol for safety critical communications to check the recipient's understanding of those instructions. Evidence from witnesses is that an informal style of communications was used.

Driver's previous experience

95 It is probable that the stoneblower driver had not considered that the regulator could be blocking his route because he reported that his experience had conditioned him to expect that once he had been given authority to drive to a certain location, the line would be clear of known obstructions to that location. The driver also stated that he had no previous experience of travelling out of a worksite with another machine running in front of him.

Uncertainty as to rules applying to travel

96 The stoneblower driver knew that the PICOP ES had authorised the COSS (stoneblower) to remove the worksite marker boards at the Nuneaton end of the worksite and that the COSS had loaded the boards on to the stoneblower. The COSS stated that he did this because he was aware that there was no-one else available to remove the worksite marker boards. The driver was not sure whether this meant that the worksite had been given up and that the stoneblower was in a possession (paragraph 60).

97 The driver stated that if he had received instructions from an ES he would have known that he was in a worksite. However, the driver was not told in which capacity the PICOP ES was acting (ie PICOP or ES) when giving instructions, as the PICOP ES identified himself only by name. The PICOP ES also did not give the driver the maximum speed at which to make the movement, as required by the Rule Book when travelling in a worksite, but not a possession (paragraph 62).

98 The PICOP ES stated that he did not give a maximum speed because, having instructed the driver to 'travel steady' (paragraph 91), he expected the driver to drive at caution and to understand that this meant a speed of between 5 and 20 mph (8 and 32 km/h). Evidence from witnesses suggests that the expression generally used by the PICOP ES when giving instructions to drivers was to "go steady". The PICOP ES stated that 'go steady', was an instruction used by ground workers to mean the same as 'at caution'. However, this term is not contained in the Rule Book or in the training material for an ES.

99 The uncertainty about whether the stoneblower was travelling in a possession or a worksite may have influenced the driver's expectation that the line was unobstructed to his authorised stopping point. However, the driver was also aware that he should be prepared to stop within the distance he could see to be clear, whether in a worksite or possession.

100 **It is possible that, immediately before the collision, the driver was distracted from the driving task, causing him to misjudge the speed of the stoneblower.**

101 It is possible that, on the approach to the bend, the driver misjudged the speed of the stoneblower because communications received immediately before the collision may have distracted him from the driving task:

- At around 04:20 hrs, the COSS (stoneblower), who was travelling in the trailing cab, called the driver on the machine's intercom system to relay a message from the PICOP ES. The PICOP ES had telephoned the COSS and on learning that he was not with the driver, asked the COSS to tell the driver to "go steady" and that the PICOP ES would ring the driver shortly.
- The intercom message from the COSS was loud and distorted and the driver did not understand what the COSS was telling him. The driver used the intercom system in the cab to ask the COSS for clarification. The COSS repeated his message, which was still not fully understood, but the driver heard the part that the PICOP ES would be ringing him.

- At 04:21 hrs a call from the PICOP ES was made to the driver's mobile telephone, which was in his trouser pocket, under his overalls. The driver stated that he had looked down while trying to locate the telephone. Telephone records indicate that the call was answered and that the call was connected for over one minute. The driver stated that he had inadvertently operated the 'answer' button. Both he and the PICOP ES stated that no conversation took place.
- A comparison of telephone records with the timing of the brake application from the stoneblower's OTDR indicates that about five seconds after the call was accepted the tail lights of the regulator came into view.

102 The stoneblower's OTDR showed that when setting off from its site of work on the return journey the driver initially accelerated to 35 mph (56 km/h) and then controlled the speed to between 22 and 33 mph (35 and 56 km/h), mainly by reducing power, but had also made two brake applications.

103 When the intercom exchange took place the driver had reduced the speed to around 24 mph (38 km/h), and maintained a speed of between 24 and 28 mph (38 to 45 km/h) for 40 seconds. However, by the time the PICOP ES telephoned the driver, the driver had re-applied power, increasing the speed to 33 mph (53 km/h). The change to a downward gradient approximately 300 metres before the point of collision would also have tended to increase the speed of the stoneblower.

104 The driver stated he did not intend to drive at 33 mph (53 km/h) on the approach to the bend. He was aware that he was due to drop off the COSS at Church Lane access point and that his normal braking point for this access point was close to where the collision occurred. He mistakenly believed that he had controlled his speed to around 20 to 25 mph (32 to 40 km/h) because he considered this was an appropriate speed from which to brake at his normal braking point to bring the stoneblower to a stop at the access point.

105 If he had applied his brakes as planned at his normal braking point it would have been possible for him to stop the stoneblower from 33 mph (53 km/h) at Church Lane access point. However, it would have required heavy braking. Calculations indicate that the application of full braking at the planned braking point would have brought the stoneblower to a halt in 260 metres, 60 metres short of the access point. Braking from 20 or 25 mph (32 to 40 km/h) would have enabled a gentler stop. For comparison, when the driver stopped at the access point on his outward journey, he reduced his speed gradually, and made a brake application at 13 mph (21 km/h) to bring the stoneblower to a halt.

106 The driver's misjudgement of his speed is consistent with, and may have resulted from, being distracted from the driving task.

107 It is also possible that the driver's handling of the distractions, his misjudgement of speed, and his response to his observation of the tail lights ahead, were affected by fatigue.

108 The driver began working on nightshift on Monday 6 August 2012 after being on leave the previous week, and worked Monday and Wednesday nights (work on Tuesday night was cancelled). He finished work on Thursday morning at 06:30 hrs and had about five hours sleep. At the time of the accident he had been awake for over 16 hours.

