



Rail Accident Investigation Branch

Rail Accident Report



**Near miss involving a track worker at Tinsley
Green Junction
17 March 2007**

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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This report is published by the Rail Accident Investigation Branch, Department for Transport.

Near miss involving a track worker at Tinsley Green Junction 17 March 2007

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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 Southern Railway 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 incident

- 5 This incident occurred at 09:33 hrs on the morning of Saturday 17 March 2007, at Tinsley Green Junction, near Gatwick Airport (Figure 1). The driver of train 1M20, the 08:55 hrs Brighton to Watford Junction service, reported to the signaller that a member of track maintenance staff had dived clear of his train with only seconds to spare. The incident had occurred as train 1M20 was being routed from the *up* fast line towards the *up* platform loop via a series of high-speed *crossovers*.

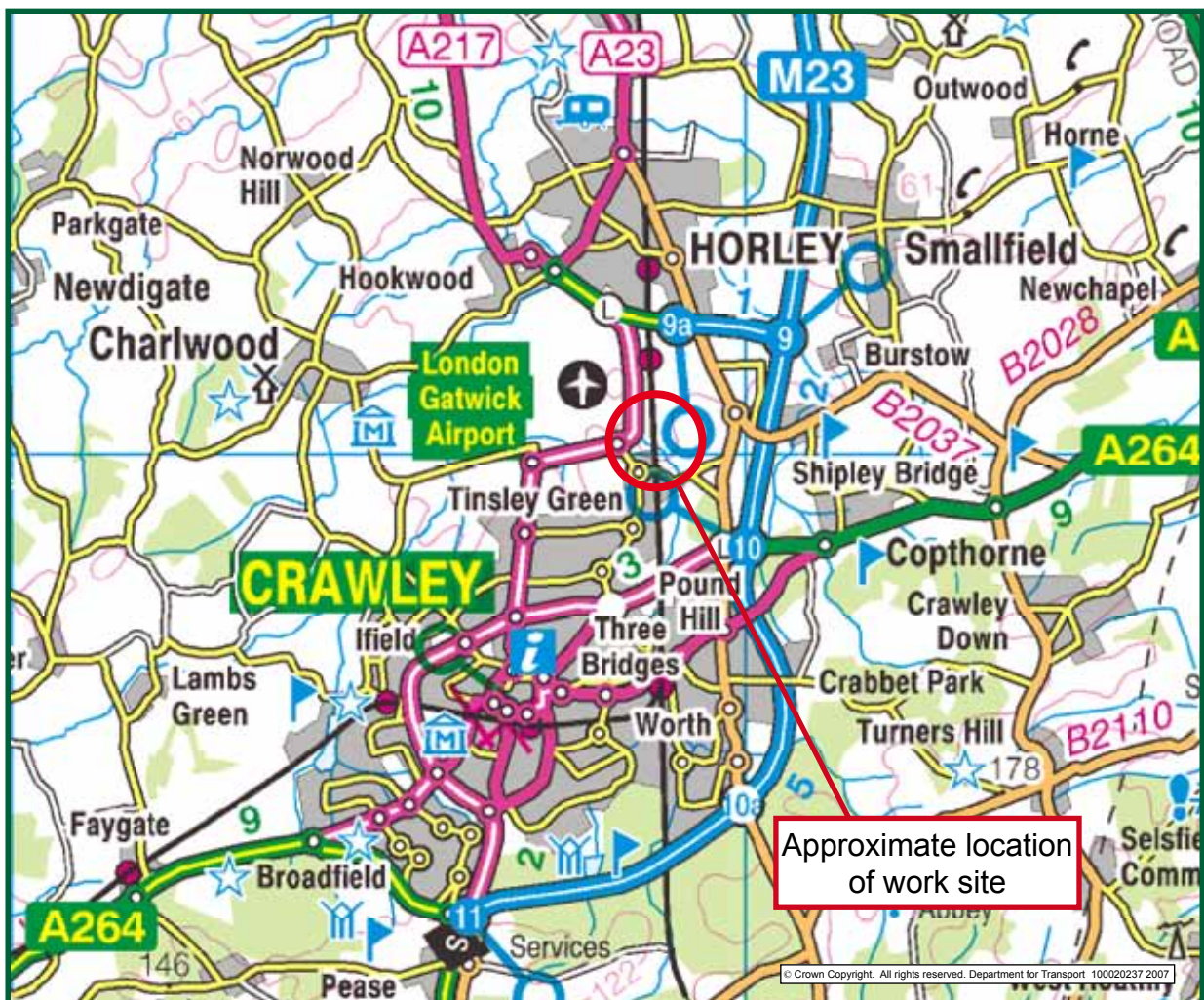


Figure 1: Location of accident

Immediate cause

- 6 The incident occurred because a member of track maintenance staff was late moving clear from the path of train 1M20. This happened because the system of work implemented by the *Controller of Site Safety* (COSS) did not take into account the possibility of trains being routed from the up fast line towards the up platform loop via the crossover on which the team were working.

Identification of causal factors

- 7 The COSS had only limited experience of *Red Zone working*. In particular, he had only rarely been required to work *Red Zone* in proximity to a crossover.
- 8 The system of work established did not involve staff moving to a *position of safety* when trains were approaching on the up fast line. This was because of a combination of the following factors:
 - (a) It was normal practice in the welding team to rely on the *lookout* observing the position of the points to determine if an approaching train was routed towards the site of work, so reducing interruptions to the work being undertaken.
 - (b) The COSS did not believe that trains would be routed over the 1732 crossover. This belief reflected a lack of local knowledge.
 - (c) The COSS did not correctly identify the hazard nor put in place an acceptable system of work.

Identification of possible causal factors

- 9 It is possible that the welder did not hear or register the verbal notification by the lookout that a train was approaching on the up fast line. In addition, the welder's assistant was remote from the welder at the time of the incident and was therefore not available to give the customary touch warning.
- 10 It is also possible that had the 'Record of Site Safety Arrangements and Briefing' form included specific information about the crossover, the speed of crossing movements and a warning about the associated hazards, the COSS would have been prompted to establish and brief an appropriate safe system of work.

Identification of contributory factors

- 11 The decision to undertake the repairs to the crossing nose of 1732A points by working in Red Zone conditions was reasonable given the circumstances that applied when the task was planned on Wednesday 14 March 2007. Nevertheless, this decision was a contributory factor.

Identification of underlying causes

- 12 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 (ie at a location such as Tinsley Green Junction). This lack of explicit instruction encourages some track workers to implement unofficial systems of work based on checking the position of points, while other staff understand this to be forbidden.

Recommendations

- 13 Recommendations can be found in paragraph 203. They relate to the following areas:
- competency of welders to act as COSS for work in a Red Zone;
 - the rules and training related to working at locations beyond facing points;
 - identification recording and briefing of hazards when working at locations beyond facing points;
 - the efficacy of existing business processes for the planning of safe systems of work;
 - checking of data provided on safe system of work forms; and
 - improving the presentation of information in operating documentation.

The incident

Summary of the event

- 14 The incident occurred on the morning of Saturday 17 March 2007 at Tinsley Green Junction, near Gatwick Airport in Sussex.
- 15 At 09:33 hrs the driver of train 1M20, the 08:55 hrs Brighton to Watford Junction service, reported to the signaller that a member of track maintenance staff had dived clear of his train with only seconds to spare. The incident had occurred as train 1M20 was being routed from the up fast line towards the up platform loop (see Figure 2) via 1732A points at Tinsley Green Junction, one mile (1.5 km) south of Gatwick Airport station. The track maintenance staff involved were a welder, his assistant and a lookout. The welder was undertaking repairs to the *crossing nose* of 1732A points.
- 16 The train struck some welding rods that had been left by the welder as he jumped clear of the approaching train.
- 17 None of the staff concerned were injured although all were shaken by the event. The train was not damaged.

