RAIB
Rail Accident Investigation Branch

Rail Accident Report

Track worker fatality at Ruscombe Junction 29 April 2007

Department for Transport

Report 04/2008
February 2008

This investigation was carried out in accordance with:

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

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Contents

Introduction

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

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

3 Access was freely given by Network Rail and First Great Western to their staff, data and records in connection with the investigation.

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

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

Summary of the report

Key facts about the accident

5 At 11:26 hrs on Sunday 29 April 2007, train 5Z71, the 10:45 hrs empty coaching stock train from Old Oak Common depot to Reading depot, struck and fatally injured a track welder at Ruscombe Junction, 5 miles (8 km) west of Maidenhead station (Figure 1). The accident occurred as train 5Z71 was being routed from the *down* main line towards the down *relief* line via two high speed *crossovers*.

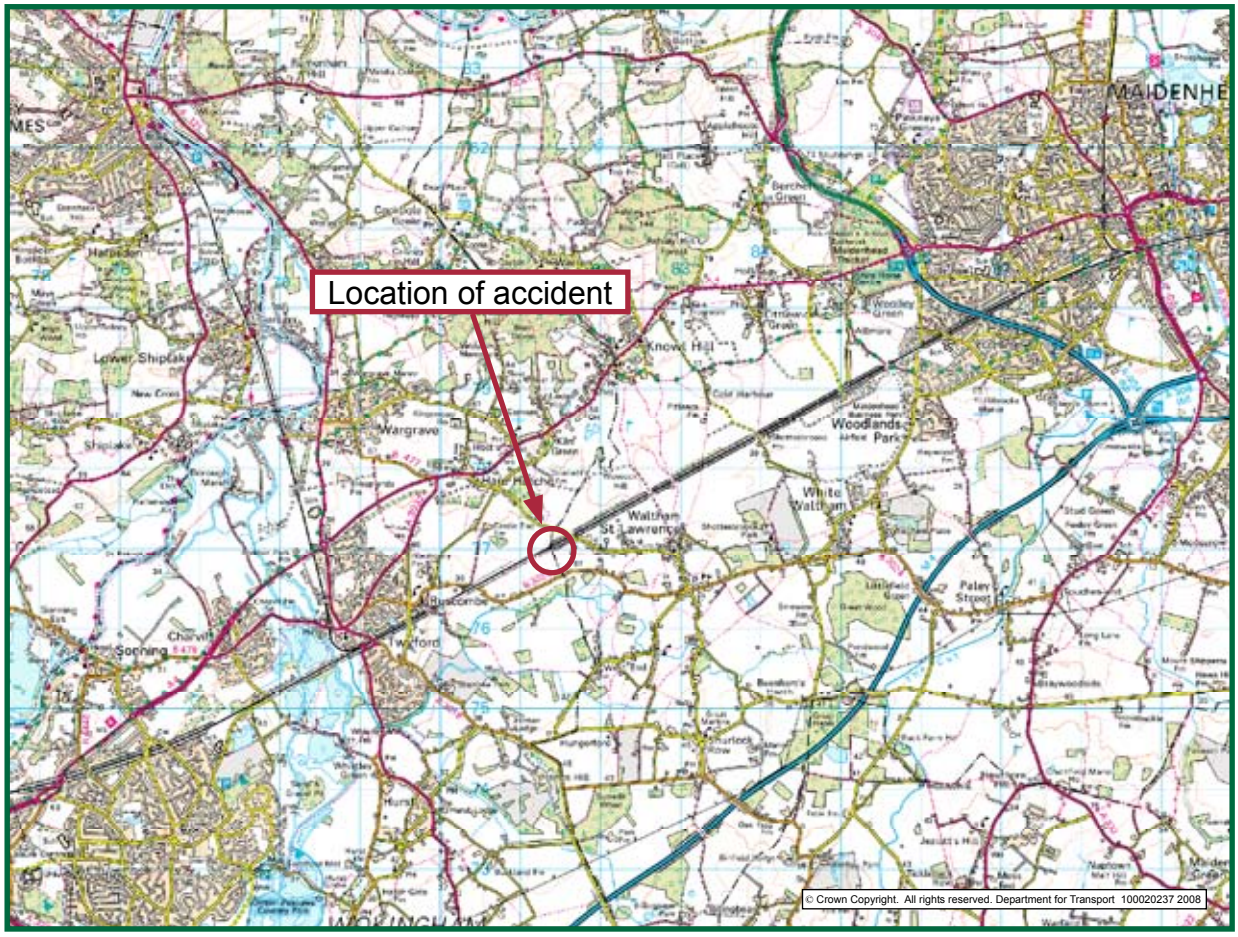


Figure 1: Extract from Ordnance Survey Map showing location of accident

Immediate cause

6 The accident occurred because the welding team did not move to a *position of safety* and the welder was struck by train 5Z71.

Identification of causal factors

7 The welder continued to *arc weld repair* the *crossing nose* even though it is likely that he had been warned both by 'touch' and verbally of the approaching train.

Identification of contributory factors

8 The relationships and interactions within the team affecting safety decision making.

9 The train driver was concentrating on signal R6 and his speedometer as his train approached the junction.

10 The train driver was late perceiving the potential hazard of the staff not moving clear and did not repeatedly sound the horn as he approached the track workers.

Identification of possible contributory factors

11 It is possible that the welder had assumed that the approaching train was not routed towards his site of work.

12 The local practice was that welding repairs should be carried out in the *Red Zone*.

13 Safety tours undertaken at Network Rail's Reading maintenance depot by management and supervisory staff were both infrequent and unrecorded before the accident.

Identification of underlying causes

14 The Rule Book and associated operating documents, such as the *controller of site safety* (COSS) handbook, are not explicit about the correct system of work when working beyond facing points.

Recommendations

15 Recommendations can be found in paragraph 255. They relate to the following areas:

- identification recording and briefing of hazards when working at locations beyond facing points;
- human factors research into the impact of peer pressure, group communications and dynamics on safety decision making in small COSS led work teams;
- rebriefing of all train drivers on the use of a repeated series of horn blasts and the application of the emergency brake;
- rules and training related to working at locations beyond *facing points*;
- implementation of a national plan to reduce the proportion of weld repairs at points and crossovers undertaken in Red zones;
- the mandatory briefing and associated timescales for Safety Bulletins; and
- the implementation of the joint protocol governing the landing of air ambulance helicopters at rail incidents and accidents.

The Accident

Summary of the event

16 At 11:26 hrs on Sunday 29 April 2007, train 5Z71, the 10:45 hrs empty coaching stock train from Old Oak Common depot to Reading depot, struck and fatally injured a track welder at Ruscombe Junction, five miles (8 km) west of Maidenhead station. The accident occurred as train 5Z71 was being routed from the down main line towards the down relief line (Figure 2) via two high speed crossovers. The team involved were the welder, a controller of site safety (COSS) and a *lookout*. The welder was undertaking arc welding repairs to the crossing nose of 850A points in one of the crossovers.

17 The COSS and the lookout were not physically injured. The train was undamaged.

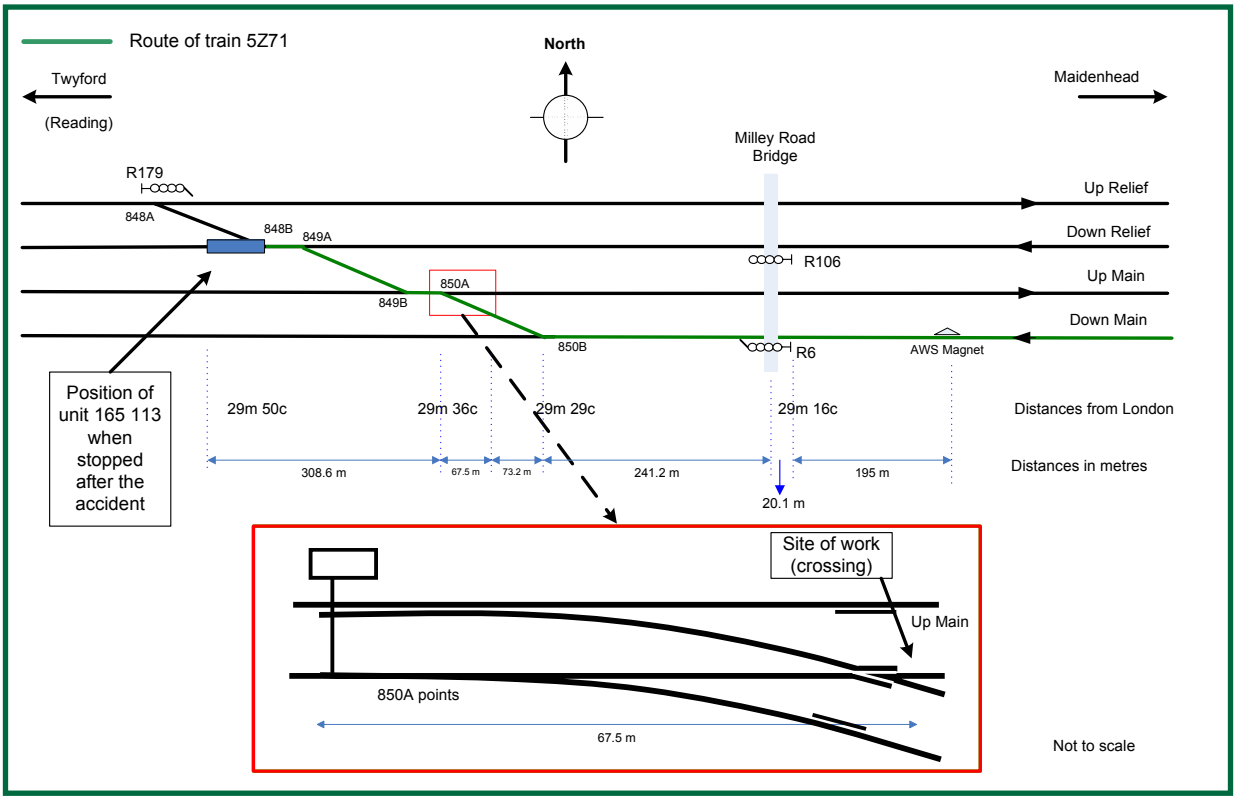


Figure 2: General layout of Ruscombe Junction, showing route of train 5Z71 in green

The parties involved

18 The track in the area of Ruscombe Junction is owned and maintained by Network Rail.

19 All of the track workers involved were employed by Network Rail and worked as part of the Reading *maintenance delivery unit* under the supervision of a welding manager. They were based at Cattle Pens depot at Reading.

20 The train involved in the accident was operated and maintained by First Great Western train operating company.

21 The train driver was employed by First Great Western and was based at Paddington.

Location

22 Ruscombe Junction is located on the railway between London and Reading.

23 At this location there are four parallel, straight and level lines. These are listed below in order, from north to south:

- *up* relief line (used by trains travelling in the direction of London);
- down relief line (used by trains travelling in the direction of Reading);
- up main line (used by trains travelling in the direction of London); and
- down main line (used by trains travelling in the direction of Reading).

24 The highest permitted speed on the main lines is 125 mph (200 km/h).

25 The highest permitted speed on the relief lines is 75 mph (120 km/h).

26 The four lines are connected at Ruscombe Junction by three high speed crossovers. Each crossover is formed by a pair of points and a short interconnecting section of track such that trains are able to transfer from one track to another (Figures 2 and 3).

27 The crossover between the up main line and the down main line has a Network Rail identifying number 850 and the individual points in it are 850A on the up main line and 850B on the down main line.

28 The highest permitted speed for trains changing tracks through the crossovers is 70 mph (112 km/h).

29 The crossovers are provided with signals for the following crossing moves to be made:

- up relief line to up main line; and
- down main line to down relief line.

30 All signalling at Ruscombe is controlled by Reading signal box. Just to the east of Ruscombe is the interface with Slough signal box.

31 None of the running lines at Ruscombe are electrified.

External circumstances

32 At the time of the accident the weather was clear, dry and sunny.

33 Visibility was good and the sighting distance for trains on all lines was well in excess of one mile (1.6 km).

The train involved in the accident

34 The empty passenger train involved in the accident consisted of a single class 165/1 diesel multiple unit (165 113). The class 165, known as a Network Turbo is formed of three cars and was manufactured by British Rail Engineering Limited in 1992.

35 The train was fitted with an *On Train Data Recorder* (OTDR) which records the speed of the train, the operation of the brakes, the horn and the *Train Protection Warning System* (TPWS) and the control positions on the train.