109 The driver's control of the stoneblower on the return journey as recorded by the OTDR indicates that he was alert prior to the collision and that, after the reported initial hesitation, he responded appropriately to his observation of the regulator by applying full braking and sounding the horn[13]. Although it is possible that the driver's behaviour and judgement were impaired by fatigue, there is no direct evidence that it was a factor.

110 **The PICOP ES changed the published possession arrangements for giving up the possession around the stoneblower and instructed both the stoneblower and regulator to travel towards the exit of the worksite.**

111 According to the arrangements Network Rail published in WON 19, the possession was to be given up around the stoneblower at signal NW4255, which is situated on the Down Arley line at 6 miles 2 chains (figure 4). This meant that at the end of work the stoneblower would be authorised to move to the signal and wait there until the possession was given up[14]. The signaller would then resume control of train movements and the stoneblower would continue its journey under normal signalling.

112 If the published arrangement had been followed the collision could not have occurred because the signal is located approximately 624 metres before the point of collision.

113 A Network Rail planner, responsible for the planning of worksite activities, reported that the arrangement in the WON was specified to provide a means for separating the movements of the stoneblower and regulator. It also provided a time contingency at the end of the possession because the stoneblower did not need to travel the whole length of the possession to exit at the possession limit boards. However, the PICOP ES stated that he changed the arrangements because he had enough time before the possession was due to be given up to allow both machines to exit at the possession limit boards. He stated that he agreed the changes with the West Midlands Signalling Centre and assumed that the signalling centre would seek authorisation from operations control.

114 Network Rail's National Control instructions for engineering work state that late changes may be referred by the PICOP to route control but will only be considered in exceptional circumstances. The route control manager on duty on the night of the possession has confirmed that no request was received from the PICOP ES (or from the signalling centre) for a change to the arrangement for giving up possession around the stoneblower.

115 There is evidence that, where machines finish their work early, it is not unusual for changes, unauthorised by operations control, to be made to planned arrangements for giving up possession around a machine. This occurs, for example, where other work is continuing and getting a machine out of the possession early avoids the risk of the machine being stuck in the possession if the other work overruns. As in this case, such changes may be agreed locally with the signaller.

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[13] The OTDR indicated that the driver made adjustments, up and down, to the speed of the stoneblower using both the power and brake controllers. He also responded promptly to the driver's vigilance alarm which sounded twelve times on the stoneblower's return journey.

[14] This would first require a procedural step to shorten the worksite so that the worksite could be given up with the stoneblower no longer within it (paragraph 60).

116 The PICOP ES did not consider it his duty to regulate the movement of the two trains in a worksite to control the risk of collision. He stated that once he had authorised the regulator to proceed to the signal protecting the Down Arley goods loop he assumed that it would shortly be on its way. However, he also expected the stoneblower driver to drive in a manner such that, on sighting the regulator, he would be able to stop short of it, or maintain a safe distance from it.

117 The transiting of two machines out of the same worksite, one travelling behind the other, is not covered by Network Rail's training course for ESs. However, the practice is not prohibited by the Rule Book and other experienced ESs spoken to during the investigation reported that they had also instructed simultaneous movements of two machines at a maximum speed of up to 40 mph (64 km/h).

Identification of underlying factors[15]

118 **In the absence of adequate controls to keep trains and plant apart, long worksites tend to increase the risk of collision.**

Worksite planning

119 The length of the worksite in which the stoneblower and regulator were working, at approximately 9 miles 56 chains (15.6 km), was regarded by several persons spoken to during the investigation, including drivers of on-track machines, Network Rail engineering access (worksite) planners and track maintainers, to be fairly typical of current worksite lengths. A rough analysis by Network Rail, conducted at the RAIB's request, of the lengths of nearly 50,000 worksites published in the WONs in 2012, found that the average length was 9 miles 48 chains (15.4 km).

120 The use of worksite marker boards to separate and protect the stoneblower and regulator in their own, shorter, worksites, and the discipline associated with authorising the movement of machines into and out of worksites, would have significantly reduced the risk of collision. However, the use of separate worksites for on-track machines within a possession is reported by engineering access planners and track maintainers to be used less frequently because of:

- increased risk to persons placing and removing multiple sets of worksite marker boards on the track;
- higher staffing costs because an ES is needed for each worksite;
- greater potential for miscommunications between the PICOP and each worksite's ES when controlling vehicle movements; and
- reduced productivity because of the time needed to set up and give up worksites and to transit machines through worksites.

121 The Network Rail work planning system aims to make the most efficient use of possessions by maximising the number of work activities (sites of work) that can safely be undertaken within them. As in this case, this has led to many worksites effectively being the same length as possessions.

[15] Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

122 Network Rail's company rules do not specify a maximum length for a worksite or the maximum length for a site of work within a worksite. (There are rules prescribing the complexity of activities that can safely be managed by a single ES, which may have the effect of limiting the length of a worksite.) The RAIB found evidence that engineering access planners were challenging requests from track maintainers to justify the length of sites of work. However, it was reported that track maintainers often resisted requests to specify shorter sites of work because they wished to retain flexibility in respect of where work was actually done within the possession. For example, the stoneblower's site of work in WON 19, item 113, extended from 7 miles 15 chains to 0 miles 60 chains although the time available was insufficient to allow stoneblowing to be carried out over the whole of this length.