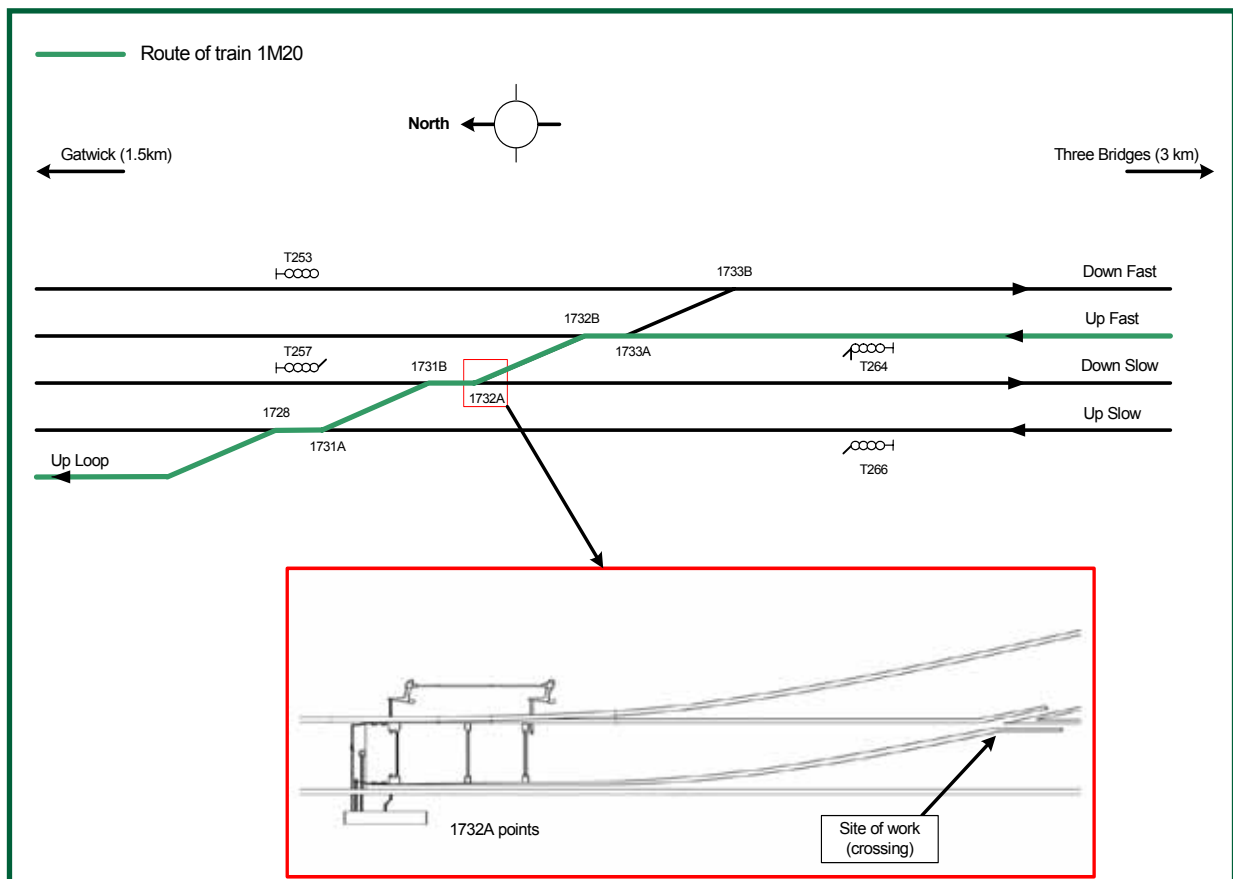


Figure 2: Track and signalling layout at Tinsley Green Junction, showing route of train 1M20

The parties involved

- 18 The track in the area of Tinsley Green is owned and maintained by Network Rail.
- 19 All of the track workers involved were employed by Network Rail. The welder and his assistant worked as part of the Area Services Team (colloquially known as the ‘Welding Team’) and were based at Redhill. The lookout was based at the Three Bridges track maintenance depot.
- 20 All of the above staff work as part of Network Rail’s Sussex Maintenance Area. This is headed by the Infrastructure Maintenance Manager (IMM), Sussex.
- 21 The train involved in the incident is operated and maintained by Southern Railway.
- 22 The train driver was employed by Southern Railway.

Location

- 23 Tinsley Green Junction is located on the main line route that runs between London, Three Bridges and Brighton. It is just under one mile (1.5 km) south of Gatwick Airport station, in Sussex.
- 24 At this location the main line consists of four parallel lines (see Figure 2). These are listed below in order, from west to east:
 - up slow (used by trains travelling towards London);
 - *down* slow (used by trains travelling towards Three Bridges);
 - up fast (used by trains travelling towards London); and
 - down fast (used by trains travelling towards Three Bridges).
- 25 To the north of the junction is a connection onto a fifth line, the up platform loop.
- 26 The permitted speed on the fast lines is 100 mph. On the day of the incident trains on the up fast were restricted to 70 mph by a temporary speed restriction imposed because of the condition of the track in the area.
- 27 The permitted speed on the slow lines is 90 mph.
- 28 The permitted speed on the up platform loop is 50 mph.
- 29 The five lines are connected at Tinsley Green by four crossovers. Each crossover is formed by a pair of points and a short interconnecting section of track such that trains are able to ‘cross over’ from one track to another. A photograph of the location is at Figure 3.
- 30 The permitted speed on all of the mainline crossovers is 60 mph. The permitted speed on the crossover at the south end of the up platform loop is 50 mph.
- 31 The signalling associated with the crossovers permits the following crossing moves to be made:
 - up fast to up slow;
 - up fast to up platform loop;
 - up slow to up platform loop; and
 - down slow to down fast.

- 32 The crossover between the up fast and down slow can be used by trains in either direction. This crossover is formed by points 1732A and 1732B.
- 33 All running lines at Tinsley Green are provided with *conductor rail* supplying 750V direct current to electric trains.

External circumstances

- 34 At the time of the incident the weather was fine and visibility good.
- 35 Tinsley Green Junction is subject to moderate levels of aircraft noise.

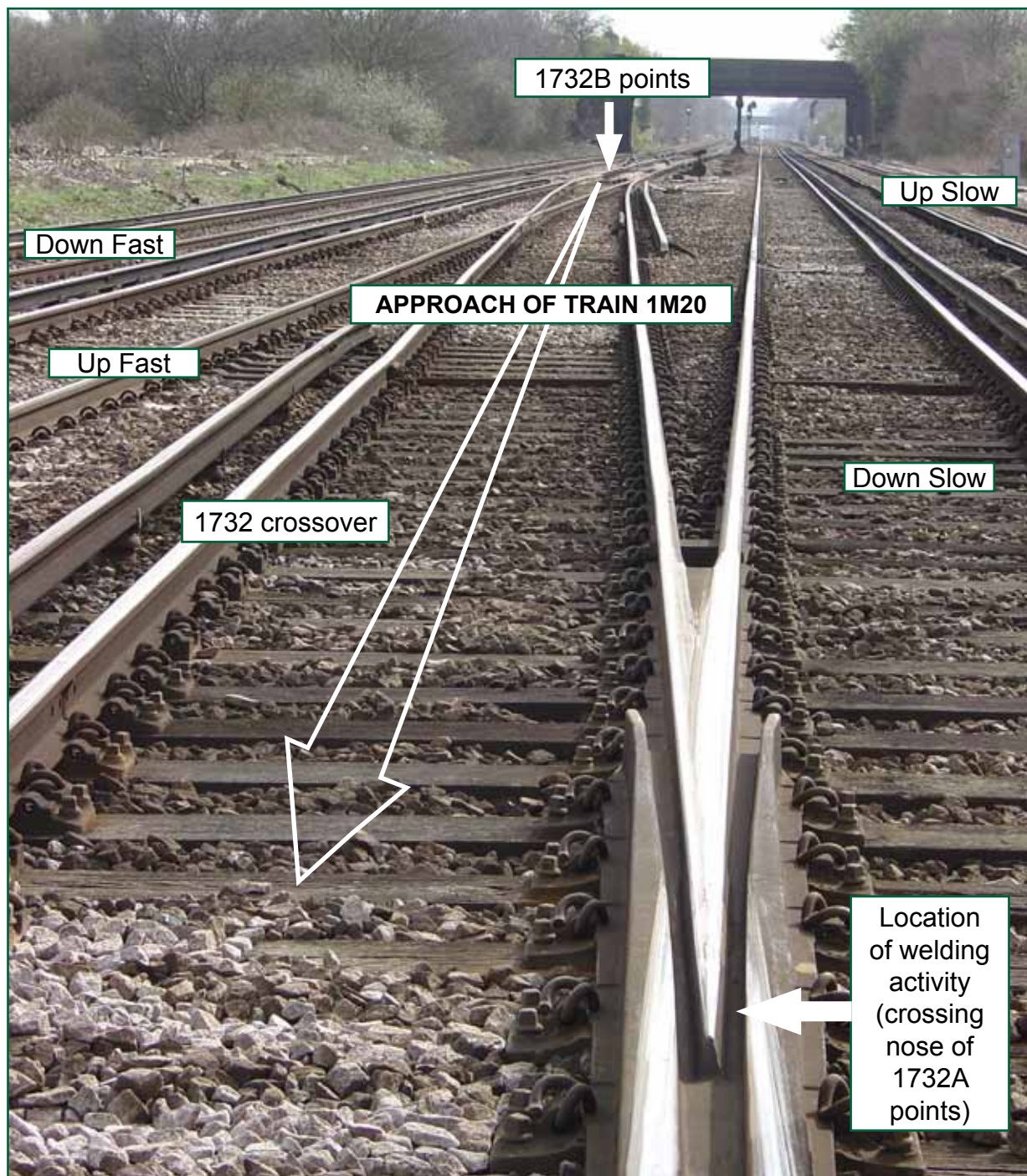


Figure 3: Tinsley Green Junction (looking south at the crossing of 1732A points)

The train involved in the incident

- 36 The passenger train involved in the incident was a four car class 377/2 electric multiple unit (377 209).