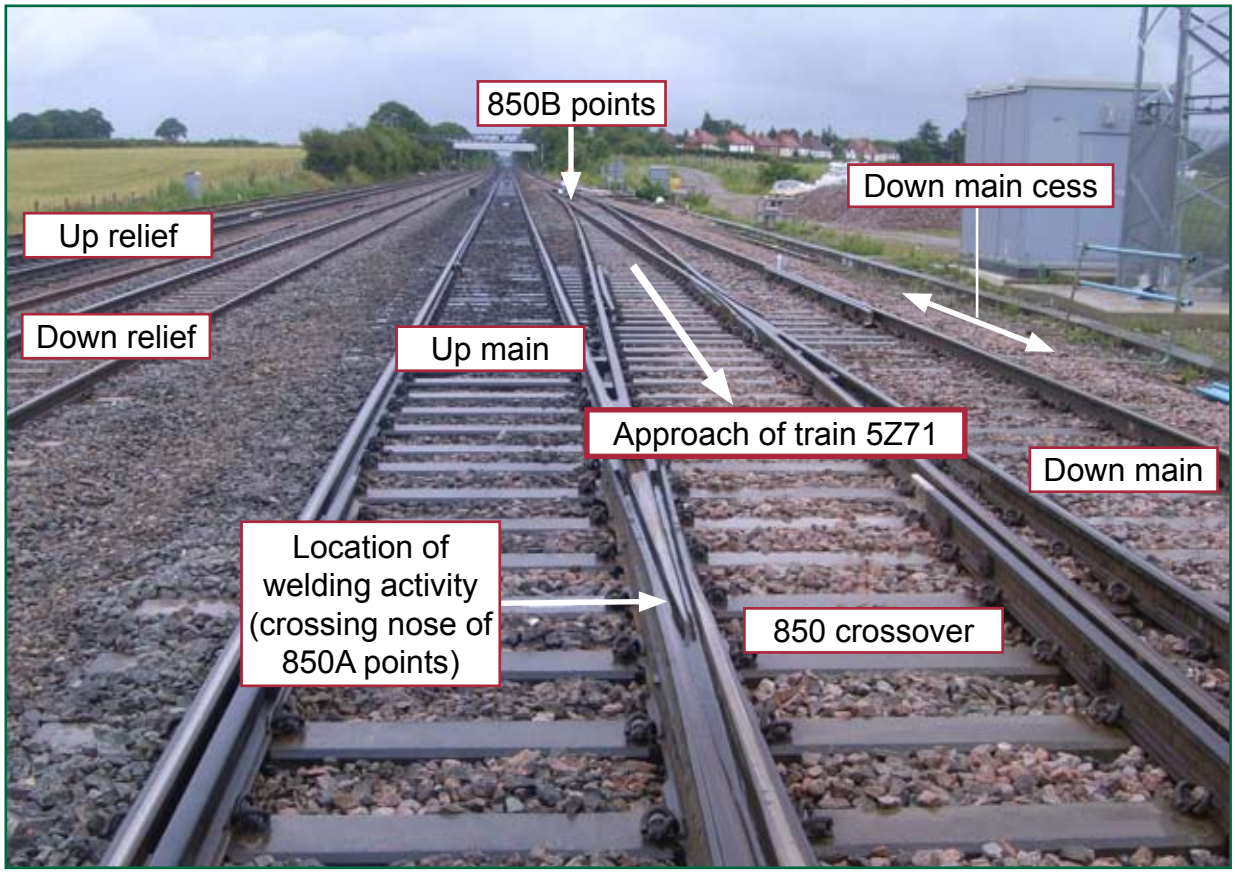


Figure 3: Ruscombe Junction (looking east at the crossing nose of 850A points)

Events preceding the accident

36 Crossovers and especially the crossing nose of a high speed crossover are subject to heavy loading from the regular passage of trains through them and consequently wear rapidly.

37 Damage to the crossing nose is repaired by arc welding. This involves the crossing nose being cut back to sound metal by grinding and weld material being built up in layers. The finished repair is ground to its final profile.

38 The majority of welders undertaking arc welding repairs prefer to sit on a light weight chair. Other welders may kneel on the ground or squat on their haunches to carry out the same work.

39 The welding team from Reading had made repairs to 850B points during daylight hours in the two weeks before the 29 April 2007.

40 The welding team had then been rostered to work a night shift on Saturday 28 April. This shift was cancelled on Friday 27 April because there was no work available and the staff agreed to work on Sunday 29 April instead.

41 The repair to 850A points was therefore planned to take place during daylight hours when the lines concerned were still open to traffic.

42 The welding team booked on at Cattle Pens depot in Reading at 07:30 hrs on the 29 April. Their preceding shift had been an eight hour day shift on Friday 27 April.

43 At about 08:00 hrs on 29 April, the welding team arrived at the access point off Milley Bridge and drove 314 m alongside the railway to the proposed site of work at Ruscombe Junction.

Events during the accident

NOTE

The following paragraphs (44 to 55) give the RAIB's view of the most probable sequence of events at Ruscombe Junction. This has been derived from an analysis of the witness evidence provided by the three persons who observed the accident (the COSS, the lookout and the driver of 5Z71), along with the following other sources of information:

- data obtained from the OTDR system; and
- relevant documentation.

44 The work started at around 08:30 hrs. The method of working adopted was based on the Network Rail approved method of touch warnings (ref. Rule Book, module T6, section 5.1) to be given by the lookout on the approach of all trains after which work would be stopped and all persons would move to the place of safety, the down main *cess*. The method of working was briefed to the staff by the COSS. Touch warnings were chosen for the following reasons:

- there was noise from the two generators placed nearby; and
- the lookout could stand directly behind the welder and not be affected by the arc light emitted during the welding process.

45 The initial welding repairs commenced on the nose of 850A points with the welder sitting on a chair in the *four foot* of the down main line to up main line crossover, on the down main side of the crossing nose of 850A points.

46 Both the COSS and lookout stood directly behind the welder in the four foot of the down main line. The lookout had good sighting of trains approaching from both directions.

47 From 08:30 hrs until 11:08 hrs, 35 trains travelling on both the relief and main lines passed the team. During this time, only one train used the crossovers. This occurred at 09:15 hrs and involved the routing of a train from the up relief line to the up main line. In this case the staff were already in the place of safety in the down main cess as they had moved clear for another train on the down main line. During the period between 08:30 hrs and 11:08 hrs no train was routed from the down main line to the down relief line.

48 At approximately 11:08 hrs, the welder moved over to the other side of the crossing nose and sat in the chair, now positioned in the four foot of the up main line, to continue welding. The lookout and COSS again positioned themselves behind the welder, but now both were standing in the up main line. The lookout had good sighting of trains approaching from both directions and gave touch warnings as before.

49 Following the movement of the staff, the method of working remained unchanged.

50 At 11:20 hrs, the lookout warned of an approaching train on the down main line. It is likely that this was the first train on the down main line after the team had moved to their new positions. The welder was warned of this train by touch and then informed that a train was approaching on the down main line. At this point it is reported that he looked up, verbally confirmed his understanding and said that he would continue working.

51 All of the welding team remained on the track in their positions as described above. The welder continued to carry out welding on the crossing nose.

52 As train 5Z71 neared the work site, in the vicinity of Milley Bridge 314 m away, it is believed that the driver sounded the horn and this was acknowledged by one of the team raising his arm above his head. The welder was given a repeat warning and again the welder responded by looking up, verbally confirming that the train was on the down main line and that he would continue working.

53 At this point, the lookout turned to look for any approaching trains on the up main line, (to check for a train that could potentially trap the team in their position), and as he looked back, he became aware that the train was approaching them from the down main line via the 850 points crossover. The train was now less than 75 m from the team, and the train covered this distance in less than 2.5 seconds.

54 The COSS and the lookout stepped back but remained in the four foot of the up main line as the train passed them. The welder was still sitting in his chair in his working position. His head was struck by the train.

55 The driver made an emergency brake application and the train stopped. The front of the train came to a stand 376 m beyond the crossing nose of 850A points.

Events following the accident

56 The driver of train 5Z71 immediately reported the accident to the signaller. The signaller put all signals in the area to show red to stop any further traffic movements.

57 The COSS immediately reported the accident to the emergency services and also to the signaller.

58 The air ambulance helicopter was the first emergency service unit to arrive, quickly followed by an ambulance vehicle and the police.

59 The train driver, the COSS and the lookout were attended to by members of the ambulance staff.

60 Train services on both the main and relief lines resumed at 15:30 hrs on 29 April 2007.

Consequences of the accident

61 The welder was fatally injured.

62 The other two members of the team were not physically injured although they were shaken by the event.

63 The driver of train 5Z71 was shaken by the event.

The Investigation

Investigation process

64 The incident was notified to the RAIB by Network Rail.

65 The RAIB attended the accident site on 29 April 2007 and initiated a full investigation.

Sources of evidence

66 The main sources of evidence used in this investigation are as follows:

- Witness interviews.
- Discussions with managers and other staff regarding procedures and training.
- Data derived from the OTDR system.
- Photographs and measurements from the site.
- Reconstruction of the accident at site.
- Cab ride through the area of Ruscombe Junction on the down main line.
- Testing of the horn operating control unit from the train involved.
- Testing of the replacement horn operating control unit installed into train 165 113 following the accident.
- Review of relevant planning documentation and applicable Network Rail standards, including the railway Rule Book.
- Meeting with the Office of Rail Regulation (ORR)/ Her Majesty's Railway Inspectorate (HMRI) regarding near-miss incidents.
- Review of other similar incidents including a near miss at Tinsley Green Junction on 17 March 2007, which was investigated by the RAIB. A report on this investigation (number 43/2007) was published on 18 December 2007.

Key Information

Background

Risk profile

67 The number of track workers killed in accidents over the last ten years is shown in Table 1:

Year	Track worker fatalities	Types of accident (excludes road accidents)
2006	**0**	
2005	**3**	Struck by train (x3)
2004	**8**	Struck by road-rail vehicle (x2) Struck by runaway trolley following deliberate tampering with braking system (x4) Fell down tunnel shaft (x1) Injured in collision (x1)
2003	**3**	Struck by plant (x1) Electric shock (x2)
2002	**2**	Crushed by load (x1) Electric shock (x1)
2001	**4**	Struck by train (x4)
2000	**2**	Struck by train (x2)
1999	**2**	Struck by train (x2)
1998	**5**	Struck by train (x3) Off-track (x1) Electric shock (x1)
1997	**0**	

Table 1: Number of track worker fatalities

68 Track workers are subject to levels of risk well in excess of the average for all workers in the railway industry. The RSSB Annual Safety Performance Report (provisional) for 2006 concludes that the risk of fatality per track worker per year is 1 in 8,300 (Figure 4). This compares to 1 in 15,300 for train drivers and 1 in 132,000 average for all workers in the industry.

69 Statistics provided by the RSSB show that the 5-year moving average track worker fatality rate (normalised by staff numbers) for 2006 was roughly similar to that in 2001 (Figure 5). However, this average was influenced by the four fatalities that occurred in 2004 as a direct consequence of a criminal act at Tebay. If the impact of this single event is excluded from the data, the track worker fatality rate is calculated to have fallen by 25 per cent between 2001 and 2006.

70 There were two track worker fatalities during 2007 (Ruscombe Junction on 29 April 2007 and Reading on 29 November 2007).