Maximum speeds within worksites

123 The possession on the night of the accident was timed for five hours, between 00:30 hrs and 05:30 hrs. The stoneblower had a distance of approximately nine miles to travel to its site of work from its starting location in the Down Arley goods loop. If the movement to and from the site of work was undertaken at 5 mph (8 km/h), the default speed for driving in a worksite (paragraph 69), it would leave little time for the work to be completed.

124 The longer the distance that a machine has to travel within a worksite to an actual site of work the higher the likelihood that the movement will be authorised at speeds higher than 5 mph (8 km/h) to maximise the time available for working. Where two or more machines are working in the same long worksite, it is foreseeable, due to pressures of time, that they will undertake simultaneous movements. Network Rail does not provide guidance on how far an on-track machine can reasonably travel within a worksite to its site of work.

125 The rule permitting a maximum speed of up to 40 mph (64 km/h) for movements in worksites facilitates long worksites. It also permits trains to run at the same speed as in possessions but without the Rule Book specified protection of only one train moving at any time (paragraph 62).

Discounted factors

The non-use of the sanding device

126 The driver did not use the stoneblower's sanding device when he made his brake application on sighting the regulator. This device applies sand to the rails to improve adhesion with the wheels and helps to prevent the wheels from sliding when the brakes are applied. It is unlikely that the use of the sander would have resulted in a better rate of deceleration and a lower speed of impact. This is because the level of wheel/rail adhesion required by the brakes was relatively low, the rails were dry and there was no evidence that wheel sliding had occurred.

A fall-off in the driver's concentration level due to length of time engaged in the task

127 Studies indicate that when engaged in monotonous work, a fall-off in drivers' concentration levels would be likely after about 30 minutes[16], and possibly after only 15 minutes[17]. When applied to train movements in long worksites, these studies suggest that it would be difficult for drivers to maintain the required level of concentration needed to make continual judgements of speed in relation to the distance seen to be clear, the braking performance of the machine, and taking into account other factors such as gradient and changes in levels of adhesion.

128 In this instance, however, the stoneblower driver had been driving for approximately seven minutes so a lack of concentration due to the time engaged in the task is discounted as a factor.

Factors affecting the severity of consequences

129 More serious injuries could have been caused if members of the regulator staff had been in the rear cab or on the track cleaning the machine, as they had been prior to the collision.

Observations[18]

130 **When driving in possessions and worksites at night, the stated maximum speed of 40 mph (64 km/h) in the Rule Book is incompatible with the braking and headlight capabilities of on-track machines.**

131 When driving in possessions and worksites, compliance with the Rule Book relies on the driver making continual judgements about the appropriate speed for the distance that can be seen to be clear and about the stopping distance that can be achieved by the train's braking performance.

132 In daylight and good visibility the distance that a driver can see to be clear of obstructions is affected by factors such as changes in gradient and curvature of the line. At night the distance that can be seen to be clear of potential obstructions of the track is additionally limited by the illumination provided by headlights of on-track machines. Calculations indicate that the beam of light from a headlight, installed and aligned in compliance with Railway Group standards, intersects the rail approximately 86 metres ahead of the machine and does not provide effective illumination beyond approximately 100 metres, or less where the track is undulating or curved.

133 Many drivers of on-track machines have knowledge of the route and are able to anticipate curves, or changes of gradient, and respond accordingly. However, it is not necessary for operating in possessions or worksites, for a driver to have route knowledge, which may add to the difficulty of maintaining a safe speed.

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[16] Wickens C D, Hollands J G, Parasuraman R & Banbury S (2013) *Engineering Psychology and Human Performance (4th Edition)*. Pearson Education Ltd.

[17] Dunn N & Williamson A (2012) 'Driving monotonous routes in a train simulator: the effect of task demand on driving performance and subjective experience' Ergonomics, 55(9), 997-1008.

[18] An element discovered as part of the investigation that did not have a direct or indirect effect on the outcome of the accident but does deserve scrutiny.

134 In the case of stoneblower DR80212, the maximum speed from which it could theoretically brake to a stop in 100 metres, the distance illuminated by its headlights, is estimated at 22 mph (36 km/h). (This estimate assumes dry, uncontaminated track and does not allow for the driver's initial reaction time or factors such as gradient.) Stoneblowers built after DR80212 have improved braking systems and would be able to brake from a higher speed in the same distance. For comparison, in 2002 the stopping performance tests for engineering acceptance purposes of stoneblowers from DR80213 onwards, indicated that they were capable of stopping from 27 mph (43 km/h) in a distance of approximately 100 metres[19].

135 However, although more modern on-track machines designed in compliance with Railway Group standards have a better braking performance and are capable of stopping in shorter distances, it is likely that few, if any, would be able to brake to a stop from 40 mph (64 km/h) in the distance illuminated by their headlights. This would require a high average retardation rate of approximately 1.6 ms^{-2} which is beyond any normal brake rate for vehicles of this type.

136 **There were a number of non-compliances with the Rule Book and company procedures relating to the management of the possession.**

137 The combination of the PICOP and ES roles allowed certain non-compliances to occur unchecked. The PICOP ES granted the worksite before the worksite marker boards had been put out at the Nuneaton end (paragraph 60).