Events preceding the accident

- 37 The need for repairs to the crossing of the 1732A points had been identified early in 2007. On 13 March 2007 the welding supervisor received notification that the repairs had become urgent. It was therefore decided that the weld repairs would be undertaken during daylight hours on 17 March when the line concerned was open to traffic (for more details of the planning process see paragraphs 91 to 111).
- 38 The following resources were agreed:
- the welding team, based at Redhill, provided a welder and an assistant;
 - the local track maintenance team, based at Three Bridges, provided a qualified lookout.
- 39 At about 08:30 hrs on 17 March the welder, his assistant and the lookout met at the access point close to the proposed site of work at Tinsley Green Junction. The welder was acting in the role of COSS and provided a briefing to his assistant and the lookout.

Events during the accident

- 40 The work started at around 09:00 hrs. The method of working adopted involved the lookout giving an audible warning of trains approaching on either of the slow lines. The welder and his assistant would then move clear to the specified position of safety (the slow line *cess*). The lookout also provided verbal notification of the approach of trains on the up fast line. However, in this latter case the welder and his assistant did not move clear since they assumed that it was safe to continue working.
- 41 The lookout was positioned adjacent to the work activity with good sighting (of more than one mile) of trains approaching from both directions.
- 42 During the first 30 minutes three trains passed by on the up fast line. On each occasion the lookout told the welder and his assistant that the train was on the up fast line and work continued without interruption.
- 43 At 09:33 hrs a continuous series of train horn blasts was heard. The lookout and welder then realised that a train was approaching them from the up fast via the 1732 crossover. As a consequence the welder dived out of the path of the train and into the *four foot* of the down slow. At the time, the welder's assistant was already in the up slow *cess*, changing a grinding wheel.
- 44 On the basis of the witness evidence it is estimated that the distance between the train and the welder at the moment when he 'dived' clear was between 50 and 80 metres. The train arrived at the spot where he had been working three or four seconds after the welder dived clear. His box of welding rods remained on the track and was struck by the train.
- 45 The front of the train came to a stand about 120 metres beyond the work site. The driver then examined his train and spoke to the track workers.

- 46 After the train departed an urgent requirement for the welding repair to be completed was identified by the welding supervisor, who had attended the site. This work was resumed by the same welder.
- 47 The resumption of work saw a modification of the method of working. From this point forward the welder moved to a position of safety when warned of a train approaching on the up fast.

Consequences of the accident

- 48 No one was injured as a consequence of the incident although all involved were shaken by the event.

The Investigation

Investigation process

- 49 The incident was not notified to the RAIB. This was because Network Rail did not consider, on the basis of the first information obtained, that the circumstances were sufficiently serious to justify notification in accordance with regulation 4 of the Railways (Accident Investigation and Reporting) Regulations 2005.
- 50 The RAIB initiated a preliminary examination of the incident after reading of the incident in Network Rail's National Operations Centre log on the following day and commenced a full investigation on 20 March 2007.

Sources of evidence

- 51 The main sources of evidence used in this investigation are:
- witness interviews;
 - discussions with managers and supervisors;
 - data derived from the 'on-train data recording' (OTDR) system (see Appendix D);
 - photographs and measurements from a visit to the site;
 - review of planning documentation and appropriate standards, including the railway rule book; and
 - meetings with rules specialists at the Rail Safety and Standards Board (RSSB).

Key Information

Background

Risk profile

52 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

- 53 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 (see Figure 4). This compares to 1 in 15,300 for train drivers and 1 in 132,000 average for all workers in the industry.
- 54 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 (see 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 percent between 2001 and 2006.
- 55 To date there have been two track worker fatalities in 2007 (Ruscombe Junction on 29 April and Reading East on 29 November).

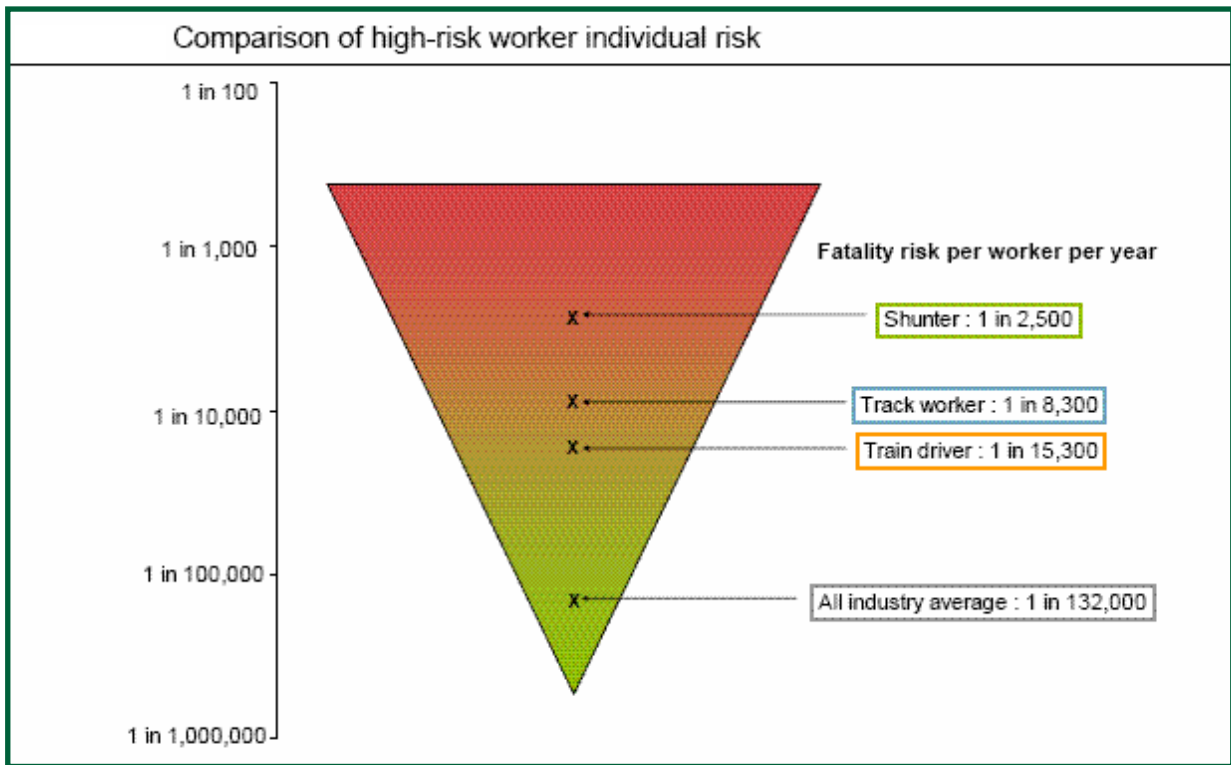


Figure 4: Levels of individual risk (extract from RSSB Annual Safety Performance report)

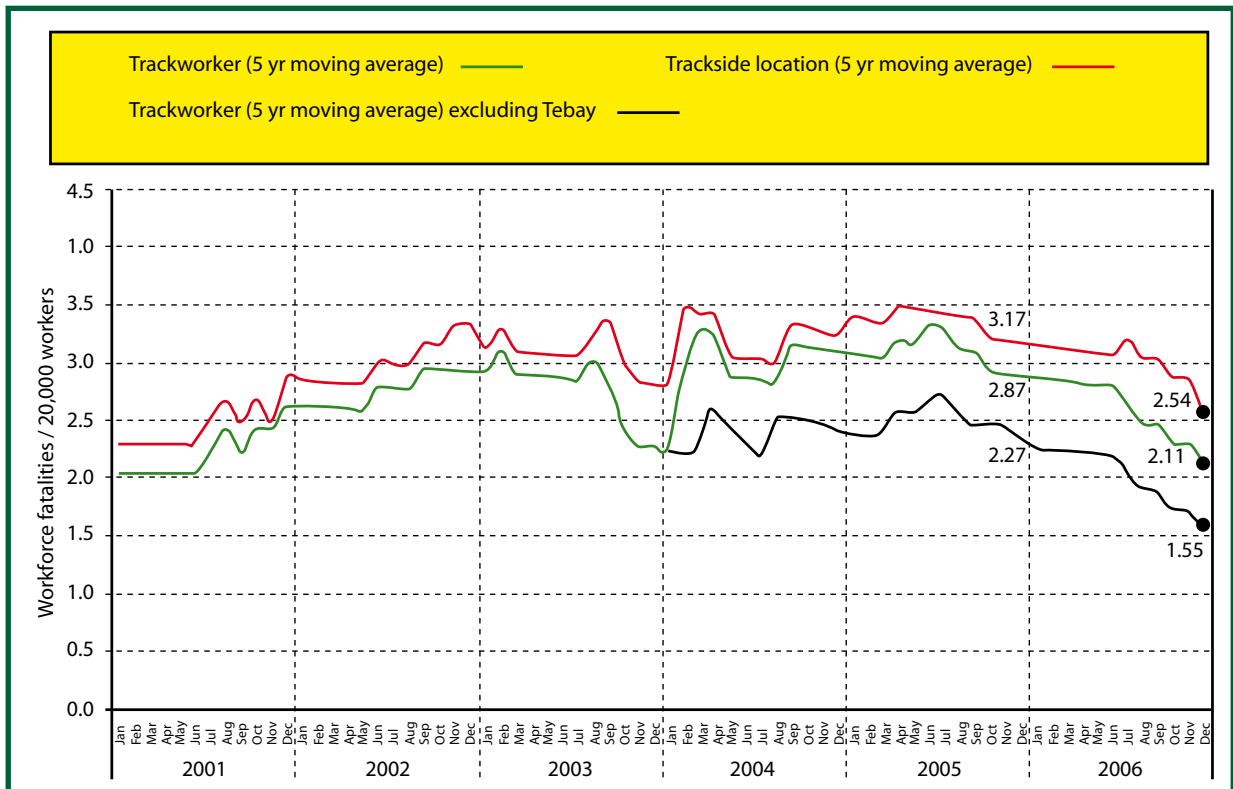


Figure 5: Track worker fatality rates normalised by staff numbers (data provided by RSSB)

Safe systems of work when working on or near the line

- 56 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.
- 57 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 ensure that trains cannot approach the site of work. This is done by establishing a work site within a *possession* or other protection.
- 58 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.
- 59 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.
- 60 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.
- 61 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.
- 62 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 protection arrangements are pre-planned and published in the *Weekly Operating Notice*.
- 63 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)

- 64 The rules related 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 that was being done at Tinsley Green on the 17 March 2007 are summarised in the following paragraphs.