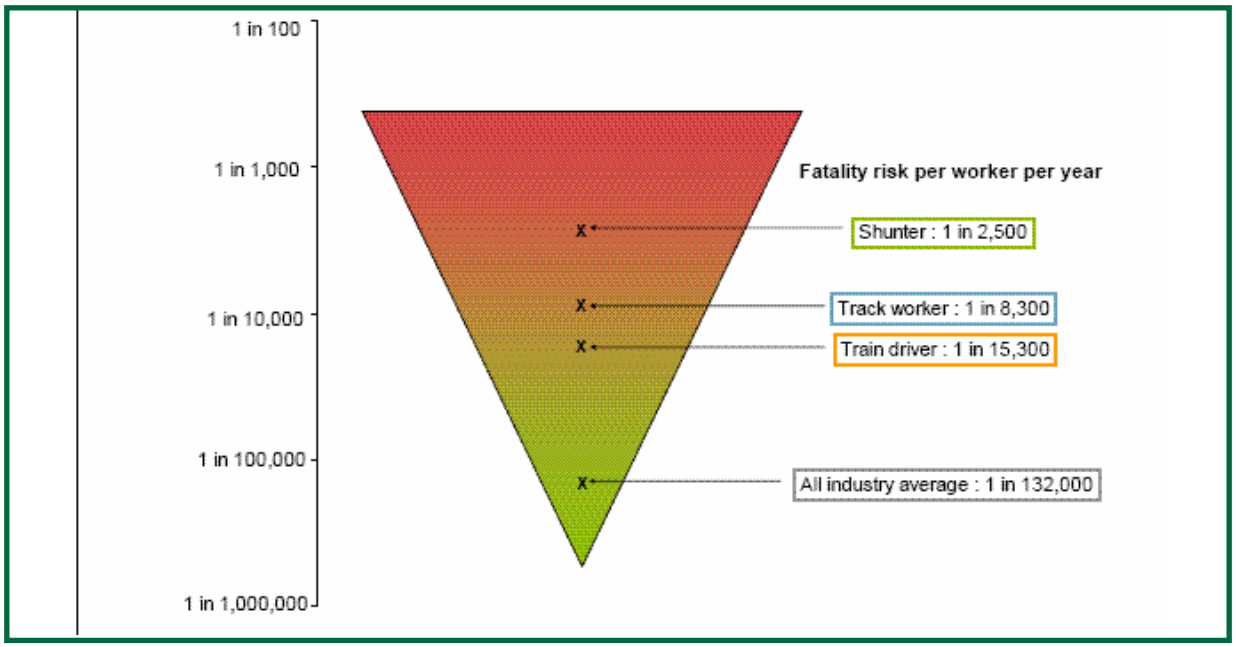


Figure 4: Levels of individual risk (extract from the RSSB Annual Safety Performance report)

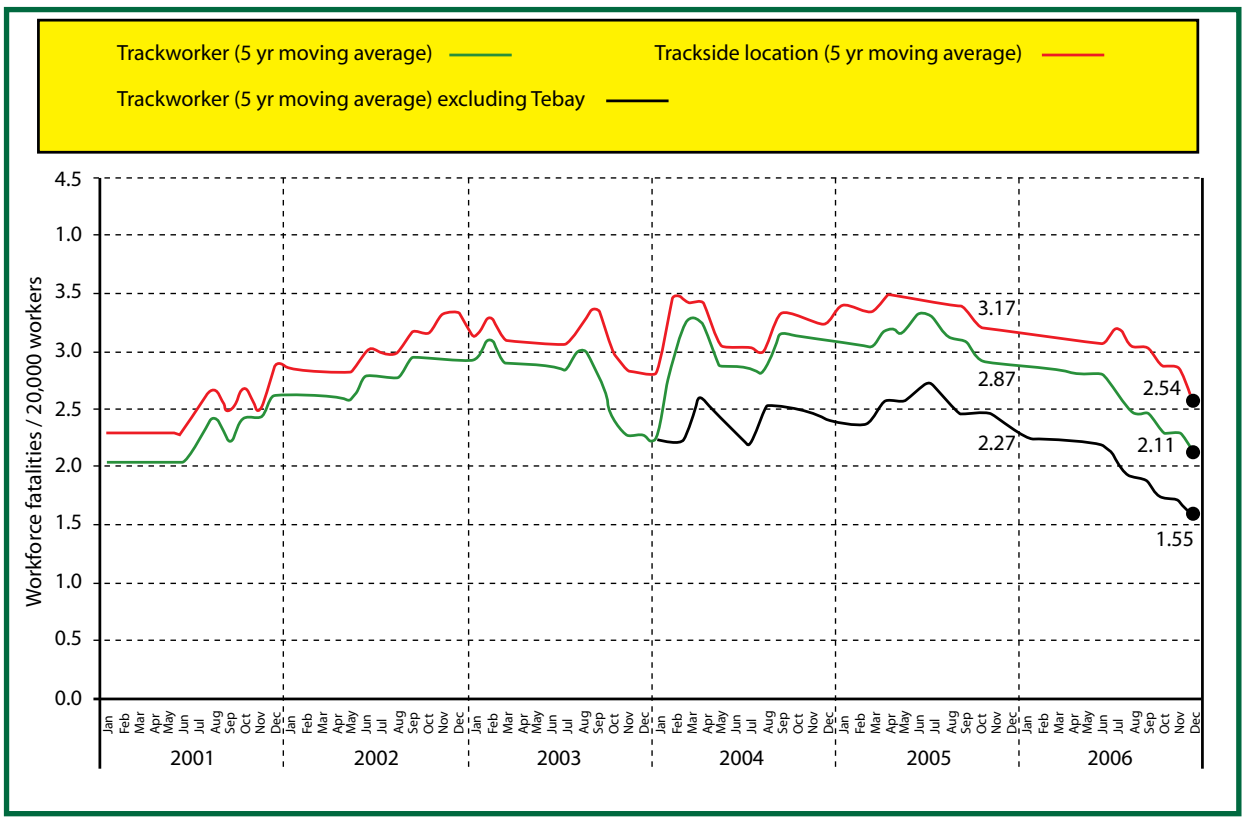


Figure 5: Track worker fatality rates normalised by staff numbers (data provided by RSSB)

Safe systems of work when working on or near the line

71 The Rule Book for the Network Rail system (GE/RT8000) describes two systems of work when undertaking activities on or near the line. These are defined as follows:

- *Green Zone*: a site of work on or near the line within which there are no train movements.
- Red Zone: a site of work on or near the line which is not protected from train movements.

72 Network Rail has a policy that work activities should take place in a Green Zone whenever reasonably practicable. However, to create a Green Zone it is necessary to arrange for there to be no train movements within the work site. To ensure that trains cannot approach, the site of work if on or about the track must be located within a *possession* or other protection.

73 A possession is a total blockage of a line for the normal passage of trains in accordance with arrangements described in module T3 of the Rule Book.

74 If it is not practicable to establish a possession, the Rule Book provides for the protection of a work site by means of special arrangements described in modules T2 and T12 of the Rule Book. The arrangements described in module T2 relate to the protection of engineering work activities. Those in module T12 apply to the protection of activities that last no longer than 30 minutes and do not endanger the safety of the line.

75 The arrangements outlined in modules T2 and T12 do not involve the total blockage of a line but instead are based on the signaller holding signals at danger to prevent the approach of trains while work is taking place. T2 and T12 protection arrangements are generally short-term and are intended to have the minimum impact on train services.

76 Given the above, most T2 and T12 protection arrangements are planned so as not to disrupt the normal passage of trains. These 'non-disruptive T2/12 protection arrangements' are planned to be implemented in the gaps between scheduled train services passing the work site.

77 On occasions it may be necessary to implement 'disruptive T2/12 protection' (ie a T2 or T12 that will disrupt the normal passage of trains). Other than in an emergency it is a requirement that such disruptive protection arrangements are pre-planned and published in the *Weekly Operating Notice*.

78 If it is not possible for a Green Zone to be established by applying module T3, T2 or T12 it is sometimes permissible for work to be carried out in the Red Zone. The rules related to *Red Zone working* are described in the following paragraphs.

Rule Book (modules T6 and T7)

79 The rules relating to the duties of the COSS and site lookout are contained in modules T6 and T7 of the Rule Book. The key provisions relevant to the type of work activities that were being undertaken at Ruscombe Junction on the 29 April are summarised in the following paragraphs.

Duties of all employees (including the lookout)

80 Module T6, section 3.6 informs staff that they will be briefed by the COSS on the hazards applying at a work site. Section 3.6 also requires that staff sign the 'RT9909 COSS Arrangements and Briefing' form, colloquially known as the RIMINI form, to confirm their understanding of the safe system of work (SSOW) that will apply. A further requirement of section 3.6 is that staff should move to a position of safety in the event that there are any doubts about the safe system of work.

81 Module T6, section 5.1, informs staff that they will be briefed by the COSS on the method of warning to be given by the lookout. Section 5.2 lays down the following actions to be taken by staff when a warning is given by the lookout:

- acknowledgement of the warning by raising an arm above the head;
- immediately moving to a position of safety; and
- staying in the position of safety until the COSS states that it is safe to start work again.

82 Module T6, section 7, covers the responsibilities of the lookout. Section 7.6 lists the means by which a lookout should warn members of his group of the approach of a train, as shown in the following extract:

"***b) Immediate Action***

When you see a train approaching ……. you must immediately give a warning to the group.

c) Giving warning by horn, whistle or shouting

You must give a warning by:

- *sounding your horn or whistle; and*
- *by shouting if necessary*

If anyone you are warning does not acknowledge your warning by raising one arm and does not move to a position of safety, you must give a series of short sharp blasts (which means an urgent warning) on the horn, or whistle until everyone has moved to a position of safety.

d) Giving warning by touch

You must immediately touch each person you are responsible for warning. You must repeat the warning to anyone who does not immediately move to a position of safety."

83 Module T6, section 7.10, requires the lookout to give a warning to the group if for any reason he is unable to perform his duties in a safe manner. Once every person in the group has returned to the position of safety he should then explain his concerns to the COSS.

Duties of the COSS

84 Module T7, section 1.1, covers the responsibility of the COSS to make appropriate arrangements associated with work on the line and the requirement for the COSS to ensure that everybody in the group is aware of the hazards that are present. Section 4.6 covers the specific briefing to be provided before work starts and the completion of the RIMINI form and its signature by all persons in the group.

85 Module T7, section 3.1 establishes the responsibility of the COSS for setting up a safe system of work. When the system of work has been pre-planned the COSS must check that the planned arrangements are adequate for the task to be undertaken. If the system of work has not been pre-planned the COSS should select the best available from a list. This list is summarised in Table 2.

Priority	Safe system of work
First	Activities to be undertaken in a Green Zone (ie a site of work on or near the line within which there are no train movements) with varying means of protection
Second	
Third	
Fourth	Activities to be undertaken in a Red Zone with warnings given by automatic systems
Fifth	
Sixth	Activities to be undertaken in a Red Zone with warnings given by a lookout using the *lookout operated warning system*
Seventh	Activities to be undertaken in a Red Zone with warnings given by one or more lookouts

Table 2: Safe systems of work for track working (listed in order of priority)

86 This hierarchy means that activities in the Red Zone with warnings given by one or more lookouts should only be undertaken when all other methods are not available.

87 Module T7, section 3.1, requires the COSS to obtain information about the site including the track layout and the direction from which trains normally approach on each line and other local features which might affect the safety of the system of work. Section 3.3 includes a checklist of factors to be taken into account when planning work on the track.

88 The Rule Book does not require the COSS to notify the signaller of the presence of his team before work commences, although it is good practice for the COSS to contact the signaller to identify whether any wrong direction moves are planned.

89 Module T7, section 9.3, defines the process to be used for ensuring that sufficient warning is given. This requires that the COSS takes into account the following factors:

- the time taken to stop work, put down tools and reach a position of safety;
- the speed of approaching trains; and
- the distance at which a lookout can clearly see an approaching train.

90 Section 9.3 specifies that the COSS must provide adequate warning of trains in both directions. This should include any trains making 'wrong-direction movements on any line at the site of work'.

91 Module T7, section 9.7, defines the ways in which lookouts should be positioned, their competency and equipment. It also requires that no COSS should also act as a lookout and no lookout should be subject to distraction.

92 Module T7, section 9.8, requires the COSS to brief the group on how warning of an approaching train will be given. In the absence of special warning systems the options outlined are:

- horn;
- whistle;
- touch; and
- shouting.

93 This section also lays down the requirement for all staff to be briefed on the location of the lookout(s) and the position of safety. All the details should be recorded on the RIMINI form.

94 The detailed methods for calculating warnings and safety times are contained in Module T7, sections 11 and 12.

Safety management and regulation

Network Rail policy on track safety

95 The management systems for ensuring the correct planning of track maintenance work activities are described in Network Rail Company Standard NR/SP/OHS/019 entitled 'Safety of people working on or near the line'. This requires Network Rail and its contractors to ensure that as much work as is reasonably possible is programmed to take place in Green Zones. This requirement is facilitated by the publication of a *Green Zone Guide* containing information about when it is possible to block one or more lines without disrupting train services and the arrangements for 'booking' blockages of the line.

96 The Green Zone Guide is a national document that is available via the Network Rail intranet. It shows the predicted availability of opportunities for *Green Zone working*. This is presented in the form of periods of time during which no trains are scheduled to pass on different lines at selected locations. Appendix C contains an extract from the Green Zone Guide showing the predicted Green Zone opportunities at Ruscombe Junction (for weekdays, Saturdays and Sundays).

97 Network Rail has identified the need to formalise the arrangements for managers to personally monitor and record safety behaviour on the track. This has led to the implementation of a new standard maintenance procedure on April 01 2007 entitled 'Safety Tours' (NR/PRC/MTC/SE0118). This standard imposed the requirement for Territory Maintenance Managers, Infrastructure Maintenance Managers and Maintenance Delivery Unit Managers to carry out a minimum of six planned systematic safety tours each year to allow management to:

- observe safety behaviour and culture;
- observe work site conditions;
- observe unsafe acts and conditions;
- to provide a visible and practical indication of management's commitment to safety; and
- to provide an opportunity for communication between management and track maintenance staff.