138 The PICOP was, in fact, not permitted by company rules to also act as an ES for the amended possession, because it incorporated a section of line that was subject to 'line clear verification'. Line clear verification is an enhanced safety procedure for proving that the line is clear after engineering work and is linked to the presence of axle counters on part of the line under possession. It restricts the roles that can be undertaken by a PICOP to maintain the integrity of the process and to ensure that, at the end of work, an independent cross-check of the number of vehicles the PICOP and ES have recorded as entering and leaving a worksite can be made. This procedure explicitly prohibits one person undertaking both the PICOP and ES roles where there are two machines working.

[19] The stopping performance tests also indicated that the braking system on stoneblowers manufactured after DR80212 was capable of braking the stoneblower to a stop from 33 mph in a distance of approximately 130 metres. This suggests that, in similar circumstances, a more modern stoneblower would possibly have stopped short of the regulator.

139 The PICOP ES had also combined the roles of PICOP and ES for a line clear verification possession the night before. The allocation of the PICOP and ES roles to different, named individuals should have been confirmed at the final planning (PICOP) meeting for the work, held on 1 August. However, at this meeting the PICOP ES stated that he made a request to carry out both roles because, in his opinion, it was safer and more productive for one person to be in control of the possession and worksite. Documentation issued after the meeting indicates that the PICOP ES's name was entered for both roles, but reportedly on the understanding that the PICOP ES would resolve the issue to comply with company rules before work commenced. The PICOP ES disputes this, stating that his request to be both PICOP and ES was accepted without challenge. No subsequent check of the actual arrangements was carried out prior to the accident. However, a qualified ES who was working in the possession on the night of 9/10 August 2012 and aware of the rules on line clear verification possessions, stated that he made an offer to the PICOP ES to fill the ES role. The offer was reportedly declined. The PICOP ES disputes being informed that he could not undertake both roles.

140 As well as changing the published arrangement in the WON for giving up possession around the stoneblower at the end of work, the arrangement for taking possession around the stoneblower at the start of work was also changed. The published arrangement was for the possession to be taken around the stoneblower at a specified signal on the Up Arley line and for the regulator to enter the possession later at the detonator protection (paragraph 58). Instead, the possession was taken around both the stoneblower and regulator at the same signal in the goods loop. This was an unconventional and unplanned arrangement which was not authorised by operations control as required by company procedure. However, the change was agreed between the PICOP ES and the West Midlands Signalling Centre.

141 **Cab discipline to avoid distracting the driver is difficult to maintain where mobile telephones are used to convey instructions to drivers in possessions and worksites.**

142 The Rule Book requires that competent persons who act as an intermediary between the PICOP or ES and the driver, do not travel with the driver (paragraph 71). However, the competent persons for the stoneblower and regulator had additional roles as part of the team on their respective machines and had reason to be in the driving cab to instruct the driver, for example, on where to stop the machine at the start of work.

143 The Harsco company policy on the use of mobile telephones stated that drivers' mobile telephones should be switched off when driving and others in the cab should have their phones switched to silent. This is consistent with the voluntary Rail Industry standard RIS-3776-TOM on the use of mobile telephonic equipment in driving cabs. The standard, however, does not differentiate between driving on the open line and driving in possessions. The investigation found that there was a general lack of clarity on whether company policies on the use of mobile telephones applied in possessions and particularly while 'travelling' in worksites.

144 Driver standards managers and drivers reported that the use of mobile telephones for communications between PICOPs, ESs, drivers of on-track machines and competent persons, while in possessions and worksites, was routine. The PICOP ES had an expectation that the stoneblower driver would have his mobile telephone switched on to receive instructions while he was driving.

Previous occurrences of a similar character and RAIB recommendations relevant to this investigation

145 The RAIB investigation identified other incidents of particular relevance which are reported below[20].

Fosse Road, 2005 (pre-dated the commencement of investigations by the RAIB)

146 In April 2005, an engineering train ran into the rear of a stationary engineering train in a worksite. The driver of the approaching train did not see the train in front until it was too late and was travelling at a speed from which he was unable to stop to avoid a collision.

147 The Network Rail investigation report noted the following factors which are relevant to this report:

- The colliding driver was not given a maximum speed to make the movement towards the stationary train.
- Instructions from the ES were given via an intermediary acting as an agent for the ES. The report of the formal investigation by Network Rail noted that there was no formal competency for acting as an agent.

148 The report recommended that Network Rail considers a clarification of the speeds in the Rule Book for movements in possessions and worksites to remove dubiety and to ensure that the speed allowed is safe and practical. It also recommended the introduction of a formal competency for the role of the engineering supervisor's agent, and to include a set protocol for authorising train movements and advising drivers of the speed of travel.

Badminton, 2006

149 In October 2006 there was a collision between two on-track machines in a long worksite at Badminton (RAIB report 30/2007). The first machine stopped to pick up crew and while stationary, the second machine collided with it at 35 mph (56 km/h).

150 The following factors are relevant to this report:

- The on-track machines had been authorised by the ES, via an intermediary, to travel to the same location.
- The report noted that the movements took place without the protection of the signalling system or suitable operational measures to control the risk of collisions.

151 RAIB report 30/2007 made a recommendation on the length of worksites which addresses a factor also identified in this investigation:

Recommendation 1

RSSB should make a proposal, in accordance with the Railway Group standards Code, to amend Module T3 of the Rule Book to require worksites to be kept as short as possible.

[20] Details of other worksite related incidents may be found in Appendix E of RAIB report 24/2009 'Freight train collision at Leigh-on-Sea 26 April 2008.