Duties of all employees when working in the Red Zone (including the lookout)

- 65 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 in order to confirm their understanding of the safe system of work 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.

66 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.

67 Module T6, section 7, covers the responsibilities of the lookout. Of particular relevance to the situation that applied at Tinsley Green Junction on 17 March 2007 is section 7.6. This section 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.

68 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

69 Module T7, section 1.1, covers the responsibilities 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 form RT9909 and its signature by all persons in the group.

70 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 (i.e. a site of work on or near the line within which there are no train movements)
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 <i>lookout operated warning system</i>
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)

- 71 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.
- 72 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.
- 73 The rule book does not require the COSS to notify the signaller of the presence of his team before work commences.
- 74 Module T7, section 9.3, defines the process to be used for ensuring that sufficient warning is given. This requires that the COSS take 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;
 - the distance at which a lookout can clearly see an approaching train; and
 - any local noise that might necessitate the provision of a warning by touch.
- 75 Section 9.3 specifies that the COSS must provide adequate warning of trains in both directions on bi-directional lines.
- 76 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.

- 77 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.
- 78 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 RT9909 form.
- 79 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

- 80 The management systems for ensuring the correct planning of track maintenance work activities are described in Network Rail Business Process Document 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 met 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.
- 81 The requirement for a Green Zone Guide is met by the publication of a national document that is available via the Network Rail web site. This 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 Tinsley Green (for weekdays, Saturdays and Sundays).
- 82 Network Rail's track maintenance organisation has identified the need to seek continuous improvement in areas related to the safety of track workers. With this objective in mind it has established a national programme of projects addressing a range of topics. Those topic areas considered relevant to this investigation are:
- a programme for the development of management skills in front line managers and supervisors (including safety management skills);
 - a programme of briefings for team leaders (including events known as 'safety days');
 - development of a national communications material and a campaign to aid dissemination;
 - research into the psychological profile of maintenance staff and associated safety behaviour (SAF/07); and
 - every Maintenance Area to develop an action plan to reduce accident frequency rates.
- 83 The above initiatives were presented to the Office of Rail Regulation (Her Majesty's Railway Inspectorate) (ORR/HMRI) on 14 December 2006 and implementation of the various actions is ongoing.

- 84 Network Rail has also 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 in order 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)

- 85 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 announced and unannounced 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.
- 86 Following the above visits the qualitative findings were collated by the Principal Inspector who was responsible for leading on topics associated with track safety. The key findings were as shown in the following extract:
- 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.
- 87 The above findings caused ORR/HMRI to conclude that Network Rail was not satisfactorily protecting the safety of track maintenance workers.
- 88 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. The main elements of this programme are listed in paragraph 82.

- 89 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.
- 90 This investigation has confirmed that ORR/HMRI are still committed to carrying out the above inspections.

The incident at Tinsley Green Junction

Planning of the work

- 91 The condition of the crossing nose of 1732A points was observed by the local track maintenance managers to be deteriorating in the early part of 2007. As a consequence repairs were planned to take place within an engineering possession during week 44 (Saturday 27 January 2007 to Friday 02 February 2007). These repairs did not take place because of a combination of defective planning and a lack of manpower.
- 92 By week 50 (Saturday 10 March 2007 to Friday 16 March 2007) the crossing had deteriorated further and the Assistant Section Manager decided that repairs were now urgent. He looked for a suitable engineering possession to permit the work to be carried out in the absence of service trains. No such possession was planned within the next few weeks and he decided to request that the work be done with service trains still operating (ie in the Red Zone).
- 93 On Wednesday 14 March the Assistant Section Manager called the welding supervisor at Redhill and requested that urgent repairs be made to the nose of the crossing on 1732A points. The welding supervisor was aware that there was no suitable planned possession in which the repairs could be undertaken and it was therefore agreed that the work be done, in a Red Zone with a lookout, on the morning of Saturday 17 March 2007.
- 94 The local welding management have confirmed that it is always their preference to schedule welding activities within engineering possessions. However, they do occasionally plan work to take place in the Red Zone if a suitable possession is not available.
- 95 The staff interviewed as part of this investigation estimated that about 95 percent of their welding is done inside engineering possessions.
- 96 Having agreed to do the crossing nose repairs the welding supervisor identified that he had no-one available to act as lookout within the welding team. It was therefore agreed that the Assistant Section Manager would provide a qualified lookout from within his maintenance team. It was further agreed that the Assistant Section Manager would arrange for the production of a 'Record of Site Safety Arrangements and Briefing' form (the 'electronic' equivalent of the RT9909 form specified in the rule book).

- 97 This form, colloquially known as the ‘RIMINI form’, is usually generated by the *Works Scheduler* located in the Maintenance Delivery Unit Manager’s (MDUM) office in Brighton. The Works Scheduler does this by inputting details of the proposed activity and the system of work into a computer system called the *Safe System of Work Planning System* (SSOWPS). The output of the system (ie the content of the form) can be summarised as follows:
- a. basic data (planned date, time, business function, emergency contact numbers);
 - b. the number, direction and speed of railway lines;
 - c. access arrangements and hazards (extracted from the *Hazard Directory*);
 - d. the proposed safe system of work (this is selected from the rule book hierarchy shown in Table 2);
 - e. details of any *Green Zone working* arrangements;
 - f. details of any *Red Zone working* arrangements; and
 - g. the planned resource.
- 98 The Assistant Section Manager duly contacted the Works Scheduler on the same day (Wednesday 14 March 2007) to request that a ‘Record of Site Safety Arrangements and Briefing’ form be generated using the SSOWPS. The Works Scheduler who took the call did not normally manage requests from Three Bridges depot but felt able to assist.
- 99 The process the Works Scheduler was required to follow when planning work activities on or near the line is laid down in Network Rail Business Process Document NR/SP/OHS/019 with further detail provided in Standard Maintenance Procedure NR/PRC/MTC/PL0094.
- 100 Clause 4.1.2 of standard NR/SP/OHS/019 required that the Works Scheduler take into account the risk minimisation hierarchy (as shown in Table 2). However, in this case the Works Scheduler did not actively consider the adoption of any system of work other than the one requested by the Assistant Section Manager (Red Zone working with warnings given by a lookout). This arose because of a combination of the following known factors:
- The Works Scheduler felt able to make the required data entries to generate the ‘Record of Site Safety Arrangements and Briefing’ form but did not feel sufficiently confident to query requests made by experienced track maintenance supervisors/managers.
 - The Works Scheduler considered that the person requesting the form was competent to select a safe system of work.
 - The Works Scheduler understood that it was the responsibility of the person requesting the work to select the appropriate system of work. This understanding was based on a correct interpretation of paragraph 4.3 of Network Rail’s Standard Maintenance Procedure NR/PRC/MTC/PL0094.
 - From experience the Works Scheduler was aware that it would be difficult to create a Green Zone to carry out the work at Tinsley Green Junction without disrupting train services. For this reason the request from the Assistant Section Manager did not seem to be unreasonable.
 - The Works Scheduler was familiar with requests to generate the form for activities in the Red Zone. In the Works Scheduler’s experience such requests were always granted unless they were for a section of line where Red Zone working is prohibited.