ORR(HMRI)

98 During 2006 the ORR(HMRI) area based teams were expressing concern about the number of near-miss incidents involving track workers that were occurring and the behaviour that inspectors had observed. For this reason it was decided to establish a national programme of visits to work sites by ORR(HMRI) inspectors in order to further assess the safety behaviour of track workers. As a consequence approximately 200 visits to track maintenance work sites throughout Britain were carried out. Visits involved discussions with maintenance staff, inspection of planning documentation and staff competency checks. In addition, inspectors observed the systems of work that had been established and the behaviour of staff.

99 Following the above visits the qualitative findings were collated by the ORR(HMRI) Principal Inspector who was responsible for leading on topics associated with track safety. The key findings were as shown:

- planning was mostly done, but often not done well;
- Red Zone working with lookout protection was the norm for maintenance;
- track workers had a preference for Red Zone working;
- non-compliance with rules, often giving rise to risk, was common;
- track maintenance staff were generally competent;
- poor planning and compliance often went unchallenged by staff at all levels; and
- Network Rail's monitoring of compliance with standards was ineffective.

100 The above findings caused ORR(HMRI) to conclude that Network Rail was not satisfactorily protecting the safety of track maintenance workers.

101 As a consequence of the above ORR(HMRI) gave active consideration to taking enforcement action to require improvements. However, ORR(HMRI) withdrew this proposal following a meeting in December 2006 during which Network Rail presented to ORR(HMRI) a programme of work designed to deliver improved staff behaviour and safety management.

102 In view of Network Rail's stated aim of improving track worker safety and the above mentioned programme of work ORR(HMRI) wrote to Network Rail in February 2007. This letter formally advised Network Rail of the inspection work undertaken by ORR(HMRI), and confirmed that HMRI was intending to repeat its programme of work site inspections between September and December 2007 with the objective of assessing the extent to which safety was improving.

103 This investigation has confirmed that ORR(HMRI) are in progress with the above inspections.

Details of the accident at Ruscombe Junction

Planning of the work

104 Repairs to 850B points had been undertaken by the same welding team during the two weeks before the 29 April 2007. This work was carried out during daylight hours when the lines concerned were still open to traffic ie in a Red Zone.

105 The staff interviewed as part of this investigation estimated that about 95 per cent of their arc welding repair activities are undertaken in Red Zone working, with lines concerned still open to traffic.

106 The welding team had been rostered to work a night shift on Saturday 28 April. This shift was cancelled on Friday 27 April because there was no work available and the staff agreed to work on Sunday 29 April instead.

107 Subsequently, on Friday 27 April, the welding manager prepared the RIMINI form as was normal for works to be undertaken by the welding team.

108 The RIMINI form was correctly completed.

109 The welding manager had added a note to the RIMINI form identifying the presence of a crossover at the site of work as a hazard to be taken into account. This reminded staff that trains can be routed over crossovers and that it should not always be assumed that trains will be routed by the straight route. The manager had also included this note in the RIMINI forms he had produced for previous work on 850B points at Ruscombe Junction since 24 April 2007.

110 The welding manager had inserted this note after reading the Network Rail maintenance Safety Bulletin no. 28, 'Near miss with train at Tinsley Green Junction on 17 March 2007'. This incident involved a welder who had jumped clear of a train that had been routed through a high speed crossover (ref. RAIB report No. 43/2007).

111 The welding manager had also attached an extract from the *sectional appendix* to the RIMINI form showing the track layout, direction of train movements and line speeds in the Ruscombe Junction area. The track layout correctly showed the high speed crossovers at Ruscombe Junction.

Safety Briefing

112 In the week before the accident, the welding manager had cancelled a safety brief to the welders because of work commitments generated by a programme of Network Rail internal audits. This brief was to have covered Safety Bulletin no. 28. The track maintenance engineer, to whom the welding manager reported, had planned to brief maintenance Safety Bulletin no. 28 to all welding staff at Cattle Pens depot in the week beginning 30 April 2007. There is no mandated time by which Safety Bulletin no. 28 had to be briefed to staff

The actions of the staff involved

NOTE

The following paragraphs (113 to 127) gives the RAIB's view of the most probable actions of the staff involved. It is based on an analysis of witness evidence provided by the two persons who were with the welder at the time of the accident, the COSS and the lookout and also the driver of train 5Z71. Relevant documentation has also been taken into account.

The COSS

113 On Friday 27 April 2007, the welding manager printed a copy of the RIMINI form (paragraph 107) and left it at the Cattle Pens depot for the COSS to pick up on the morning of Sunday 29 April before travelling to Ruscombe Junction.

114 The COSS provided the team with a briefing, based on the contents of the RIMINI form, in the down main cess at Ruscombe Junction before the work started. The briefing had included a reminder that all lines were open to traffic and the following description of the system of work to be applied:

- work was to take place under Red Zone conditions with a lookout to provide warnings of all approaching trains;
- the lookout was to stand close behind the welder and to give warnings by the use of 'touch' on the approach of any train; and
- when warned by the lookout, the team should go to the position of safety, the down main cess adjacent to the down main line (Figure 3).

115 It is not clear whether the risk associated with the presence of the crossover was described during the above briefing.

116 Before work started, the COSS calculated the *required warning time* (25 seconds), the *warning distance* needed and the *sighting distance* available. The correctly calculated values derived for up trains and down trains were in accordance with the methodology laid down in sections 11 and 12 of Module T7 and recorded on the RIMINI form. These values confirmed that the sighting distance available was sufficient for work to take place in safety.

117 The COSS had not filled in the 'sighting distance available' section on page 7 on the RIMINI form (Appendix D). However, the sighting distance for trains on all lines was well in excess of one mile (1.6 km) (paragraph 33).

118 The lookout and welder then signed the RIMINI form to confirm their understanding. At this point neither the lookout nor the welder raised any queries.

119 A copy of the completed and signed RIMINI form is at Appendix D.

The lookout

120 The lookout arrived with the other team members at 08:00 hrs at the access point off Milley Bridge. The lookout understood the COSS briefing to mean that he should remain behind and close to the welder and warn of the approach of trains on any line by the 'touch' method, after which the team would move to the position of safety nominated by the COSS.

121 Once the work had started, the lookout gave warnings of the approach of all trains, both by touch and by verbally informing the others of which line the train was approaching on; e.g. 'there is one on the down main.'

122 When the welder was working from the four foot of the crossover, the entire team moved to the position of safety on the approach of all trains on the up and down main lines. However, in the case of trains on the up relief line (a total of around seven), the team continued their work. The team were not in danger from trains travelling on the down relief line.

123 The lookout did not question the system of work that had been established. He perceived both the COSS and especially the welder to be experienced and knowledgeable.

The welder

124 The welder arrived with the other team members at 08:00 hrs at the access point off Milley Bridge.

125 Following the COSS briefing the welder requested that he be given a warning when a train was sighted far in the distance (a distance in excess of the minimum sighting distance required) so that welding repairs could be cleaned up before the team moved to their place of safety.

126 The welder's work at the crossing nose was nearly complete when the accident occurred. The welder was undertaking his final weld following some grinding work on the nose of 850A points.

127 The welder was expected home at lunchtime. There is evidence that the welder asked the COSS and the lookout to remind him when it was 11:30 hrs.

128 The Network Rail company phone issued to the welder had not been used for any voice calls on the 29 April.

The train driver

129 Train 5Z71 comprised empty coaches and was not booked to stop at any stations between Old Oak Common depot and Reading station.

130 The train passed through Maidenhead station at approximately 11:19 hrs and approached the Ruscombe Junction area at a speed of 73 mph (117 km/h). The driver had received the correct *signal aspect sequence* for the down main line to down relief line route that had been set at Ruscombe Junction. Signal R6, the junction signal, was showing a single yellow aspect with an illuminated *junction indicator*.

131 As the driver passed over the *Automatic Warning System* (AWS*)* magnet at signal R6, (195 metres on the approach to signal R6 - Figure 2), he applied the brake in order to slow his train to the authorised speed for the junction of 70 mph (112 km/h). While the train was braking he noticed some track maintenance staff working on the track ahead. The train had decelerated to a speed of 68 mph (109 km/h). He noticed that one of the group was welding.

132 Although not detected by the OTDR (paragraph 156), it is believed that at this point the train driver sounded the horn and the COSS acknowledged this. No members of the welding team moved clear (paragraph 52).

133 The driver remained concentrating on signal R6 in case it changed aspect. As the train neared the signal it changed from a single yellow aspect with an illuminated junction indicator to a green aspect with an illuminated junction indicator.

134 As the train passed signal R6, it was 334.5 m away from the site of work. This was 11 seconds before reaching the welder.

135 As the train approached the welding team, they continued to work and did not move clear.

136 When the train arrived at the facing end of 850B points (the start of the crossover), it was 73.2 m away from the site of work, 2.48 seconds before reaching it.

137 The driver applied the full emergency brake 334.5 m after passing signal R6 and just after he struck the welder. The train was travelling at 66 mph (106 km/h).

138 After coming to a stand with his cab 376 m beyond the site of work, the driver immediately contacted the signaller before climbing down onto the track. The driver then proceeded to the down main cess to await the emergency services.

Competence

The staff involved

139 All staff on site were qualified for the work they were undertaking and their respective certification was in order.

140 The welder had worked on the railway for 20 years and as a senior welder at the Reading depot for over three years. The COSS had worked on the railway for two and a half years and was a trainee welder. The lookout had worked on the railway for one and a half years and was also was a trainee welder.

141 The welder had previously been a COSS but had failed his Red Zone assessment in August 2004 and was unwilling to undertake any further COSS training.

142 The welder had had a previous disciplinary offence on his record in October 2005. This involved a safety breach of the Rule Book and unauthorised work, as part of a group of other staff, outside an engineering possession without setting up a safe system of work. The matter was concluded by a final written warning to the welder in November 2005.

143 Both the COSS and lookout had clean safety and disciplinary records.

144 The train driver had worked as a train driver since December 1999; initially for Thames Trains and subsequently for First Great Western. He had a clean safety and disciplinary record.

145 All three members of the welding team had undergone technical and safety competence assessments as part of Network Rail's 'Assessment in the Line' (AITL) process. This process had been introduced in December 2006 for all Network Rail maintenance personnel.

146 The welder had undergone a safety (Personal Track Safety (PTS) and lookout) and a technical AITL in February and March 2007. This was undertaken by the Competence Assurance Team Leader. Performance reports for track safety and technical competencies were completed and endorsed by the welder and the welding manager. The Network Rail AITL summary showed that the welder passed his PTS at level 3 (competent) and lookout at level 3 (competent). However he failed his Safety Critical Communication at level 2 (trained, requires mentorship). The welding manager undertook the mentoring of the welder.

147 The COSS had undergone a safety (PTS, COSS and lookout) and a technical AITL in February 2007 and March 2007. This was undertaken by the Competence Assurance Team Leader. Performance reports for track safety and technical competencies were completed and endorsed by the COSS and the welding manager.

148 The Network Rail AITL summary showed that the COSS passed his PTS at level 3 (competent), lookout at level 3 (competent), COSS at level 3 (competent) and Safety Critical Communication at level 3 (competent).

149 The lookout had undergone a safety (PTS and lookout) and a technical AITL in February and March 2007. This was undertaken by the Competence Assurance Team Leader. Performance reports for track safety and technical competencies were completed and endorsed by the lookout and the welding manager. The Network Rail AITL summary showed that the lookout passed his PTS at level 3 (competent) and lookout at level 3 (competent). However he failed his Safety Critical Communication at level 2 (trained, requires mentorship). Mentoring was undertaken by the welding manager.

150 Had the accident had not taken place, the welding team intended to return to Ruscombe Junction on Monday 30 April to continue the arc welding repairs. However, the welder's *Sentinel* card, (PTS AC & DC) expired at midnight on 29 April but he had been issued with an 'authority to work' form to work on or near the line the following week by the AITL system.

151 The welding manager had been briefed by the AITL team to undertake the AITL process for his staff. The manager had also been trained as a *D32 assessor* in February 2003.

152 The welding manager was not formally trained to complete the RIMINI form although this was done correctly.

153 On Friday 27 April, a Network Rail Mobile Operations Manager (MOM) made an unannounced visit to the welding team working at Ruscombe Junction. The MOM checked through the COSS's RIMINI form and assessed their SSOW. The MOM offered advice to the COSS about the positioning of the lookout. The MOM did not find any problems with the completion of the form and the SSOW that had been set up. During the MOM's inspection, the welding manager also arrived to inform the staff that their Saturday night shift had been cancelled.