Status of actions taken

The Office of Rail Regulation (ORR) reported to the RAIB in November 2008 that this recommendation had been implemented. A new clause had been inserted into the Rule Book stating that each worksite must be kept as short as possible. However, the clause was later removed in March 2011 when Module T3 of the Rule Book was re-issued. The reason given was that the length of worksites is a matter for Network Rail's planning system and not something that is decided on the day. A requirement for 'sites of work' (these are separate work activities which take place within a worksite (paragraph 78)) to be as short as possible was broadly incorporated in Network Rail company standard NR/L3/NDS/302 Issue 5 'Planning of engineering access and NDS-supplied resource for work deliverers' and subsequently in NDS/PLN/LP/070A Issue 1 'Planning of Engineering Access'.

Comment

The RAIB considers that the actions taken to implement this recommendation have not resulted in worksites being as short as possible, for reasons outlined in paragraphs 120 to 122. However, Recommendation 1 of this report addresses the wider issue of safety in relation to the movement of trains in worksites which should encompass the concerns that gave rise to recommendation 1 of the Badminton report.

Leigh-on-Sea, 2008

152 In April 2008 an engineering train collided with a stationary train in a worksite on a curve after travelling over four miles from the start of the worksite (RAIB report 24/2009).

153 The following factors are possibly relevant to this report:

- The colliding driver did not recognise that he was within a worksite, and did not know the location of the stationary train.
- The driver was given instructions for the movement by an intermediary and there was a lack of clear understanding reached on the nature of the intermediary's role in controlling the movement.

154 RAIB report 24/2009 made seven recommendations, all of which are relevant to the collision near Arley. However, recommendations 1, 2, 5, 6 and 7 are of particular relevance:

Recommendation 1

Network Rail should introduce a procedure that will provide a written record of instructions between the Engineering Supervisor, train driver and 'competent person' with verbal read back to confirm an understanding of the planned movement.

Status of actions taken

In September 2010 Network Rail reported an industry view that the existing rules were adequate but that the application of them was weak. The recommendation was also thought to be impracticable because of the burden of recording, for example, the authorisation of repeated short movements of a ballast train when unloading ballast.

The ORR reported to the RAIB in May 2011 that it had taken note of the weak application of existing rules and that a programme of inspections planned for 2011-2012 would include the effectiveness of communications between the various parties involved with the movements of engineering trains in and out of possessions. The ORR subsequently advised that this inspection activity had indicated that the communication of information to drivers was still not satisfactory. This led to the development of a communications protocol in the form of a flow chart which sets out how the drivers and crew should receive information to ensure their safety in the worksite.

Recommendation 2

Network Rail should incorporate a challenge stage within the planning process so that possession and worksite length is minimised and that planned train movements are operationally risk assessed.

Status of actions taken

In September 2010 Network Rail advised that a challenge stage had been incorporated in the planning process such that the reason for the length of worksite will be questioned when the worksite is requested. The ORR reported to the RAIB that it considered the recommendation had been implemented but that it would be following it up as part of an inspection plan in 2010/2011. The ORR subsequently advised the RAIB that its inspections had identified the need for more active challenges to the risk control arrangements, including the length of worksite proposed by the maintenance deliverer. However, the ORR's actions to follow up these findings had been disrupted by Network Rail's devolution of the possession planning function to route level. A further inspection project has therefore been established to address possession management issues, including the challenge process to the length of worksites.

Comment

The RAIB found evidence of challenge in the planning process to specify shorter sites of work but that this was often resisted by track maintainers (paragraph 122). Recommendation 1 of this report addresses the wider issue of safety in relation to the movement of trains in worksites which should encompass the concerns that gave rise to recommendation 2 of the Leigh-on-Sea report.

Recommendation 5

Network Rail should modify the Engineering Supervisors Training Manual to accurately reflect the specification within its company standard relating to the requirements on the Engineering Supervisor to give precise and explicit instructions to drivers or a 'competent person'.

Status of actions taken

In September 2010 the ORR reported to the RAIB that this recommendation had been implemented by the inclusion of the recommended requirements in the training material for engineering supervisors.

Recommendation 6

RSSB should make a proposal, in accordance with the Railway Group standards code, to introduce a requirement to modify the modules within the Rule Book relating to the requirement on the Engineering Supervisor so as to require him to give precise and explicit instructions to the driver or 'competent person' as shown in the Network Rail company standard NR/SP/CTM/021.

Status of actions taken

In November 2009 the ORR reported to the RAIB that the RSSB had made a proposal to modify the Rule Book and that the recommendation had been implemented. (GE/RT8000/HB12 'Duties of the engineering supervisor (ES)' issued in June 2011, included revised rules on the information to be provided to drivers and competent persons.)

Recommendation 7

Network Rail in conjunction with RSSB should make a proposal, in accordance with the Railway Group standards code, to define the competence and limitations of the role of a 'competent person' authorised by the Engineering Supervisor, so that this role can only pass on the instruction to the driver given by the Engineering Supervisor on the movement of trains within a worksite but cannot guide or manage such movements.

Status of actions taken

In November 2009 the ORR reported to the RAIB that Network Rail and RSSB had responded to the recommendation and that the ORR would be taking no further action (see paragraph 72 and footnote 5).

Washwood Heath, 2010

155 In March 2010 a passenger train passing a track maintenance activity was struck and damaged by a length of rail that was being mechanically handled (RAIB Report 01/2011). The PICOP ES in the accident at Arley was also the ES in the Washwood Heath accident.