- 101 The 'Record of Site Safety Arrangements and Briefing' form generated by the Works Scheduler includes a number of items of note, which are described in the following paragraphs.
- 102 The location and extent of the activity is shown as being between 27 miles 0 *chains* to 29 miles 1 chain. The section of the route between these two mileages encompassed the planned site of work (27 miles 32 chains). However, the location of the work is shown as Gatwick Airport.
- 103 Gatwick Airport station is outside the above range of mileages. Nevertheless, the information concerning lines and direction of trains that has been entered on the form has been derived from page 1/171 of Table A of the *Sectional Appendix* which corresponds to Gatwick Airport station (the correct data relevant to Tinsley Green Junction was contained in page 1/172). As a result the form contained some significant errors. These are indicated in table 3.
- 104 In addition, the 'Record of Site Safety Arrangements and Briefing' form makes no mention of the precise location of planned work (27 miles 32 chains) despite this being clearly known at the time the form was requested (local practice was often to produce a form for a section of line rather than for specific locations).
- 105 The nature of the work is shown as '3 Bridges Pway'. No mention is made of welding repairs to the crossing nose.
- 106 Three hazards associated with the site are also listed on the form:
- aircraft noise;
 - Red Zone working prohibited; and
 - restricted clearance.
- 107 Of the above, only 'aircraft noise' is appropriate to the site of work. No mention is made of the hazard posed by the presence of a high speed crossover.
- 108 The investigation has identified that many of the inaccuracies in the form arose as a result of the Works Scheduler selecting data appropriate to Gatwick Airport rather than Tinsley Green (see paragraph 103).
- 109 The following factors are known to have contributed to the Works Scheduler's incorrect completion of the form:
- the Works Scheduler was unfamiliar with the location;
 - the Works Scheduler did not fully understand the nature of the work and its location and was therefore unable to place the work into context; and
 - the Works Scheduler was distracted by other activities being undertaken at the same time.
- 110 The software used by the Works Scheduler (the SSOWPS) is not designed to detect an inconsistency between the mileages and other data entered (ie the level of automation and cross-checking is limited).
- 111 There is no system in place for the manual checking of data contained on the forms generated by the SSOWPS prior to them being issued to the COSS.

Line		Direction of trains		Speed	
As shown on form (erroneous items marked in red)	Actual (at planned site of work)	As shown on form (erroneous items marked in red)	Actual (at planned site of work)	As shown on form	Actual (at planned site of work)
UP FAST	UP FAST	Bidirectional	Up	100 mph	100 mph
DOWN FAST	DOWN FAST	Bidirectional	Down	100 mph	100 mph
UP SLOW	UP SLOW	Bidirectional	Up	90 mph	90 mph
DOWN SLOW	DOWN SLOW	Bidirectional	Down (with possibility of up movements via 1732A crossover)	90 mph	90 mph (60 mph through crossover)
UP PLATFORM LOOP GATWICK	(No such line at Tinsley Green)				
DOWN PLATFORM LOOP GATWICK	(No such line at Tinsley Green)				

Table 3: Comparison between the entries on the Record of Site Safety Arrangements and Briefing Form

The actions of the staff involved

The welder (the COSS)

- 112 As indicated earlier (paragraph 96) it had been agreed that the Three Bridges Permanent Way office would make arrangements for the production of a SSOWPS generated 'Record of Site Safety Arrangements and Briefing' form. This was printed on Wednesday 14 March and handed to the lookout to deliver to the COSS.
- 113 On arrival at the access gate at Tinsley Green at 08:30 hrs on 17 March the lookout handed the 'Record of Site Safety Arrangements and Briefing' form to the welder who had been designated to act as COSS (and was qualified to do so).
- 114 Witness evidence confirms that the welder, in his capacity as COSS, provided the team with a briefing at the access gate before they went onto the track side. This briefing was based on the contents of the 'Record of Site Safety Arrangements and Briefing' form and the welder's own experience. It is known to have included each of the following:
- the type of work to be performed (weld repairs);
 - its location (crossing nose of 1732A points);
 - a reminder of generic hazards such as slips, trips and falls; and
 - a reminder of the hazard posed by aircraft noise.
- 115 In addition, the welder identified that all lines were open and the speed of trains on each. He also informed the team that all lines were bidirectional. This information was incorrect but consistent with the pre-printed section of the 'Record of Site Safety Arrangements and Briefing' form (i.e. the entry on the form was incorrect).
- 116 Before work started the COSS calculated the *required warning time* (25 seconds), the *warning distance* needed and the *sighting distance* available. The values derived for up trains and down trains were calculated in accordance with the methodology laid down in sections 11 and 12 of Module T7 and recorded on the 'Record of Site Safety Arrangements and Briefing' form. These values confirmed that the sighting distance available was sufficient for work to take place in safety.
- 117 The welder briefed the team on the system of work to be applied. He explained that the work was to take place under Red Zone conditions with a lookout to provide warning of approaching trains. The lookout was instructed to stand close to the site of work (ie on the down slow in proximity to 1732A points) and to give warning by use of the horn on the approach of any train. The team was briefed that when warned by the lookout they should go to the position of safety, the cress adjacent to the up slow.
- 118 The briefing by the welder was silent on the method of protection from trains that might be routed from the up fast onto the up slow or up platform loop via 1732 crossover. No mention was made of the hazard posed by trains that might be routed via the crossover. No mention was made of any requirement for the lookout to observe the position of points.
- 119 The welder's assistant then signed the 'Record of Site Safety Arrangements and Briefing' form to confirm his understanding. The name and *Sentinel number* of the lookout was also added to the form (the lookout did not sign the form). Neither had raised any queries.
- 120 A copy of the completed and signed 'Record of Site Safety Arrangements and Briefing' form is to be found at Appendix E.

- 121 At about 09:00 hrs work commenced on the crossing nose of 1732A points. It is unclear from witness evidence whether or not the welder and his team moved to a place of safety on the approach of trains on the up slow line. However, it is known that when told of the approach of trains on the up fast line, he would remain where he was and continue to work normally.
- 122 The above behaviour in relation to trains on the up fast is explained by two incorrect assumptions made by the welder. These are as follows:
- The welder was unsure of the direction of train movements over the crossovers at Tinsley Green Junction and had formed the impression that a crossing movement from the up fast was most unlikely.
 - The welder assumed that the lookout would be watching the position of the switch toe on 1732A or 1732B points in order to determine the routing of the trains. He therefore interpreted the verbal notification given for trains on the up fast as information that a train was about to pass rather than a warning requiring him to move to the position of safety.
- 123 The first of the above assumptions was based on limited knowledge of the area and the timetable.
- 124 The second assumption was consistent with the unofficial system of work he had adopted before when working with a lookout provided from within the welding team at Redhill. This system of work is based on the lookout observing the position of the points in order to assess the route set for an approaching train. Although not sanctioned by the rule book and the COSS handbook, this system of work was widely adopted by members of the welding team when working in proximity to points in order to avoid the need to move clear from approaching trains that were routed away from the site of work. The welder was unaware that the lookout, who was a member of the local track maintenance team, was not observing the position of the points.
- 125 The COSS had only worked in the Red Zone about five times each year and was therefore in a relatively unfamiliar environment. He had only rarely been required to act as COSS in a Red Zone in proximity to a crossover.

The lookout

- 126 It was unusual for the lookout to work as part of a welding team. Ordinarily he worked as part of the track maintenance team based at Three Bridges depot. He was therefore familiar with the area in general and the layout of the junction at Tinsley Green.
- 127 The lookout was at the access point at Tinsley Green by about 08:30 hrs. He handed the 'Record of Site Safety Arrangements and Briefing' form to the welder who was to act as COSS and listened to his briefing. The lookout understood the briefing to mean that he should remain close to the welder and warn of the approach of trains on any line by use of a horn after which the team would move to the position of safety nominated by the COSS. He was not briefed on the need to observe the position of the points nor did he have any expectation that this was the system of work to be adopted. Furthermore, the lookout had been informed during his training that 'watching the points' is an unsafe method of working.
- 128 Once the work started the lookout gave warnings on the approach of all trains. In the case of trains on the up fast he also informed the welder of the line on which the train was approaching.

- 129 It is known that in the case of trains approaching on the up fast the welder elected to remain at work and the welder's assistant and lookout remained with him.
- 130 The lookout did not question the system of work that had been established. He perceived the welder/COSS to be experienced and knowledgeable. For this reason it did not occur to him that the system of work that had been established was dangerous.

The welder's assistant

- 131 The welder's assistant had believed that the lookout was observing the position of the points. Like the welder he had interpreted the verbal notification given for trains on the up fast as information that a train was about to pass rather than a warning requiring him to move to the position of safety.
- 132 The welder's assistant had seen it as his job to ensure that the welder had registered the lookout's warnings. He did this by touching him to reinforce the warning given by the lookout. This informal method of working was consistent with normal practice within the welding team. However, the welder's assistant was not passed as competent to act as lookout.
- 133 At the time of the incident the welder's assistant was in the cess of the up slow changing the wheel on the grinder. For this reason he was not in position to provide an additional touch warning.

The train driver

- 134 Train 1M20 was timetabled to call at both Three Bridges and Gatwick Airport stations and its scheduled route between the two stations was via the up slow line. However, on 17 March 2007 the signaller had erroneously routed the train onto the up fast line at Balcombe Tunnel Junction. The driver did not query this route since it is listed in the Sectional Appendix as an authorised alternative to the up slow line.
- 135 While train 1M20 was stopped in platform 4 at Three Bridges the signaller informed the driver that he wished to route his train into the up platform loop via the junction at Tinsley Green (to do this the signaller first needed to restore signal T264 to danger thereby causing a change of aspect in the signal at the northern end of platform 4).
- 136 The driver confirmed his understanding and the train departed Three Bridges at its scheduled time of 09:31 hrs.
- 137 The driver accelerated his train to a speed of 70 mph and held this speed for around 30 seconds. By now he was within 700 m of Tinsley Green Junction and he gently applied the brake in order to slow his train to the authorised speed for the junction, 60 mph. While the train was braking he noticed some track maintenance staff working on the down slow. After several seconds he realised that two of the track workers were on the points that the train was about to traverse.
- 138 The driver sounded his horn at a distance of around 600 m from the site of work. Two of the track workers acknowledged his warning but contrary to his expectations did not move clear. After waiting five seconds for the track workers to move clear the driver became concerned and started to sound his horn in a continuous series of blasts. After a further nine seconds (with the train now about 200 m from the site of work) the track workers had not moved and the driver applied the emergency brake. He continued to sound his horn.