The content of Network Rail track safety training

154 Neither the initial, nor the refresher COSS training material, explain to the trainer or trainees the correct method of working beyond facing points or in an area with high speed crossovers.

155 Page 65 of the December 2006 (issue 8) of the Network Rail COSS trainers' material stated that working at junctions and crossovers 'must be taken into account when setting up a SSOW'. However, no detail is given of the working arrangements to be applied at such locations. Witness evidence including a Network Rail trainer suggests that trainers do not read out verbatim everything that is written down in their training material.

Performance of the train

156 Witness evidence suggests that the train horn was sounded once as the train approached the welding team at Ruscombe Junction. After the accident the horn (on the driving end of coach 58965 1st class end) on the unit involved in the accident (165 113) was tested by First Great Western and found to be operating correctly.

157 On the day of the accident, the OTDR did not register that the horn had been operated, although when the horn was tested by First Great Western after the accident, the OTDR did record this fact.

158 The horn is operated by the driver with a small joystick handle, with a high or low tone emitted when the handle is moved from its central 'off' position (the handle is moved forward for a high tone and backwards for a low tone). Micro-switches are installed as part of the horn control unit to interface and input into the OTDR when operated.

159 On the 30 April 2007 the horn operating control unit was removed from unit 165 113, (on the driving end of coach 58965 1st class end).

160 The horn operating control unit from the driving end of the unit involved in the accident (165 113) and also a new control unit subsequently fitted in the driving end of coach 58965 was tested by the RAIB with the following results:

- Both horn operating control units were working correctly.
- It is possible to operate the horn at maximum volume without operating the micro-switches.
- The horn handle operating end can be moved 2 centimetres in either direction from its central position before the micro-switches will operate. The handle then has another 1 cm of travel left before it reaches its limit.
- On both units, the horn sounded at maximum volume as soon as the drivers handle is slightly moved either forwards or backwards.

161 The operation of the horn including the micro-switches and OTDR interface are tested whenever the train receives *scheduled maintenance* and if found not to be working correctly, the complete horn operating control unit is replaced.

162 The braking performance of the train involved has been analysed using data derived from the OTDR, table 3.

163 The braking performance was consistent with Railway Group Standard GM/RT2044, 'Braking System Requirements and Performance for Multiple Units'.

Speed of response	Time duration (secs) from the first application of the emergency brake to the first measurable retardation of speed	2.0
Emergency braking rate	Deceleration (m/s/s)	1.5
Distance to stop (from 66 mph)	Distance (in metres) from the first application of the emergency brake to the train coming to a stand	381
Time to stop (from 66 mph)	Time (in secs) from the first application of the emergency brake to the train coming to a stand	20
Wheel slide protection system	Nil activation	

Table 3: Braking performance of unit 165 113

Response to the accident

164 The British Transport Police (BTP) breathalysed both the COSS and lookout directly after the accident. Both results were negative.

165 The BTP breathalysed the driver of train 5Z71 directly after the accident. The result was negative.

166 Following any accident on the railway, and in line with either Railway Group Standard GE/RT/8070 or current industry good practice, all those directly involved with an accident should be screened for the presence of alcohol or drugs.

167 Despite assurances given to the RAIB immediately after the accident, the COSS and the lookout were not 'for cause' drugs and alcohol screened on the day of the accident. This was due to confusion between Network Rail and the BTP.

168 The on-call manager of First Great Western decided not to 'for cause' drugs and alcohol screen the train driver on the day of the accident. The driver had remained at the site to be interviewed and there were no facilities available to facilitate the screening process. A driver competence manager accompanied the driver whilst on site and escorted the driver home after the interviews had been completed.

169 Toxicology analysis undertaken for the pathologist has indicated that the welder was not under the influence of alcohol or drugs at the time of the accident.

170 The Air Ambulance helicopter was deployed by the South Central Ambulance Service, NHS Berkshire Division, as part of the emergency response to the accident. The helicopter arrived at Ruscombe Junction at approximately 11:35 hrs and landed approximately 100 m from the site of the accident, (between Milley Bridge and 850B points) across the down and up main railway lines (Figure 2).

171 The helicopter landed on the railway lines without formal permission from Network Rail. There was some confusion in the terms used in the conversation between the Network Rail control and the Ambulance control as to whether the lines were blocked and all trains had been stopped.

Other previous accidents/ incidents

172 On 17 March 2007, a welder was nearly struck by a train at Tinsley Green Junction, near Gatwick, in similar circumstances to those at Ruscombe Junction. This incident is also the subject of a RAIB investigation (ref. RAIB report No 43/2007), which was not concluded at the time of the Ruscombe accident.

173 On 2 July 2006, an air ambulance helicopter landed across the tracks at Burnham in response to an accident. The helicopter landed without permission from Network Rail. In this instance train movements had been stopped on the four railway lines at Burnham and a serious accident was avoided. A joint operating procedure was subsequently written by Network Rail and the air ambulance team to prevent this type of incident happening again.

Urgent Safety Advice

174 The RAIB issued an Urgent Safety Advice to Network Rail, (dated 3 May 2007), following the incident at Tinsley Green Junction and the accident at Ruscombe Junction. This can be found in Appendix E.

Analysis

The reliability of the evidence

175 There is no independent account of the actions taken by the parties at the site (i.e. there is no uninvolved observer). For this reason it is impossible to be completely certain as to the sequence of events and actions taken by the COSS and the lookout. Nevertheless, after careful analysis of the witness and other evidence, the RAIB has found no substantive reason to doubt that the events and actions were broadly as described in paragraphs 44 to 55 and 113 to 127.

Identification of the immediate cause

176 The accident occurred because the welding team did not move to a position of safety and the welder was struck by train 5Z71.

Identification of causal and contributory factors

Planning of the work

The decision that the work be undertaken in the Red Zone

177 Had the repairs to the crossing been carried out when trains were stopped (ie if the work had been within a Green Zone) this accident could not have occurred. However, the welding manager who requested that this work be undertaken in the Red Zone has argued that there was no practicable alternative available at the time.

178 There was a range of impediments to the establishment of Green Zone working that had applied when the task was planned on Friday 27 April. These were as follows:

1. Arc welding repairs are undertaken during daylight hours. This is the preferred method of work by welders from the Reading area. The anecdotal reason given is that the welders can observe the work they are undertaking and the passage (and weight effects) of a train over their repair work.
2. There was no suitable T3 possession in which the work could take place during daylight hours.
3. There was limited opportunity, even during night hours and at weekends, for the application of T2 protection arrangements without disrupting train services (Appendix C).
4. Implementation of T2 protection would have required the deployment of three persons to act as handsignallers at the protecting signals and/or place detonators (ref. module T2H). This deployment of additional resource would have been contrary to the guidance contained in Network Rail standard NR/SP/OHS/019. This states:

   'generally you should not use Green Zone protection if to do so would increase the number of man/hours involved with the work, including time spent track-side waiting for the Green Zone and the time spent setting up the protection, by more than 25 per cent. This is because the additional risks begin to outweigh the safety benefits'.
5. The duration of the planned work precluded the work taking place in accordance with T12 protection arrangements.

179 The welding manager's decision of 27 April 2007 to carry out the welding work under Red Zone conditions conforms with the local (unwritten) practice to limit most welding to daylight hours. Had the welding manager considered welding at night, it is more likely that the work could have been scheduled in a Green Zone. The local preference to weld crossings in daylight was a possible contributory factor to the accident.

180 Network Rail's professional head of welding is of the opinion that arc welding repairs may be undertaken at night. He also contends that there is no requirement to witness the passage of a train over the work.

181 Arc welding repair activities in the areas covered by the former Southern region of Network Rail are normally undertaken within engineering possessions and at night, i.e. when the majority of train movements have been stopped. This is partly because welding cannot be safely undertaken on a running rail adjacent to a live 750V DC third rail.

182 The RAIB has assessed the inherent safety of Ruscombe Junction. This assessment has taken into account the excellent sighting distances in both directions and the wide, easily accessible, positions of safety. No physical factors have been identified at Ruscombe Junction that could have prevented the implementation of safe Red Zone working arrangements.

RIMINI forms

183 The welding manager, without input from a *works scheduler*, prepared all RIMINI forms for the welding teams at Reading including the form for the 29 April 2007. This was contrary to the process laid down in Network Rail company standard NR/PRC/MTC/PL0094, 'Planning and documenting the safe system of work arrangements'. However, the welding manager had completed the form correctly and had some additional comments and information attached to assist the COSS in his duties.

184 The welding manager had added a note to the form identifying the presence of a crossover at the site of work as a hazard to be taken into account. The welding manager had also attached an extract from the sectional appendix to the form showing the track layout, direction of train movements and line speeds in the Ruscombe Junction area.

185 The information contained within the RIMINI form was neither causal nor contributory to the accident.

186 The work was planned at short notice on Friday 27 April because the welding team were suddenly made available following the cancellation of the Saturday 28 April night shift. The short term planning period played no part in the accident.

The behaviour of the welder

Why did the welder not perceive the risk?

187 The apparent reluctance of the welder to move to a position of safety suggests that he did not believe that the train approaching on the down main could be routed via the crossover. The reasons for this remain unclear. However it is possible that this belief arose because no trains had been routed from the down main line to the down relief line on the day of the accident.

188 For the first part of the work carried out on 850A points crossing nose, when the welder was sitting in the four foot of the crossover, the welding team would have had to move to a position of safety for every train that approached them on the down and up main lines.

189 When the welder moved to his new position, sitting in the up main line, he was now clear of trains travelling on the down main line through the junction. When the lookout warned of a train approaching on the down main, it appears that the welder no longer perceived any risk from the train. He acknowledged that he was aware of the train to both the COSS and lookout and continued working.

190 The investigation has revealed that welding teams in the Reading area will sometimes continue to work beyond facing points if they believe that an approaching train is not routed towards the site of work. This unofficial method of working is based on observing the position of points (colloquially known as 'point watching') to determine the routing of the train. It is therefore possible that the welder had become used to remaining in position beyond a set of facing points. This may have desensitised him to the risk at such locations and modified his behaviour when warned of an approaching train.

191 Given the above, it is possible that the welder had made the assumption that it was safe to work despite the warning that had been given. This assumption may have been based on an erroneous belief that the lookout or COSS was observing the lie of the points. Alternatively, the welder may have become so engrossed in his task that he was unable to fully assess the situation.

192 There is no evidence to suggest that point watching was discussed at the brief given by the COSS before the work commenced.

193 Welding management and supervisory staff are aware that 'point watching' is taking place. Furthermore, it has been suggested by some managers in Network Rail that any prohibition of this practice would greatly impede the efficiency of work activities at some locations (eg the approach to London termini). This is seen as a particular issue with welding because the quality of a weld can be affected by numerous interruptions to the work.

194 The risk of relying on the position of points in order to predict the route of an approaching train is not formally covered in either the COSS or lookout training although the training material states that when a warning is received of an approaching train, all staff must move clear immediately. Critically, no definition of what constitutes 'an approaching train' is given.

195 Given the above factors, it is possible that an erroneous assumption by the welder that the train was not routed towards his site of work was a possible contributory factor.

Why did the welder not stop work?

196 Witness evidence from the investigation has shown that the welder was sometimes slow to move clear from the line to a position of safety when warned by a lookout. It has been alleged that this was a common practice of welding staff when working beyond facing points. Witnesses have stated that on some previous occasions on other days (when warned by a lookout) the welder did not move clear at all and continued work while trains travelled past on adjacent lines.

197 There is witness evidence to suggest that the welder also sometimes found it difficult to follow instructions given to him by younger, less experienced staff.

198 The nature of arc weld repairs can result in welders being reluctant to interrupt work, down tools and move off the track. Undertaking weld repairs is time consuming and significant time is lost if the work is interrupted.

199 Arc welding work requires close concentration by the welder. The welder holds a welding protection mask in front of his face to protect his eyes from the arc light emitted during the welding. In his other hand, the welder holds other tools to construct the weld. The face mask has a small window in which the welder sees his work and with generators running close by (to provide power for the welding tools), the welder can be deeply absorbed in the work.

200 At Ruscombe, the welder's work at the crossing nose was nearing completion before the accident occurred. The welder was undertaking his final weld following some grinding work on the nose of 850A points. The welder requested that he be told when it was 11:30 hrs (paragraph 127). It is therefore possible that the welder was keen to finish his last repair and was reluctant to interrupt his welding work when he was so close to completing it.

201 The apparent reluctance of the welder to move to a position of safety when informed of the approach of train 5Z71 was therefore a causal factor.

The behaviour of the COSS and Lookout

Why did the COSS or the lookout not perceive the risk?