156 The following factors are relevant to this report:

- The planned system of work was changed and a system that did not comply with the Rule Book or Network Rail's procedures was adopted.
- The person in charge of the work was not adequately managed and was not challenged over his unsafe method of work.

157 RAIB report 01/2011 made four recommendations, all of which are relevant to the collision near Arley. However, the first part of recommendation 2 is of particular relevance because it sought to achieve improved management surveillance and supervision at Saltley Infrastructure Maintenance Delivery Unit to detect instances of individual supervisors implementing unsafe systems of work.

Recommendation 2

Network Rail should determine why its management systems did not prevent the unsafe system of work being used for the (work) and make the necessary changes to prevent recurrence.

Status of actions taken

In September 2012 the ORR reported to the RAIB that Network Rail had taken action to implement this recommendation. The actions focussed on the development of an improved safety culture and included a programme of increased site inspections covering behavioural issues, the production of a route safety improvement plan to promote the engagement of staff, and a workshop to address safety culture and behaviours at Saltley Infrastructure Maintenance Delivery Unit. Action had also been taken to retrain the staff involved in the incident and to subsequently monitor their performance. Network Rail reported to the ORR that there had been a significant improvement in how managers and supervisors carried out their roles with regard to safety in Saltley Infrastructure Maintenance Delivery Unit. As a result, unless further information came to light to challenge the accuracy of the reported actions taken, the ORR considered the recommendation closed.

Comment

The RAIB considers that the measures put in place by Network Rail did not prevent a recurrence of unauthorised changes to the planned method of working or ensure compliance with other rules for worksite safety (paragraphs 111 to 115, and 137 to 140).

Recommendation 3 of this report therefore addresses the need for Network Rail to further examine why the steps it took to implement improved management surveillance and supervision at Saltley Infrastructure Maintenance Delivery Unit remain did not bring about sustained behavioural change.

Near miss at Park Lane Junction, near Water Orton on 25 September 2011 (not investigated by the RAIB)

158 A signalling technician placing worksite marker boards on the track for his own worksite was twice involved with a near-miss with an on-track machine. The incidents were subject to a local investigation by Network Rail. The ES in this incident was also reported to be the COSS (stoneblower) in the accident at Arley.

159 The following issue is identified as relevant to this report:

- The ES got on the machine with worksite marker boards for his worksite, which should already have been put out.

160 One of the local remedial actions identified in the report was for Saltley Infrastructure Maintenance Delivery Unit to supply additional resource to assist ESs with placing out and retrieving worksite marker boards (paragraphs 41, 44 and 96). A briefing was also to be issued to all ESs at Saltley Infrastructure Delivery Unit reminding them of the importance of following the Rule Book, particularly in relation to the putting out of worksite marker boards.

Comment

The evidence from this investigation suggests that the local actions taken were not effective in preventing a recurrence of a similar nature.

Summary of conclusions

Immediate cause

161 The immediate cause of the accident was that the driver was unable to stop the stoneblower to avoid a collision with the stationary regulator on the same line (**paragraph 83**).

Causal factors

162 The causal factors were a combination of the following:

a. the driver did not control the stoneblower to a speed such that, on sighting the regulator, he was able to stop short of it (**paragraph 87, Recommendation 1**);

b. the stoneblower driver's speed of travel was probably influenced by his belief that the line was clear to his authorised stopping point **(paragraph 90, Recommendation 2)**;

c. immediately before the collision, it is possible that the driver was distracted from the driving task, causing him to misjudge the speed of the stoneblower (**paragraph 100, Recommendation 2**); and

d. the PICOP ES changed the published possession arrangements for giving up the possession around the stoneblower and instructed both the stoneblower and regulator to travel towards the exit of the worksite (**paragraph 110, Recommendations 1 and 3**).

Underlying factors

163 The underlying factor was that, in the absence of controls to keep trains and plant apart, long worksites tend to increase the risk of collision (**paragraph 118, Recommendation 1**).

Additional observations

164 Although not linked to the accident on 10 August 2012, the RAIB observes that:

a. when driving in possessions and worksites at night, the stated maximum speed of 40 mph (64 km/h) in the Rule Book is incompatible with the braking and headlight capabilities of on-track machines (**paragraph 130, Recommendation 1**);

b. there were a number of non-compliances with the Rule Book and company procedures relating to the management of the possession, including irregularities in establishing the worksite, the combining of the PICOP and ES roles, and amendments to the published possession arrangements at the start of the possession (**paragraph 136, Recommendation 3**); and

c. cab discipline to avoid distracting the driver is difficult to maintain where mobile telephones are used to convey instructions to drivers in possessions and worksites (**paragraph 141, Recommendation 2**).

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

165 In November 2012 Harsco Rail revised its Professional Train Driving policy to clarify that mobile telephones should be switched off when driving or travelling on an on-track machine, whether under normal running or in possessions. They may only be turned on when the machine is stationary with the brakes applied, and it is safe to do so. This revised policy was subsequently briefed out to drivers.

166 Network Rail has begun a project to conduct a fundamental review of how it manages possessions and worksites and to achieve better planning of worksite activities by improving the competence of possession planners.

Other reported actions

167 In November 2012 Harsco Rail revised its Professional Train Driving policy to emphasise that, when in possessions, drivers should ensure that they receive the correct information, including the speeds and distances of travel, and not to act until all information is received and understood. Further, it stipulated that drivers should drive at a speed from which they can stop in the distance they can see to be clear but not exceeding 20 mph (32 km/h). The company speed limit of 20 mph (32 km/h) was supported by a bulletin headed '20's plenty'. The revised policy was issued to drivers and reinforced by a company briefing. However, the policy was subsequently withdrawn, at the request of Network Rail, because it reportedly caused problems of inconsistency when working with other operators.