- 139 About four seconds later the train arrived at the facing end of 1732B points (the start of the crossover). The driver could see a single track worker squatting over the rail about 100 m ahead of him. Within about two seconds the worker looked up, noticed the approach of the train and dived into the four foot of the down slow line, clear of the train.
- 140 After coming to a stand with his cab about 120 m beyond site of work the driver climbed down onto the track in order to check for damage to his train and to talk to the track workers involved in the incident.
- 141 The driver could not see any damage to his train, but found that the train had come to a stand with its *collector shoes* off the conductor rail. To restart he rolled forward until a shoe contacted the conductor rail. He was then able to drive to Gatwick Airport station where he was met by a Driver Manager.
- 142 In accordance with Southern Railway's post-incident procedures, the driving of the train was then taken over by another driver and the train restarted its journey at 10:17 hrs.

Competence

The staff involved

- 143 All staff on site were qualified by Network Rail for the work they were doing and their certification was in order.
- 144 The performance of the COSS was subject to assessment as part of a random site safety inspection performed on 1 November 2006 by the Network Rail Workforce Safety and Environment Coach (WS&EC) at Brighton. During this assessment the WS&EC observed that the COSS had established a safe system of work and the staff were working safely.
- 145 The Works Scheduler was fully qualified for the role having passed Parts 1 and 2 of the Network Rail Core Planner Skills training.

The content of Network Rail track safety training

- 146 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.
- 147 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 safe system of work'. However, no detail is given of the working arrangements to be applied at such locations.
- 148 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.

Performance of the train

149 The train horn was clearly heard by all witnesses. After the incident the horn on the unit involved in the incident (377 209) was tested by Southern Railway and found to be operating correctly.

150 The braking performance recorded by the train's OTDR, as shown in Table 4, is consistent with the design specification.

Speed of response	Time duration (secs) from the first application of the emergency brake to the first measurable retardation of speed	1.6
Average braking rate	Deceleration (ms ⁻²)	1.3
Distance to stop (from 60 mph)	Distance (in metres) from the first application of the emergency brake to the train coming to a stand	310
Time to stop (from 60 mph)	Time (in secs) from the first application of the emergency brake to the train coming to a stand	22
<i>Wheel slide protection system</i>	Nil activation	

Table 4: Braking performance of unit 377 209 (see also Appendix D)

Subsequent events

151 On 29 April 2007 a welder was killed at Ruscombe Junction, near Maidenhead, in similar circumstances to those at Tinsley Green. On 29 November a track worker was killed at Reading East after lifting possession marker boards. Both accidents are also the subject of a RAIB investigation.

Analysis

Identification of the immediate cause

152 The incident recurred because a member of track maintenance staff was late moving clear from the path of train 1M20. This occurred because the system of work implemented by the COSS did not take into account the possibility of trains being routed from the up fast line towards the up platform loop via the crossover on which the team were working.

Causal and contributory factors

Planning of the work

The decision that the work be undertaken in the Red Zone

153 Welding activities within the Sussex Maintenance Area are normally carried out in a Green Zone established within a planned engineering possession. In this instance an opportunity to carry out the weld repairs to the nose of 1732A crossover in a possession was lost because of inadequate planning and the non-availability of resources. As a consequence, by Wednesday 14 March 2007 the task had become urgent.

154 The manager who requested that this work be done in the Red Zone, and the welding supervisor who agreed to the system of work, have both stated that in their view there had been no practicable alternative available when they discussed the problem on 14 March.

155 The investigation has identified a range of impediments to the establishment of Green Zone working that had applied when the task was planned on Wednesday 14 March. These are as follows:

1. There was no suitable T3 possession in which the work could take place.
2. There was very limited opportunity, even during night hours and at weekends, for the application of T2 protection arrangements without disrupting train services (see Appendix C).
3. Given the perceived urgency of the task there was insufficient time to plan and publish arrangements to permit the disruption of train services.
4. Implementation of T2 protection would have required the deployment of two persons to act as handsignalers at the protecting signals and/or to place detonators (Ref. module T2H). This deployment of additional resource would have been contrary to the guidance contained in Network Rail Business Process Document 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%. 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.
6. Although the work was considered to be urgent the condition of the crossing nose did not justify the taking of an emergency possession.

- 156 Tinsley Green Junction has excellent sighting distances (of greater than one mile) in both directions and wide, easily accessible, positions of safety. No other physical factors have been identified at Tinsley Green Junction that could have prevented the implementation of safe Red Zone working arrangements.
- 157 The setting up of T2 protection does not provide an absolute guarantee that work sites will remain safe. This form of protection can fail if the signaller forgets to hold a signal at danger or in the event of misunderstanding between signaller and a COSS or handsignaller¹.
- 158 Given the above factors it is concluded that the decision taken on Wednesday 14 March to arrange for the work to take place under Red Zone conditions was reasonable given the perceived urgency of the task and the circumstances that applied at the time. For this reason the findings and recommendations are focused on the way in which Red Zone working was implemented on this occasion and the way in which the system of work became unsafe.

Information provided to staff

- 159 The 'Record of Site Safety Arrangements and Briefing' form produced by the Works Scheduler contained false data concerning the track layout and directions of train movements. Neither the software system that generated the form, nor the manager who requested that the work be planned, detected that the data entered did not correspond to the location of the work. This absence of a check on a form containing safety related data is of concern. It could be addressed one or more of the following ways:
- systematic self-checking by the Works Scheduler or another member of the same team;
 - a check by the person requesting the work (ie the task originator); or
 - an automatic data consistency check performed by the SSOWPS software (ie enhanced automation).
- 160 It is the view of the RAIB that one or more of the above options should be pursued in order to ensure that data printed on the form is correct when issued to the COSS. In addition, the current rule book requirement for the COSS to check the adequacy of the planned system of work should be retained.
- 161 Despite a general concern about the accuracy of data on the form, there is no evidence to suggest that the entry of incorrect data on the form was causal or contributory to the incident that occurred on 17 March 2007.
- 162 Key information on the 'Record of Site Safety Arrangements and Briefing' form was omitted. The form includes no mention of the type of work to be performed and is non-specific about the mileage of the work site. In addition, the form makes no mention of the crossovers and the permissible speeds across them. The hazard information does not include any mention of the possibility of trains crossing between lines at this location.
- 163 Had the form included a clear description of the work site location and a warning about train movements it is possible that this would have prompted the COSS to establish and brief a system of work that allowed for the possibility of trains crossing. It is therefore possible that this omission was a causal factor.

¹ Control measures implemented by Network Rail include safety critical communications protocols and signaller's reminder appliances.

164 The reasons for the omissions on the form included:

- the Works Scheduler had insufficient local knowledge to interpret the information about the nature of work and its precise location; and
- the software system used to generate the form, the SSOWPS, did not permit the entry of data about points and crossovers.

The system of work

165 The system of work established by the COSS appeared not to take the presence of the crossover into account. This occurred because the COSS did not perceive that trains approaching on the up fast line posed a hazard to him and his team. This misperception arose because of a combination of the following factors:

- the COSS had only limited experience of working in the Red Zone;
- the COSS had limited knowledge of train services through Tinsley Green Junction but had formed the impression that a crossing movement from the up fast was most unlikely; and
- the COSS had assumed that the lookout would observe the position of the 1732A or B points and notify him when they had moved into *reverse* (ie when the route had been set towards his work site).

166 All of the above factors were causal during the incident at Tinsley Green Junction. However, it is not possible to know the extent to which each applied.

167 The misperception of risk on the part of the COSS resulted in the implementation of a defective system of work in which the lookout gave a verbal notification of trains approaching on the up fast but the welder continued to work. In such cases the lookout and the welder's assistant would remain on the work site rather than move to the designated position of safety.

168 Whilst this system of work was in place neither the lookout nor welder's assistant perceived their system of work to be unsafe. Both had respect for the welder's ability as a COSS, trusted his briefing, and saw no reason to question the system he had put in place.

169 Further evidence of a defective system of work was the establishment of three distinct types of warning. These were:

- horn blast from lookout on the approach of trains on the slow lines;
- verbal notification on the approach of trains on the up fast line; and
- touch warnings by the welder's assistant.

170 The existence of three types of warning created the risk of misunderstanding and confusion.

171 At the time of the incident the welder's assistant was standing in the up slow cess changing a wheel on the grinder. Consequently he did not deliver his customary touch warning on the approach of train 1M20. This fact, coupled to the absence of a horn blast, meant the welder was dependant on hearing, and correctly interpreting, the verbal warning given by the lookout. Since the lookout did not appreciate the danger of the situation his verbal notification was not delivered with any urgency and was delivered over the sound of the welding operation.