202 Both the COSS and the lookout involved in this accident at Ruscombe Junction have stated that they were told during training that the position of points should not be relied upon as an indication of the route set. They stated that they never watch the points but will always warn of the approach of all trains. Neither the COSS nor the lookout noticed that 850 crossover was in the *reverse* position[1].

203 On the occasions mentioned in paragraph 196, the COSS and lookout would also remain with the welder as trains travelled past. The COSS and lookout were both less experienced than the welder. Witness evidence suggests that they would tend to follow the welder's lead and remain with him for the following reasons:

- when working with the same welder, he would not always move to a position of safety in these circumstances;
- both the COSS and lookout were trainee welders and therefore looked to the welder for professional guidance;
- the welder was an experienced member of staff; and
- they were unwilling to leave the welder alone on the track if they went to the position of safety.

Why did the COSS and lookout not move clear?

204 There is no evidence of any conflict between the team members, but the evidence suggests that the team appeared to work in the way that the welder wanted the team to work. This sometimes appeared to be in conflict with the safe system of work that the COSS had set up and briefed to the team.

205 There is witness evidence that on previous days the welder and COSS had had discussions about when the welder should have moved clear for a train. There is evidence to suggest that the COSS was briefing a system of work based on the contents of the RIMINI form. However, the actual method of working was informal and controlled mainly by the welder.

[1] The switch toes of 850A and 850B points could be clearly seen from the site of work in their reverse position.

206 On the day of the accident, following the last warning given by the lookout of a train approaching on the down main line, the lookout turned to look out for trains approaching on the up main or relief lines. Given that the team was not in a position of safety at this point the lookout was now focussed on the risk of a train approaching in the up direction causing the team to become trapped. Neither the lookout nor the COSS considered the possibility that the train approaching on the down main line might also be routed towards them.

207 Neither the COSS nor the lookout were able to pull the welder clear of train 5Z71 because they both expected the train to travel straight past them on the down main line and not use the crossover. They were both shocked and surprised when they realised that the train was approaching them (the time taken for the train to reach them from the switch tips of 850B points was less than 2.5 seconds), and as the train approached at 66 mph (102 km/h) they both stumbled backwards. In the short period of time before the train reached them, they were both unable to reach out and pull the welder away.

Further observations

208 The welder had requested that the lookout gave an additional warning when a train was sighted far in the distance so that welding repairs could be cleaned up before the team moved to their place of safety.

209 This was an informal way of working and in breach of the Rule Book (module T6, section 5.2). The safe system of work was therefore based on providing information of approaching trains to the welder, rather than on a simple unambiguous warning that a train was approaching the work site.

Team dynamics

210 The actions of the team reveal a number of behavioural issues affecting safety decision making. These include the following:

- the influence of peer pressure;
- the interaction between the experienced welder and his less experienced colleagues;
- leadership and authority in small work teams; and
- group communications within the teams.

211 Given the issues identified above, it is concluded that the relationships and interactions of the team was a contributory factor.

The driving of the train

Why did the driver of train 5Z71 not perceive the risk?

212 The driving of the train on the approach to Ruscombe Junction was normal and without incident. The driver had correctly adjusted the train's speed on the approach to the junction and was aware of signal R6, the junction signal, displaying a single yellow aspect with an illuminated junction indicator.

213 The driver knew that his next signal would be at red if the junction signal remained at single yellow. The driver continued to concentrate on signal R6 as his train approached in case the signal changed to a less restrictive aspect and further braking could be avoided. The signal changed to a green aspect with an illuminated junction indicator as the train approached.

214 At this time, the driver was also aware of the track workers on the line ahead including the arc light emitting from the arc welding equipment being used by the welder.

215 There is evidence to suggest that the train driver sounded the horn once on his approach to signal R6 and that he was acknowledged by one member of the group which reassured him that they would move to their position of safety.

216 Train drivers encounter staff working in Red Zones regularly every day and are not expected to slow their trains for them unless it becomes clear that the staff are not moving clear. The train driver must sound a warning (and is also required to repeat it) if the warning is not acknowledged and/ or the staff do not appear to be moving clear of the line (ref. Rule Book, module TW1, section 10.2). In reality, train drivers would not expect every member of a team to acknowledge the warning as some persons may be working at the time.

217 The driver did not perceive the potential hazard of the staff not moving clear of his train until he was close to their work site.

The driver's actions

218 The driver was concentrating on signal R6 and this may have caused him to be distracted. The driver may also have been briefly distracted by looking at the train's speedometer, to ascertain if the train was at the correct speed for the diverging route. The driver's focus on the signal and the speedometer is therefore seen as contributory factor.

219 When the driver realised that the team had not moved, he could not believe what he was seeing and took no immediate action. It is likely that this was due to a lack of familiarity with the situation he was encountering combined with an element of shock.

The driver's behaviour as he approached the welding team

220 Had the driver repeatedly sounded the horn after passing signal R6, at approximately 240 m from the tips of 850B points, then the welding team might have been alerted that the train was crossing over from the down main line across to the down relief line and moved clear at the last moment. The fact that he did not do so is a contributory factor.

221 Evidence from the OTDR shows that the driver applied the emergency brake just after he struck the welder. The RAIB has calculated that had the driver applied the emergency brake 210 metres from the worksite (the earliest the driver might reasonably be expected to apply the emergency brakes in this situation[2]) this would have provided only 0.7 seconds extra for the welder to move clear. It is therefore unlikely that delay in the application of the emergency brake was a causal or contributory factor.

Monitoring of staff behaviour.

222 The monitoring and checking of Network Rail staff at work on or about the line was carried out as part of general safety inspections. These have been undertaken at Reading depot by various management and supervisory staff. However, they were both infrequent and unrecorded.

223 Network Rail company standard, NR/PRC/MTC/SE0118 Issue 1 'Standard Maintenance Procedure - Safety Tours' was first issued in September 2006 with a compliance date of 1 April 2007. All monitoring of staff on site, since 1 April, is now recorded and the records kept by Network Rail within the maintenance delivery unit at Reading.

224 Had there been more effective monitoring and supervision of track workers in the Reading area, it is possible that the behaviour of welding teams may have been detected and corrected at an earlier opportunity (paragraph 100). This is therefore seen as a possible contributory factor.

[2] Based on an assessment of actual driver performance during a near-miss incident at Tinsley Green on 17 March 2007 (Ref RAIB report No. 43/2007)

Identification of underlying causes

Role of the Rule Book and COSS handbook

225 Module T7, section 9.7, of the Rule Book defines the ways in which a COSS should use a lookout to provide warning of the approach of trains. This section states that the lookout should give a warning of the approach of trains. The term 'approach of trains' is not defined. It could be argued that the need to move to a position of safety only applies if the train is approaching on a route that is set towards the work site. Furthermore, there is no explicit description in the Rule Book, or the COSS handbook, of the arrangements that should be applied when working beyond facing points or on a crossover.

226 Both the Rule Book and the COSS handbook are silent on whether it is permitted to check the lie of the points before deciding on the need to move to the position of safety.

227 This lack of clarity and explicit instruction means that it has become possible for an unofficial system of work to develop based on observing the lie of points, and it is possible that the welder assumed that such a system was in place and thus decided to continue welding.

228 There is a need for the Rule Book and all subsidiary documents to provide clear instructions on how lookouts should be deployed when staff are working beyond facing points or on a crossover. In developing these instructions the railway industry should take into account the hazards associated with 'point watching'. These hazards include:

- lookouts may be distracted from observing approaching trains because they were looking at the position of switch toes; and
- the position of points and the associated route could be misread.

229 The lack of clarity in the presentation of safety rules was an underlying cause of this accident.

Other issues identified during the investigation

Train Horn

230 If the driver's handle is only moved lightly away from its central position, the micro-switches within the train horn operating control unit (that are directly connected to the OTDR) do not operate (paragraph 157).

231 Although the micro-switches do not operate every time the horn is sounded, it has been proved that the horn will sound at maximum volume (high or low tone) as soon as the drivers handle is moved away from its central position.

232 The above design characteristics have resulted in the absence of evidence as to when the horn was sounded. However, this factor was neither causal or contributory to the accident.

Air Ambulance Helicopter landing

233 The helicopter landed on the railway lines without formal permission from Network Rail due to confusion between the Network Rail control and the Ambulance control as to whether the lines were blocked and all trains had been stopped.

234 There was no actual risk to trains and the helicopter because all train movements had been immediately stopped following the telephone call between the driver of train 5Z71 and the signaller.

235 However, were this scenario to occur in different circumstances where the trains had not been immediately stopped or stopped only on the main lines (and the relief lines were still open to traffic), then there would have been potential for a serious accident.

236 This investigation is also aware of the incident of an air ambulance landing at Burnham (paragraph 173) and is therefore concerned that the NHS and Network Rail should ensure that the existing joint protocol is sufficient and correctly implemented.

Conclusions

Immediate cause

237 The accident occurred because the welding team did not move to a position of safety and the welder was struck by train 5Z71 (paragraph 176).

Causal factors

238 The welder continued to arc weld repair the crossing nose even though it is likely that he had been warned both by 'touch' and verbally of the approaching train (paragraph 201, **Recommendation 1**).

Contributory factors

239 The relationships and interactions within the team affecting safety decision making (paragraph 211, **Recommendation 2**).

240 The train driver was concentrating on signal R6 and his speedometer as his train approached the junction (paragraph 218, **Recommendation 3**).

241 The train driver was late perceiving the potential hazard of the staff not moving clear and did not repeatedly sound the horn as he approached the track workers (paragraph 220, **Recommendation 3**).

Possible contributory factors

242 It is possible that the welder had assumed that the approaching train was not routed towards his site of work (paragraph 195, **Recommendation 4**).

243 The local practice was that welding repairs should be carried out in the Red Zone (paragraph 179, **Recommendation 5**).

244 Safety inspections undertaken at Network Rail's Reading depot by management and supervisory staff were both infrequent and unrecorded before the accident (paragraph 224).

Underlying causes

245 The Rule Book and associated operating documents, such as the COSS handbook, are not explicit about the correct system of work when working beyond facing points (paragraph 229, **Recommendation 4**).

Additional observations

246 There is no Network Rail procedure in respect of how and when Safety Bulletins are briefed to their staff (paragraph 112, **Recommendation 6**).

247 Neither the train driver, the COSS nor the lookout were 'for cause' drugs and alcohol screened after the accident. This is not in line with either Railway Group Standard GE/RT/8070 or current industry good practice, whereby all those directly involved with an accident are immediately 'for cause' screened (paragraphs 164 to 168).

248 Micro-switches within the train horn operating control unit that are directly connected to the OTDR do not operate if the drivers handle is only slightly moved away from its central position (paragraph 231).

The emergency response

249 The air ambulance helicopter landed on the railway lines without permission from Network Rail, although there was confusion between the Network Rail control and the Ambulance control on whether the lines were blocked and all trains had been stopped.

250 Fortunately, at the time that the helicopter landed, all train movements had been stopped by the Network Rail signaller (paragraph 236, **Recommendation 7**).

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

251 The RAIB issued an Urgent Safety Advice to Network Rail following the accident on 4 May 2007. The urgent safety advice warned of the potential risks working at high speed crossovers especially beyond facing points (Appendix E).

252 Network Rail has published a Safety Bulletin (no 29) dated 1 May 2007, which was issued to all maintenance staff. They have also issued a full formal investigation report into the accident. The investigation report contains sixteen recommendations and nine local actions for implementation.

253 First Great Western have briefed drivers not to expect track workers to move clear just because they have acknowledged the train warning horn, to remain vigilant to the presence of track workers throughout the train's approach and be prepared to operate the emergency brake should the driver feel the safety of the track workers is compromised.

254 The South Central Ambulance Service, NHS Berkshire Division, in consultation with Network Rail has issued a new instruction to their air ambulance that the helicopter will not land on or within 3 m of the railway track. This instruction will also be amended in the air ambulance operational manual.

Recommendations

255 The following safety recommendations are made[3]:

Recommendations to address causal factors

1 Network Rail should update the COSS handbook and associated training material with the objective of ensuring that staff that are qualified to act as COSS are fully aware of the hazards associated with working in a Red Zone at locations beyond facing points and can set up appropriate safe systems of work (paragraph 238). Included in the revised documentation should be a clear definition of the term 'approaching train' (paragraph 194).

Recommendations to address contributory factors

2 Network Rail, in consultation with RSSB, should carry out human factors research into the impact of peer pressure, group communications and dynamics on safety decision making in small COSS led work teams. This should include a consideration of how teams are constituted and how a relatively inexperienced COSS can deliver authority, compliant behaviour, leadership and a challenge function. The findings of this research should be used to inform a review of training and management systems (paragraph 239).