168 The Supplier Safety Working Group for on-track machines, which represents Network Rail and the companies that supply on-track machines to Network Rail, issued a briefing reminding all drivers of the Rule Book's requirements regarding speed in worksites.

169 A poster, sponsored by Network Rail and its operators of on-track machines, was issued for displaying on machines, to remind staff that worksite marker boards must not be carried on the machine and that the marker boards must be in place before the machine arrives on site. This replaced a similar poster that was issued some years ago.

170 In May 2013 Network Rail issued a briefing for PICOPs and ESs containing learning points from the accident at Arley. The briefing reminds PICOPs and ESs that when controlling movements of trains the PICOP or ES should instruct the driver to make the movement 'at caution' (no more than 5 mph (8 km/h)) and be in a position to stop short of any obstruction, regardless of conditions. Also, all movements should be 'at caution' (5 mph (8 km/h)) unless specific instructions on the maximum speed to be applied have been given by the PICOP or ES. The maximum speed must not exceed 40 mph (64 km/h) and account must be taken of darkness, fog, low adhesion, curvature of the line or anything else that might affect a driver's ability to stop short of any obstruction. The briefing is to be delivered between June and September 2013 and the date individuals are briefed must be registered on Sentinel[21].

[21] Sentinel is a system for managing and controlling certain safety critical competencies on the railway. The scheme is used to ensure that persons who work on railway infrastructure are medically fit and competent to discharge their duties.

171 Network Rail has withdrawn training material for engineering supervisors which endorsed the practice of authorising a maximum speed of 40 mph (64 km/h) except where agreements on a lower speed have been reached with other worksite users. Network Rail's stated position is that existing speed limits in the Rule Book remain appropriate but recognises that higher speeds in worksites have become custom and practice. Instead of drivers defaulting to 5 mph (8 km/h) in worksites and only driving faster if specifically instructed to do so, the situation has developed where higher speeds are the norm unless specifically instructed to run at a lower speed. It is also recognised that long worksites have encouraged this behaviour. Network Rail is also planning to issue revised key point cards for engineering supervisors and to rebrief the driver community through RSSB's 'Red' programme[22].

172 RSSB has drafted a new Railway Industry standard, RIS-1702-PLT, to address the issue of on-track machines travelling in possessions. This standard, planned for publication in September 2013, includes a provision for machine manufacturers to state the maximum night-time travelling speed in the operating instructions. This speed is to be calculated on the basis of the distance illuminated by the headlights and the stopping distance capability of the machine (for a specified co-efficient of friction).

173 RSSB has also indicated that it is looking at the handbook for engineering supervisors to ensure that the rules relating to the authorisation of maximum speeds in worksites are clearly explained.

[22] Further information is available on http://www.rssb.co.uk/NP/OPSAFETY/Pages/RedProgramme.aspx.

Recommendations

174 The following recommendations are made[23]:

1 *The purpose of this recommendation is to point Network Rail to areas identified in this investigation for potential inclusion in its planned review of the management of engineering possessions and worksites and to encourage a fundamental assessment of the fitness for purpose of current arrangements. The recommendation is intended to achieve an improvement in the means for controlling the risk of collision between trains (and with plant) when travelling to and from their sites of work, and to gain assurance that arrangements for controlling the risks of collision are effectively planned and followed.*

Network Rail should:

a. Review potential systems of work, and/or technical solutions, for reducing the risk of collision between trains when travelling to and from their sites of work. This review should include consideration of the following options:

i. greater use of the signalling system during engineering work for controlling the movement of trains (paragraph 163);

ii. means for detecting the position of trains when normal signalling is suspended; and

iii. planning arrangements for engineering work that address the issue of simultaneous movements of trains travelling to and from their sites of work and which minimise the potential for such moves to bring trains in close proximity (paragraphs 162a and 163).

continued

[23] 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 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.raib.gov.uk.

b. Review (in consultation with RSSB as appropriate) permitted train speeds applying to movements in sections of line that are closed to normal traffic for engineering work, taking account of human factors affecting a driver's ability to judge the distance they can see to be clear, the stopping distance that can be achieved by their train's braking performance, the limitations of headlight illumination in darkness and a driver's route knowledge (paragraphs 162a and 164a).

c. Seek an understanding of the reasons for, and scale of, local unauthorised deviations from possession plans, the effectiveness of the planning process to avoid such changes, as well as the suitability of procedures and managerial arrangements for identifying, and subsequently reviewing, unauthorised changes (paragraph 162d).

The measures identified to further reduce the risk of collisions during engineering work should then be implemented in accordance with a timebound programme.

2 *The purpose of this recommendation is to achieve effective communications between those managing engineering possessions and train drivers (and others working in the possession) so that the potential for miscommunication is reduced to a minimum and that communications take place only when it is safe to do so.*

Network Rail should:

a. Review the equipment and protocols used by those managing possessions for communicating with train drivers to ensure that:

i. Drivers are provided with all the information they need to carry out movements safely. The review should consider the use of a standardised format so that any missing information can be readily identified and queried by the driver. In addition to information such as the authorised maximum speed of travel and the driver's treatment of signal aspects, the format could also include confirmation that there are no vehicles obstructing the line to the driver's authorised stopping point (paragraph 162b).

ii. Communications with drivers are made in a manner which does not risk distracting the driver from the driving task (paragraphs 162c and 164c).

continued

b. Network Rail should define when it may be necessary and appropriate to use competent persons as intermediaries when communicating instructions on vehicle movements to drivers. It should then further consider the formal competencies and non-technical skills required of a competent person and the means by which their competency and non-technical skills may be assured. Consideration should also be given to the practicalities of relaying instructions to drivers in ways that do not risk distracting drivers from their driving task (paragraphs 162b, 162c and 164c).