172 In view of this, it is possible that the welder did not hear or properly register the verbal notification provided by the lookout. If so, this is considered to be a causal factor.

‘Point watching’

- 173 With regard to the last bullet in paragraph 165, it is custom and practice for some welders in the Sussex Area to sometimes use the position of points as an indication that a train approaching on another track is not routed towards their work site. This method of working is colloquially known as ‘point watching’.
- 174 Welding management and supervisory staff are aware that ‘point watching’ is taking place within their teams and have stated that this method of working is acceptable provided care is taken. Furthermore, it has been suggested that any prohibition of this practice would greatly impede the efficiency of work activities at some locations (e.g. 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.
- 175 However, there is no evidence that ‘point watching’ is prevalent among the track maintenance staff at Three Bridges depot. The lookout involved in this incident at Tinsley Green has stated that he was told during training that the position of points should not be relied upon as an indication of the route set. He states that he never watches the points but will always warn of the approach of all trains.
- 176 Had the lookout tried to observe the points he would have found it difficult to discern the position of the 1732B switch toes at the southern end of the crossover. The 1732A switch toes were clearly visible.

The welder acting as COSS

- 177 During this incident the COSS was also the individual carrying out the main work activity. Welding is known to require close concentration on the task. In addition, the welder must work with a visor to protect his eyes and is subject to the noise generated by his equipment.
- 178 Because of the above impediments, it is possible that the welder’s close involvement in the primary task detracted from his ability to monitor the safety of the system of work he had established. However, it is also possible that his inappropriate perception of the situation would not have been altered had he been less involved in the primary task. It is therefore not possible to conclude that the involvement of the COSS in the welding activity was a causal factor.

Identification of underlying causes

Role of the rule book and COSS handbook

- 179 The actions of the COSS (paragraph 165) and his team (paragraph 168) are likely to have been different had they correctly understood the system of work to be adopted when working in proximity to a crossover/points. This failure to understand is likely to have arisen because of a lack of clarity in the current rule book.
- 180 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. For this reason 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.

- 181 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.
- 182 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.
- 183 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.
- 184 Given the above, it is concluded by the RAIB that the lack of clarity in the presentation of safety rules was an underlying factor in the causation of this incident.

Other issues identified during the investigation

The role of Table A of the Sectional Appendix

- 185 At paragraph 165 it is indicated that the COSS had formed the impression that a crossing movement from the up fast was most unlikely. This incorrect assumption arose due to a lack of local knowledge and the absence of clear guidance on the form generated by the SSOWPS.
- 186 The task of planning work activities and establishing a safe system of work, in proximity to a junction are dependent on all people involved fully understanding the direction of train movements. At present this understanding cannot be gained by reference to Table A of the Sectional Appendix. This table gives no indication of the direction of train movements over points and crossovers. In the case of Tinsley Green Junction the table shows the down slow line at Tinsley Green Junction to be unidirectional (ie there is no indication that trains can pass over the 1732 crossover in either direction).
- 187 The pages of the Sectional Appendix covering Gatwick Airport and Tinsley Green Junction are reproduced at Appendix F.
- 188 The safe planning of work activities and the implementation of safe systems of work would be facilitated by the inclusion of information concerning the direction of train movements through crossovers and junctions.
- 189 Network Rail is now aware that Table A of the Sectional Appendix gives two different titles for the up platform loop. Pages 1/172 and 2/201 describe it as the 'up platform loop'. Page 1/171 describes the same section of track as the 'up loop'. RAIB understands that this inconsistency is to be corrected.

Conclusions

Immediate cause

190 The incident occurred because a member of track maintenance staff was late moving clear from the path of train 1M20. This occurred because the system of work implemented by the COSS did not take into account the possibility of trains being routed from the up fast line towards the up platform loop via the crossover on which the team were working.

Causal factors

- 191 The COSS had only limited experience of Red Zone working. In particular, he had only rarely been required to work Red Zone in proximity to a crossover (paragraph 165 and Recommendation 1).
- 192 The system of work established did not involve staff moving to the position of safety when trains were approaching on the up fast line (paragraph 165). This arose because of a combination of the following factors:
- (a) It was normal practice in the welding team for reliance to be placed on the lookout observing the position of the points in order to determine if an approaching train was routed towards the site of work so reducing interruptions to the work being undertaken (paragraph 173 and Recommendation 3);
 - (b) The COSS did not believe that trains would be routed over the 1732 crossover. This belief reflected a lack of local knowledge (paragraph 165 and Recommendations 4 & 8); and
 - (c) The COSS did not correctly identify the hazard nor put in place an acceptable system of work (paragraph 167 and Recommendations 2 & 4).

Possible causal factors

- 193 It is possible that the welder did not hear or register the verbal notification by the lookout that a train was approaching on the up fast line. In addition, the welder's assistant was remote from the welder at the time of the incident and was therefore not available to give the customary touch warning (paragraph 171).
- 194 It is also possible that had the 'Record of Site Safety Arrangements and Briefing' form included specific information about the crossover, the speed of train crossing movements and a warning about the associated hazards, the COSS would have been prompted to establish and brief an appropriate safe system of work (paragraph 163 and Recommendation 4).

Contributory factors

- 195 The decision to undertake the repairs to the crossing nose of 1732A points in the Red Zone was reasonable given the circumstances that applied when the task was planned on Wednesday 14 March 2007. Nevertheless, this decision was a contributory factor.

Underlying causes

196 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 (i.e. at a location such as Tinsley Green Junction). This lack of explicit instruction permits some track workers to implement unofficial systems of work based on checking the position of points, while other staff understand this to be forbidden (paragraphs 179 to 184 and Recommendation 3).

Additional observations

- 197 At paragraph 100 it is noted that the Works Scheduler did not feel sufficiently confident to query requests made by experienced track maintenance supervisors and managers. This unwillingness to question or challenge was reinforced by the Works Scheduler's belief that it was the job of the 'task originator' to select the most appropriate system of work from the 'hierarchy' of options. This perception was based on the text contained at paragraph 4.3 of Standard Maintenance Procedure NR/PRC/MTC/PL0094 but is in apparent contradiction to the process laid out in Business Process Document NR/SP/OHS/019 (paragraphs 99 and 100)
- 198 Although not causal or contributory to the incident that occurred on 17 March 2007 the above factors give rise to concern about the correct implementation of the existing processes (Recommendation 5).
- 199 The 'Record of Site Safety Arrangements and Briefing' form generated by the Works Scheduler contained a number of factual errors. These errors were not detected as part of any internal checking within the planning office, nor by the SSOWPS software system. Similarly the manager who requested the form did not check the adequacy of the output (paragraph 160 and Recommendations 6 & 7).
- 200 The direction of train movements over the crossovers at Tinsley Green Junction is missing from Table A of the Sectional Appendix. This has the potential to impede the safe planning of the task and the establishment of a safe system of work (paragraph 188 and Recommendation 8).

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

201 Network Rail have already carried out a preliminary investigation. The results of this investigation were reported in a 'Significant Incident Alert Report' dated 20 March 2007. This included a recommendation that the incident be the subject of a Safety Bulletin to all track staff. On the following day this was duly issued to all Network Rail maintenance Areas for briefing to staff.

202 Network Rail has since completed a Formal Investigation of the incident.

Recommendations

203 The following safety recommendations are made²:

Recommendations to address causal and contributory factors

- 1 Network Rail's IMM Sussex should identify all welders in the Area who have only limited experience of working in the Red Zone. The IMM should ensure that all such welders that are qualified to act as COSS have the necessary skills, knowledge and experience to set up a safe system of work in the Red Zone (paragraph 191).
- 2 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 (paragraphs 191 and 192). Included in the revised documentation should be a clear definition of the term 'approaching train' (paragraph 148).
- 3 Network Rail should prohibit lookouts from being required to observe the position of points as a means of determining if an approaching train is routed towards the site of work. Associated rules (e.g. 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 192 and 196).
- 4 Network Rail should modify its management processes to require that all RT9909 'Record of Site Safety Arrangements and Briefing' forms issued to Controllers of Site Safety contain details of any high speed crossovers and/or points, the direction and speed of associated train movements and a specific warning about the hazards at such locations (paragraph 194).

Recommendations to address other matters observed during the investigation

- 5 Network Rail should carry out a detailed assessment of the way in which Business Process Document 0019 and Standard Maintenance Procedure 0094 are being applied. This assessment should include a survey of Work Schedulers to assess the extent to which they feel able to question, or challenge, requests made to them. The results of this assessment should be used to inform a review of the effectiveness of the existing management arrangements and steps taken to rectify any deficiencies identified (paragraph 198).

continued

² Responsibilities in respect of these recommendations are set out in the Railways (Accident Investigation and Reporting) Regulations 2005 and the accompanying guidance notes, which can be found on RAIB's web site at www.raib.gov.uk

- 6 Network Rail should implement a process to ensure that any person requesting that a plan be prepared by a Works Scheduler checks that an appropriate safe system of work has been selected and the adequacy of the resulting 'Record of Site Safety Arrangements and Briefing' form. This check should include a review of the accuracy of data contained and completeness of hazard identification (paragraph 199).
- 7 Network Rail should assess the feasibility of configuring the SSOWPS to automatically check that the work site data entered in the system corresponds with the work site location (paragraph 199).
- 8 Network Rail should review the presentation of information in Table A of its Sectional Appendices with the objective of clarifying the direction of signalled train movements through junctions and crossovers (paragraph 200).