3 First Great Western should rebrief all train drivers on the use of a repeated series of horn blasts and the application of the emergency brake. Driver training modules should be updated to include a scenario of track workers not moving clear of an approaching train (paragraphs 241 and 253).

Recommendations to address possible contributory factors

4 Associated rules (eg Rule Book, module T7) and training documentation should clearly state that when working beyond facing points lookouts should give a warning, and staff move to the position of safety, for all trains approaching those points in the facing direction (paragraphs 242 and 245).

5 Network Rail should implement a national plan to reduce the proportion of weld repairs at points and crossovers undertaken in Red Zones so far as is reasonably practicable (paragraph 243).

continued

[3] Those identified in the recommendations have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to ORR(HMRI), to enable them to carry out their duties under regulation 12(2) to:

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken. Recommendation 7 is also addressed for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005 to the National Health Service.

Copies of both the regulations and the accompanying guidance notes (paragraphs 167 to 171) can be found on RAIB's web site at www.raib.gov.uk

Recommendations to address other observations

6 Network Rail should introduce a procedure that mandates the briefing of Safety Bulletins to its staff within specified timescales (paragraph 246).

Recommendations to address issues associated with the emergency response

7 Network Rail and the National Health Service (NHS) should take steps to correctly implement the existing protocol governing the landing of air ambulance helicopters at rail incidents and accidents (paragraph 250).

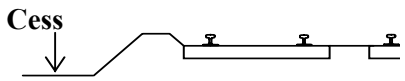
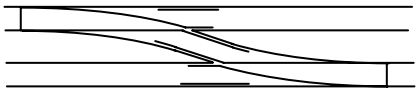
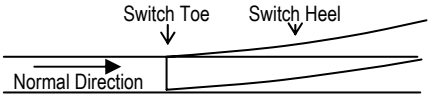
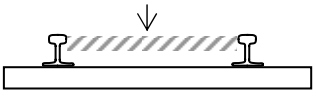
Appendices

Glossary of abbreviations and acronyms — Appendix A

AITL	Assessment in the Line
AWS	Automatic Warning System
COSS	Controller of Site Safety
MDUM	Maintenance Delivery Unit Manager
MOM	Mobile Operations Manager
NHS	National Health Service
ORR (HMRI)	Office of Rail Regulation (Her Majesty's Railway Inspectorate)
OTDR	On train data recorder
PTS	Personal Track Safety
RAIB	Rail Accident Investigation Branch
RSSB	Rail Safety and Standards Board
SSOW	Safe System of Work

Glossary of terms — Appendix B

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

Arc welding repairs	The repair of cracks, damage and wear to Crossings and Rails using the electric arc welding process. The area concerned is cut back to sound metal using an angle grinder, with Dye Penetrant Inspection (DPI) and Magnetic Particle Inspection (MPI) being used to ensure that all necessary suspect metal is removed. The weld material is then built up in layers and the finished repair ground to its final profile.*
Automatic Warning System (AWS)	A safety system for alerting drivers about the signal aspect or speed restriction ahead, sounding a horn in the cab for a red, single or double yellow aspect or a bell to indicate a green signal.
Cess	The part of the track bed outside the ballast shoulder that is deliberately maintained lower than the sleeper bottom to aid drainage.* 
Controller of Site Safety (COSS)	A person holding a safety critical qualification demonstrating the holder's competency to arrange a safe system of work *
Crossing nose	The blunt machined end of a crossing vee.* 
Crossover(s)	Two turnouts that are connected to permit movements between parallel tracks.* 
D32 assessor	A National Vocational Qualification (NVQ) for supervisors to become more effective 'in-house' trainers. NVQ's are work related, competence based qualifications.
Down (main/relief line)	Lines normally used by trains in the direction of Reading (westbound).
Facing point	A Set of Points or Set of Switches installed so that Traffic travels from Switch Toe to Switch Heel in the Normal Direction of traffic. Also Facer, Facing, Facing Points.* 
Four foot	The area between the two running rails of a standard gauge railway. The actual dimension of this space is 1435 mm (4' 8½").* 
Green Zone	A site of work on or near the line within which there are no train movements.
Green Zone Guide	A publication containing information about when it is possible to block one or more lines without disrupting train services and the arrangements for 'booking' blockages of the line.*
Green Zone working	Carrying out work activities in the Green Zone.

Junction indicator	An arrangement of lines of white lights mounted above a Colour Light Signal which, when lit, displays the Diverging Route through a Junction to a driver. They are used for high speed Lines.*
Lookout	The person responsible for warning the team of the approach of trains.
Lookout Operated Warning System	The generic term for any system that warns staff of the approach of trains triggered by a lookout.*
Maintenance delivery unit	A unit consisting of staff responsible for the maintenance of an area of railway and reporting to an infrastructure maintenance manager.
On Train Data Recorder	A data recorder fitted to traction units collecting information about the performance of the train.
Position of safety	A place far enough from the track to allow a person to safely avoid being struck by passing trains.*
Possession	A period of time during which one or more tracks are blocked to trains to permit work to be safely carried out on or near the line.*
Red Zone	A site of work on or near the line which is not protected from train movements.
Red Zone working	Carrying out work activities in a Red Zone.
Relief (line)	Alternative title for a slow line, mainly used on the Western region.*
Required warning time	The time required for everyone in the group to stop work & down tools, to reach a position of safety (plus ten seconds) and take into account lookout variables. The warning time in conjunction with permitted train speeds is calculated to find the sighting distance.
Reverse (points)	Lie of a set of points when they are in the opposite position to that shown on the signalling scheme plan. In many cases this is a diverging route.*
Sectional Appendix	The publication produced by each Network Rail Route containing key operational data such as details of Running Lines, train speeds and directions. Location information is given in miles and chains.*
Sentinel (card)	A competency database operated by NCCA on behalf of Network Rail. The system records designated personal safety and technical skills and issues Sentinel cards to authorised persons following training events carried out by approved training providers.
Scheduled maintenance	A planned series of examinations carried out on trains with specified frequency and content.
Sighting distance	The distance at which trains must be detected by equipment or be clearly in view of the lookout. The distance is calculated from the Sighting Distance Chart taking into consideration the permitted speed of the approaching train and the minimum warning time needed to reach a position of safety.*
Signal aspect sequence	A sequence of signal aspects shown to the train driver that relay certain routing and section clear information to him.

Train Protection Warning System	An automatic trackside and trainborne system which stops trains that pass signals at danger so as to mitigate the risk of a collision.
Up (main/relief line)	Lines normally used by trains in the direction of Paddington (eastbound).
Warning distance	The distance which is required to enable a warning which gives everyone in the group time to reach a position of safety at least ten seconds before the train arrives.
Weekly Operating Notice	A document providing information about engineering work, speed restrictions, alterations to the network and other relevant information to train drivers and other operating and engineering staff .*
Wheel Slide Protection System (WSP)	WSP systems are fitted to modern rolling stock with the twin objectives of minimising extension of stopping distances under low adhesion conditions and avoiding damage to wheels during slides. They work by automatically releasing and re-applying the brake on slipping wheelsets in order to find and make use of the maximum level of adhesion available.
Works Scheduler	A person responsible for planning work activities.

Green Time Working

X 1-20min, L 21-40min, M 41-59min, H 60min

	00:00-01:00	01:00-01:59	02:00-02:59	03:00-03:59	04:00-04:59	05:00-05:59	06:00-07:00	07:00-07:59	08:00-08:59	09:00-09:59	10:00-10:59	11:00-11:59	12:00-12:59	13:00-13:59	14:00-14:59	15:00-15:59	16:00-16:59	17:00-17:59	18:00-18:59	19:00-19:59	20:00-20:59	21:00-21:59	22:00-22:59	23:00-23:59
LOCATION							**Ruscombe**	**Weekdays**																
DM	L	M	H	L	L	M	L	X	X	X	X	X	X	X	X	X	X	X	X	X	X	L	L	
DRL	L	L	M	M	L	L	L	X	X	X	X	X	X	X	X	X	L	X	X	X	X	X	X	
UM	M	H	M	H	L	H	L	X	X	X	X	X	X	X	X	X	X	X	X	X	L	L	L	
URL	L	L	L	X	L	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	L	
LOCATION							**Ruscombe**	**Saturday**																
DM	L	M	H	L	H	M	L	X	X	X	X	X	X	X	X	X	X	X	L	X	L	L	L	
DRL	L	L	L	M	L	H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
UM	M	H	M	H	L	M	M	X	X	X	X	X	X	X	X	X	X	X	L	L	L	X	L	
URL	L	X	L	M	L	L	X	X	X	X	X	X	X	X	X	X	X	X	X	L	L	L	L	
LOCATION							**Ruscombe**	**Sunday**																
DM	L	H	H	H	H	H	H	H	L	L	X	L	X	L	X	L	X	X	X	X	X	X	L	L
DRL	L	L	H	H	H	H	H	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
UM	H	H	H	H	H	H	H	H	M	L	L	L	L	X	L	L	L	X	X	L	L	L	L	M
URL	M	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	X	L	L	X	X	L	L	L

Copy of the completed and signed RIMINI form **Appendix D**

COSS RECORD OF ARRANGEMENTS AND BRIEFING FORM RT9909

RED ZONE

MLN1

Note!!!!!!!

- It is down to the c.o.s.s to make sure that

The site is safe!!!!!!!

If the paperwork is not right

- Then inform your manager

Network Rail

If it is not safe then don't do it!!!!!!!

Hard hats will be mandatory from 01/04/04

Page 1 of 9

COSS RECORD OF ARRANGEMENTS AND BRIEFING FORM RT9909
SELECTION OF SAFE SYTEM OF WORK ON OR NEAR THE LINE

Date of work: 29/04/07	**Time of work: 07:30**
Nature of Work: Arc repair 850A crossing	
Location: Ruscombe	

The following safe systems of work are organised in priority order. Each should be considered with the highest achievable syste consistent with the nature, location and duration of the work being selected.

If a safe system of work **IS** selected, tick the **YES** box next to the system. When this has been done the Authorisation section at the foot of the form should be completed. This Authorisation should only be given by a manager/supervisor with line responsibili for the work. This manager/supervisor may also complete the form.

Protection Systems 1 to 3 (Green Zone Working)
If a Green Zone method of protection **IS NOT** selected, tick the **NO** box next to the method, provide an explanation in the box below and then consider the next method. If none of the methods of protection is selected, consider the Red Zone methods of warning below.

	SAFE SYSTEM OF WORK	SELECTED?	
		YES	NO
1	**Safeguarded Green Zone** *If this method is NOT selected, please give reasons here* All lines open, no 20min slots		✓
2	**Fenced Green Zone** *If this method is NOT selected, please give reasons here* All lines open, no 20min slots		✓
3	**Separated Green Zone** *If this method is NOT selected, please give reasons here* All lines open, no 20min slots		✓

Warning Systems 4 to 7 (Red Zone Working)
If work is to be carried out under Red Zone conditions, the following Supplementary Red Zone Questions must first be answered. If the answer to any of the questions is **YES,** Red Zone working **IS NOT** permitted and a Green Zone must be selected. If all of the questions are answered **NO,** continue overleaf.

SUPPLEMENTARY RED ZONE QUESTIONS		YES	NO
A	Is the line speed greater than 125mph (200kph)? (Answer NO if a temporary or emergency speed restriction to 125mph (200kph) or less applies)?		✓
B	Does the total warning time required exceed 45 seconds?		✓
C	Are there three or more lines open to traffic between the site of work and the designated position(s) of safety?		✓
D	Does the Railtrack Hazard Directory prohibit Red Zone working at this location?		✓

CONTINUED OVERLEAF

COSS RECORD OF ARRANGEMENTS AND BRIEFING FORM RT9909

Red Zone method of warning **IS NOT** selected tick the **NO** box next to the method, provide an explanation in the bo below and then consider the next method. If none of the methods of warning 4 to 7 is selected, consider Red Zone Working with Unassisted Lookout (Method 8).

	SAFE SYSTEM OF WORK (continued)	YES	NO
4	**Red Zone with Automatic Track Warning System (ATWS)** *If this method is NOT selected, please give reasons here* **None installed**		✓
5	**Red Zone with Train Operated Warning System (TOWS), supplemented where necessary by other warnings** *If this method is NOT selected, please give reasons here* **None installed**		✓
6	**Red Zone with Lookout Operated Warning System (LOWS)** ***There are no no safer systems available due to urgency of work*** **None installed**		✓
7	**Red Zone with Pee Wee activated by lookout** *If this method is NOT selected, please give reasons here* **Banned**		✓

Red Zone Working with Unassisted Lookout (Method 8)

Warning by unassisted lookout is regarded as the last resort. If work is to be carried under Red Zone conditions with warning given by unassisted lookout, the following Supplementary Red Zone with Unassisted Lookout Questions must first be answered. If the answer to any c the questions is **YES,** Red Zone working with warning given by unassisted lookout **IS NOT** permitted and an alternative safe system of work must be selected. If both of the questions are answered **NO,** tick the **YES** box next to the method and complete the Authorisation section at th foot of the form.