Any resulting actions should be implemented as soon as possible.

3 *The purpose of this recommendation is to gain assurance from Network Rail that it understands why the managerial arrangements in place at Saltley Infrastructure Maintenance Delivery Unit have not prevented a recurrence of non-compliant behaviour and to ensure that any measures put in place to address these issues will be effective in the long term.*

Network Rail should review why the measures taken to implement Recommendation 2 from RAIB report 01/2011 to achieve improved management surveillance and supervision at Saltley Infrastructure Maintenance Delivery Unit, did not detect or prevent unauthorised changes being made to a plan of work and instances of non-compliance with its company standards for possession management. It should then implement any measures identified to bring about a sustained behavioural change (paragraphs 162d and 164b).

Appendices

Appendix A - Glossary of abbreviations and acronyms

COSS	Controller Of Site Safety
ES	Engineering Supervisor
ORR	Office of Rail Regulation
OTDR	On-Train Data Recorder
PICOP	Person In Charge Of Possession
RAIB	Rail Accident Investigation Branch
RRV	Road-Rail Vehicle
WON	Weekly Operating Notice

Appendix B - Glossary of terms

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

Assistant track section manager	An assistant to the manager responsible for the inspection and maintenance of a section of track.
Automated finishing machine	A machine also known as a regulator, that combines a number of processes, included the redistribution of top ballast (regulating), the storing and insertion of ballast, track stabilisation and the control of track geometry.
Axle counter	A track mounted device that counts passing axles. An axle counter evaluator compares the number of axles entering and leaving a block section, so that the signalling system can determine whether the section is clear or occupied.*
Bogie	A metal frame equipped with two or three wheelsets and able to rotate freely in plan, used in pairs under rail vehicles to improve ride quality and better distribute forces to the track.*
Competent person	A person who is passed as being qualified and has the required knowledge and skills to carry out a particular rule, regulation, instruction or procedure.
Controller of site safety	A member of staff responsible for the application of a safe system of work at a worksite on a railway line.
Down	The direction from Nuneaton towards Whitacre Junction.
Engineering supervisor	The person nominated to manage the safe execution of works within an engineering worksite. This includes arranging the marker boards, authorising movements of trains into and within the worksite and managing access to the site by controllers of site safety.
On-track machine	Any piece of specialist railway plant which moves only on the rails and is normally self-propelled, eg ballast cleaners, dynamic track stabilisers, pneumatic ballast injection machines, tamping and lining machines and track relaying machines.
On-train data recorder	A data recorder fitted to traction units collecting information about the performance of the train.
Person in charge of possession	The competent person nominated to: establish the protection for the possession and its removal at the end of the possession; manage access to the possession area by engineering supervisors; establish engineering worksites within the possession; liaise with the signaller regarding the passage of the train into and out of the possession; and to control the movement of trains between the protection and worksites.

Possession	The closure of a specific section of line to railway traffic to allow engineering work to take place on the infrastructure in accordance with the module T3 of the Rule Book.
Possession limit board	A miniature version of the stop sign used on the roads, denoting the end of a possession.*
Road-rail vehicle	A road vehicle that has been adapted to make it capable of running on railway track as well as on the road.
Stoneblower	A machine that pneumatically injects ballast to automatically restore the vertical and lateral alignment of the track.
Up	The direction from Whitacre Junction to Nuneaton.
Weekly operating notice	A document published by Network Rail providing information about engineering work, speed restrictions, alterations to the network and other relevant information to train drivers.
Worksite	The area within a possession that is managed by an engineering supervisor. A worksite is delimited by marker boards when an engineering train is present. These are illuminated signs placed in the four foot at each end of the work site.
Worksite marker boards	Devices used to delimit the ends of an engineering worksite. They are made of yellow plastic and are fitted with two highway-style flashing road lamps. These show yellow on the worksite side and red on the possession side. One is placed on each track at each end of the worksite, and the area between them is under the jurisdiction of the engineering supervisor.*

Appendix C - Key standards current at the time

GE/RT8000/HB11 Rule Book, issue 1, 'Duties of the person in charge of the possession (PICOP)' June 2011	RSSB
GE/RT8000/HB12 Rule Book, issue 1, 'Duties of the engineering supervisor (ES)' June 2011	RSSB
GM/RT2483 'Visibility requirements for trains', issue 1, June 2004	RSSB
RIS-3776-TOM 'Rail Industry standard on the use of mobile telephonic equipment in driving cabs', issue 1, December 2009	RSSB
GM/TT0170 'Braking system and performance for traction units', issue 1, Revision A, September 1993	British Railways Board
NDS/PLN/LP/070A 'Planning of engineering access', issue 1, January 2012	Network Rail
GM/RT2180 'Visibility and audibility of trains on the track', issue 1, January 1995	Railtrack Plc
NR/L3/NDS/302 'Planning of engineering access and NDS-supplied resource for work deliverers', issue 5, March 2011	Network Rail

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