SUPPLEMENTARY RED ZONE WITH UNASSISTED LOOKOUT QUESTIONS		YES	NO
E	Are more than two lookouts (excluding site and touch lookouts) required to provide warning of trains approaching from any one direction?		✓
F	Are more than four lookouts (excluding site and touch lookouts) required to provide warning of trains approaching from all directions?		✓
G	Is the sighting distance that can be achieved with lookouts insufficient to provide the warning time required?		✓

	SAFE SYSTEM OF WORK (continued)	YES	NO
8	**Red Zone Working with Lookout**	✓	

Authorisation

Authorised by	
Name:	**Position: Welding Manager**
Signed:	**Date:** 27/04/07

COSS RECORD OF ARRANGEMENTS AND BRIEFING FORM RT9909

GENERAL INFORMATION					
Name of COSS				Sentinel Card No	
Date	29-04-07				
Nature of work*	**Arc repair 850A crossing**				
Time work started	8:00			Time work finished	15:00
Location and lines affected*	**Ruscombe** 29m34c to 29m34c Up & Down Main				
How to contact the Signaller in an emergency*	**Reading PSB 0118 959906, 078 2397 Fault Control 01793 515758**				

Lines at the site*	Dn Main	Up Main	Dn RLF	Up RLF	**Notes:**
Direction (any SLW etc?)	Down	Up	Down	Up	**All platforms are Red zone banned. Coss to brief that the cross over's at Ruscombe are 70mph and never assume that trains will go strait on.**
Open or blocked?*	OP	OP	OP	OP	**Nearest Hospital** **Royal Berks A/E** **London Road Reading** **Tel: 01189 875111**
Speed (line or T/ESR)	125	125	75	75	

Access and egress arrangements to/from working area*	**Milley Bridge**
Hazards associated with access/egress (conductor rails, tripping, vegetation, overhead cables or OLE, etc.)*	**General underfoot hazards normally associated with track work. Sleepers, rails and vegetation, Hardhat site.**
Hazards associated with the site (conductor rails, tripping, vegetation, overhead cables or OLE, buried services, etc.)*	**General underfoot hazards normally associated with track work. Sleepers, rails and vegetation, Hardhat site. Welding hot work, Grinding**
Limits of the working area and how these are defined*	**On site by coss**
Permit to work arrangements (AC or DC lines) if appropriate. If no permit to work is held electrified lines are LIVE*	**N/A**

SAFE SYSTEM OF WORK				
*Tick the relevant box. Only tick the "Planned" column if **you have been provided with** a planned safe system of work.*	Walking on or near the line to/from the working area		Whilst carrying out the work	
	Planned*	Actual	Planned*	Actual
Safeguarded Green Zone,				
Fenced Green Zone				
Separated Green Zone				
Red Zone with ATWS				
Red Zone with TOWS				
Red Zone with LOWS				
Red Zone with Pee Wee				
Red Zone with Lookout(s) only	✓		✓	

COSS RECORD OF ARRANGEMENTS AND BRIEFING FORM RT9909

Reason and authority for change from planned safe system of work	

GREEN ZONE WORKING ONLY (complete as applicable)*	
Type of fence (fenced only)	
Distance from line (fenced only)	
Separation distance (separated only)	
How Site Warden will give the warning (separated only)	

RED ZONE WORKING ONLY	
How the warning will be given*	**Touch**
Location(s) of position(s) of safety	ROUND MAIN CESS

Details of any SEPARATED GREEN ZONE Site Wardens, RED ZONE ATWS Operator or RED ZONE Lookouts (TOWS, LOWS, Pee Wee, distant, intermediate, site, machine or touch)

Name	Sentinel Card No	Location	Role
		Site	LKT

DECLARATION (Each member of the group to sign to confirm they have been briefed)

Signature	Sentinel Card No	Signature	Sentinel Card No

COSS DECLARATION. I have made the above arrangements and am satisfied that all members of the work group understand the safe system of work.	
Signature	

re the work is pre-planned, these parts of the form should be completed before it is provided to the COSS

COSS RECORD OF ARRANGEMENTS AND BRIEFING FORM RT9909

Checklist for IWA & COSS

Item	Item Considered?
Location and limits of work, how limits are to be marked	✓
Nature of work	✓
Hazard Directory information/restrictions applicable	✓
RED zone prohibitions	
Buried services, etc.	
Line speed and signalled directions of movements	
Electrified lines	
Permit to work needed? Arrangements?	
Access and egress	✓
Access point(s)	✓
Arrangements for getting to/from site	✓
Hazards not listed in Hazard Directory	✓
Tripping Hazards	✓
Obstructed Cess	
Restricted sighting	
Limited clearances, etc.	
Work related hazards	✓
Lines blockages required (Possession worksite, T(ii) or (i))	
Any possession arrangements (in worksite or not?)	
Method of protection/warning	✓
Safeguarded GREEN zone	
Fenced GREEN zone (installation/dismantling plan)	
Rigid or tensioned barrier	
2m or 6'6" (line speed over 100 mph)	
1.25m or (line speed over 100 mph or less)	
Netting of barricade tape	
2m or 6'6" (line speed over 40 mph or less)	
1.25m or 4' (line speed 40 mph or less)	
Separated GREEN zone	
2m or 6'6" with Site Warden(s) (How many? Who?)	
3m or 10' to nearest line	
2m or 6'6" working alone or with one other	
RED zone with ATWS (design, installation, operator)	
RED zone with TOWS	
RED zone with LOWS (design installation, Lookout, operator)	
RED zone with Lookout(s) and Pee Wee (calculate warning time and sighting distance. How many Lookouts needed? Who?)	
RED zone with Lookout(s) only (calculate warning time and sighting distance. How many Lookouts needed? Who?)	✓
Emergency arrangements	✓
Methods for contacting signaller in an emergency	✓
Contact numbers for signalbox(s), Electrical Control(s), Production Control	✓
Contact details and location of nearest hospital with A&E	✓

COSS RECORD OF ARRANGEMENTS AND BRIEFING FORM **RT9909**

METHOD FOR CALCULATING WARNING AND SIGHTING TIMES

	Up Trains	Down Trains
Time needed to stop work and down tools	5	5
Time needed for everyone to reach a position of safety	5	5
Add 5 seconds if Site Lookout is looking in both directions	5	5
Add 5 seconds if working alone (without Lookout)		
Add 5 seconds if using a Distant Lookout		
Add 5 seconds if using an Intermediate Lookout		
Add 10 seconds (minimum time to be in a place of safety)	10	10
Total warning time needed (must not exceed 45 seconds)	25	25
Line Speed (from Sectional appendix or TSR / ESR)	125	125
Sighting distance needed	70	70
Sighting distance available		

Notes:

- The sighting distance available must be equal to or greater than the sighting distance needed.
- If the sighting distance available is less than the sighting distance needed, an Intermediate and/or Dist Lookout must be appointed and the figures re-calculated.
- No more than one distant and one Intermediate Lookout may be used in any one direction.
- No more than a combined total of four Distant and Intermediate lookouts may be used.
- If either:
  - the warning time needed is greater than 45 seconds, **or**
  - the necessary number of Lookouts is not available, **or**
  - the sighting distance needed is still not available

  Working with warning given by Lookout(s) is prohibited.

SIGHTING DISTANCE CHART — CHAINS

The warning time must be sufficient to enable everyone to be in a position of safety at least 10 seconds before the arrival of a train.

Permissible Speed	Sighting Distances to Provide Minimum Warning Time of:						
	15sec	20sec	25sec	30sec	35sec	40sec	45sec
125 mph	46	56	70	84	97	112	125
120 mph	40	54	67	81	94	107	120
115 mph	39	52	64	80	90	103	115
110 mph	37	49	62	74	87	99	110
105 mph	35	47	59	70	82	94	105
100 mph	34	44	56	67	78	89	100
95 mph	32	43	54	64	75	84	95
90 mph	30	40	50	60	70	80	90
85 mph	29	38	47	57	66	76	85
80 mph	27	36	44	54	63	72	80
75 mph	25	34	46	50	59	67	75
70 mph	24	32	39	47	55	63	70
65 mph	22	29	36	44	51	58	65
60 mph	20	27	34	40	47	54	60
55 mph	19	24	31	37	44	49	55
50 mph	17	23	28	34	39	44	50
45 mph	15	20	25	30	35	40	45
40 mph	14	18	24	27	32	36	40
35 mph	12	16	20	24	27	32	35
30 mph	10	14	17	20	24	27	30
25 mph	9	12	14	17	20	23	25
20 mph	7	9	12	14	16	18	20
15 mph	5	7	9	10	12	14	15
10 mph	4	5	12	7	14	9	10
5 mph	2	3	4	4	5	5	5

GREAT WESTERN – SECTIONAL APPENDIX TABLE A Line of Route GW103 Page 2.25 9 May 2005

Location	Mileage M	Mileage Ch	Running Lines & Speed Restrictions	Signalling & Remarks
			UR DR UM DM 60/75 60/75 125 125	TCB Reading (R) SB RAB
CSR Channel change DM	24	60		NRN Channel 09
CSR Channel change DR	25	60		
Wallham (Maidenhead) WILD	26	21		CSR Channel 05
CSR Channel change UR	28	60		
			60/70	CSR Channel 04
CSR Channel change UM	29	38		
Ruscombe	29	45	70#	# – 60/70 in Down direction
			70	ATP – UM and DM
			60/75 60/75 125 125 UR DR UM DM	

ELR – MLN1

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RAIL ACCIDENT INVESTIGATION BRANCH
URGENT SAFETY ADVICE

1. INCIDENT DESCRIPTION			
LEAD INSPECTOR		CONTACT TEL. NO.	
INCIDENT NAME (DATE)	Tinsley Green (17 March 2007) and Ruscombe Junction (29 April 2007)		
TYPE OF INCIDENT	Near-miss and worker fatality		

2. URGENT SAFETY ADVICE	
USA DATE:	03 May 2007
TITLE:	Safe systems of work at high speed crossovers and junctions
ACTIVITY:	Track maintenance
CIRCUMSTANCES:	On 17 March 2007 a welder narrowly avoided being struck by an approaching train, by jumping out of the way, as it was crossed from the up fast to the up slow line via a crossover at Tinsley Green, near Gatwick Airport. On the 29 April 2007 a welder was struck and killed by a train as it was routed from the down main to down relief line at Ruscombe Junction on the Great Western main line between Maidenhead and Twyford.
SAFETY ISSUES IDENTIFIED	1. RAIB has identified that some track maintenance staff are insufficiently aware of all the hazards associated with Red Zone working on, or in proximity to, high speed crossovers and junctions. Consequently, there are instances of staff not moving to a place of safety when warned by lookout if they believe that the train is not being routed towards them. 2. The RAIB has identified unofficial systems of work based on the lookout observing the position of points in order to ascertain the route set for an approaching train. 3. The Rule Book is not explicit about the system of work and lookout arrangements to be applied at crossovers and junctions. 4. High speed 'ladder' junctions generate particular hazards to persons carrying out Red Zone working.
REASONS FOR ISSUE:	Advice is given to Network Rail and contractors that there is an urgent need to address the above safety issues. In particular: 1. The need for safe systems of work to take into account the particular requirements for working at crossovers and junctions (particularly high speed 'ladder' junctions linking three or more parallel tracks). 2. The need to ensure that lookouts always give adequate warnings of the approach of any train that might be routed towards the place of work and the elimination of unofficial systems of work based on the lookout observing the position of points in order to ascertain the route set for an approaching train. 3. The need for staff to move to a place of safety when receiving a lookout's warning, regardless of the position of any points and the route displayed by signals (i.e. staff should not make any assumption about the route set for an approaching train). 4. The need for a review of the rules and acceptability of risk associated with maintenance activities carried out in the Red Zone at high speed junctions (including 'ladder' junctions linking three or more parallel lines).

USA SIGN-OFF*			
INSPECTOR NAME:		CI / DCI NAME:	
INSPECTOR SIGNATURE:	ELECTRONIC COPY	CI / DCI SIGNATURE:	ELECTRONIC COPY
DATE:	03 May 2007	DATE	03 May 2007

*When sending this form by email insert ELECTRONIC COPY into the signatory boxes.

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