Appendices

Glossary of abbreviations and acronyms

Appendix A

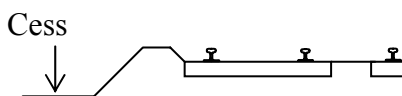
COSS	Controller of Site Safety
IMM	Infrastructure Maintenance Manager
ORR (HMRI)	Office of Rail Regulation / Her Majesty's Railway Inspectorate
OTDR	On-train data recording (system)
RAIB	Rail Accident Investigation Branch
RSSB	Rail Safety and Standards Branch
SSOWPS	Safe System of Work Planning System

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

Cess



The part of the track bed outside the ballast shoulder that is deliberately maintained lower than the sleeper bottom to aid drainage.*

Chain

A unit of length, being 66 feet or 22 yards (approximately 20117 mm). There are 80 chains in one standard mile.*

Collector shoe

A device mounted on the train that runs along the top surface of a conductor rail and collects electrical traction current

Conductor rail

An additional rail, generally of a unique section (such as 150 pounds per yard), used to convey and enable collection of electrical traction current at track level.*

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)

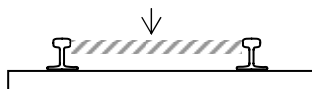


Two turnouts that are connected to permit movements between parallel tracks.*

Down (fast/slow line)

Lines normally used by trains in the direction of Three Bridges (southbound)

Four foot



The area between the two running rails of a standard gauge railway. The actual dimension of this space is 1435mm (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.

Hazard Directory

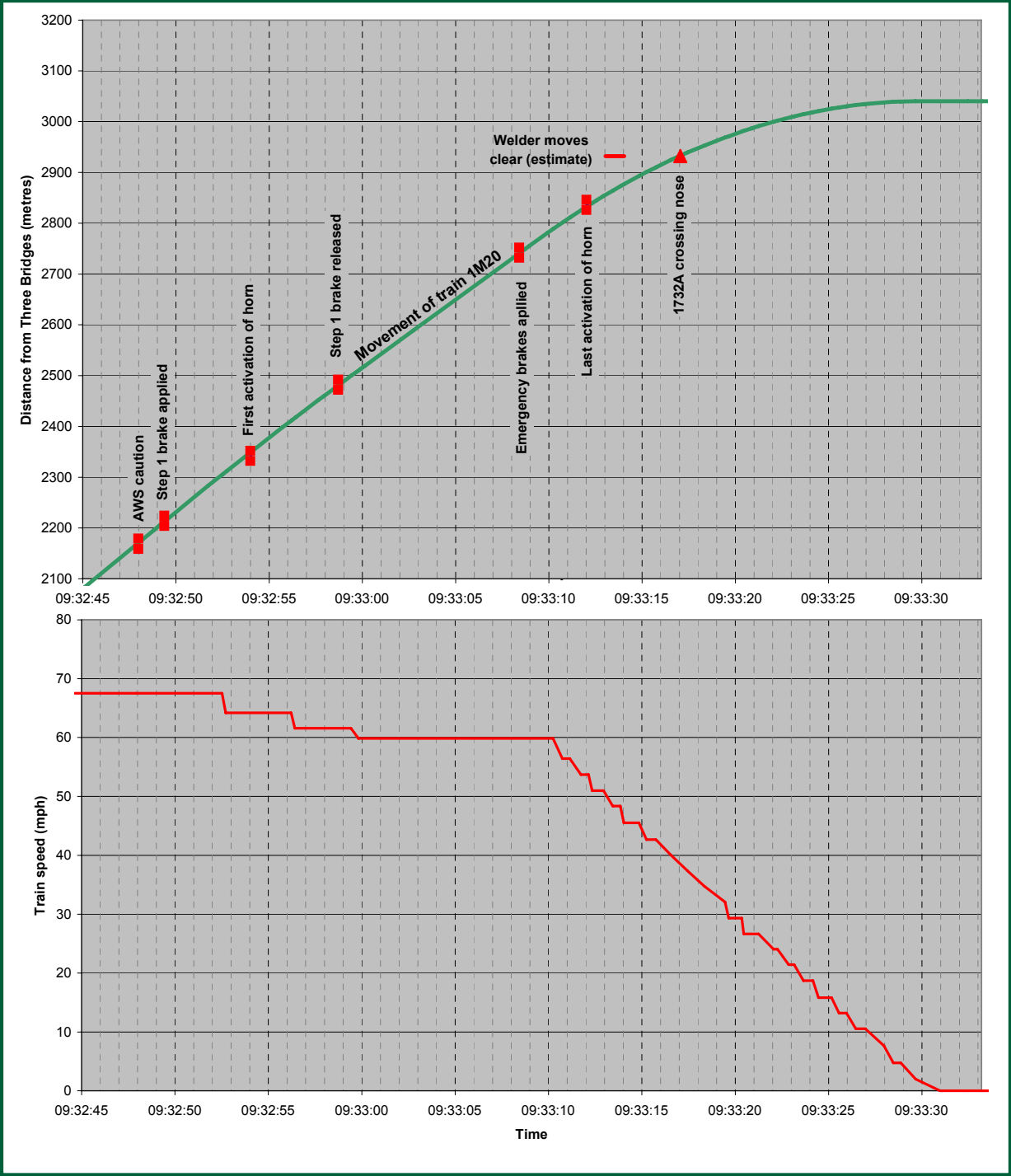
Periodic report from Network Rail identifying potential working hazards for maintenance staff.*

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.*
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.
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).
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. *
Rule book	The publication detailing the general responsibilities of all staff engaged on the railway system.*
Safe System of Work Planning System	Software system developed by Network Rail to assist the planning of safe systems of work on or near the track.
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 number	A unique number allocated to any person registered on the Sentinel system (a database containing details of staff competencies). This number is printed on their Sentinel identification card.
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.*
Up (fast/slow line)	Lines normally used by trains in the direction of Gatwick Airport (northbound)
Up platform loop	A line normally used by up trains calling at Gatwick Airport.
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	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.

Reconstruction of event from OTDR data and witness recollections

Appendix D



Copy of the completed and signed 'Record of Site Safety Arrangements and Briefing' form

Appendix E

RECORD OF SITE SAFETY ARRANGEMENTS AND BRIEFING FORM							
FOR SSOWPS REF No.		Status: <input type="checkbox"/> accepted		GZAC Ref			
GENERAL INFORMATION							
Name of COSS/IWA			Sentinel Card No				
Start Date: 17/03/2007 08:00:00			End Date: 17/03/2007 18:00:00				
Business Function: P Way			MDUM: Brighton				
Nature of Work: 3 Bridges P way							
Location: GATWICK AIRPORT							
Start Mileage: 27 m		0 ch		End Mileage: 29 m		1 ch	
How to contact the signaller in an emergency							
Three Bridges Panel 4			Tel: _____				
ECR: Brighton			Tel: _____				
Line	Direction	Opn/Blk	Speed	From	To	Protecting	
UP and DOWN Fast	Bt	Open	100	SIG	SIG		
UP and Down Slow	Bt	Open	30	SIG	SIG		
UP Platform loop Gatwick	Bt	Open	30	SIG	SIG		
Down Platform Loop Gatwick	Bt	Open	30	SIG	SIG		
Planned safe system for access and egress arrangements to/from working area			Red Zone with Lookout(s) only or IWA Tinsley Green				
Hazards associated with access/egress (conductor rails, tripping, vegetation, overhead cables or OLE)							
Hazards associated with the site (conductor rails, tripping, vegetation, overhead cables or OLE, buried services, etc.)			Aircraft Noise Red Zone Working Prohibited Restricted Clearance				
Limits of the working area and how these are defined							
Permit to work arrangements (AC or DC lines) if appropriate. If no permit to work is held electrified line are live							
SAFE SYSTEM OF WORK							
Tick the relevant box. Only tick the "Planned" column if you have been provided with 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 All Blocked				No		No	
Fenced or Separated Green Zone with one or more lines blocked				No		No	
Fenced Green Zone				No		No	
Separated Green Zone				No		No	
Red Zone blocking one or more lines for a position of safety				No		No	
Red Zone with ATWS				No		No	
Red Zone with TOWS				No		No	
Red Zone with LOWS				No		No	
Red Zone with PacWee				No		No	
Red Zone with Lookout(s) only or IWA				Yes		Yes	
Reason and authority for change from planned safe system of work, if appropriate							

GREEN ZONE WORKING ARRANGEMENTS	
Type of fence & distance (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	HORN
Location(s) or position(s) of safety	CSS

Planned Resource		
<input type="checkbox"/> 1 Site LJO	<input type="checkbox"/> 0 Touch LJO	<input type="checkbox"/> 0 Intermediate/Distant LJO

Detail of any SEPARATED GREEN ZONE Site Wardens, RED ZONE ATWS Operator or RED ZONE Lookouts (TOWS, LOWS, Pee Wae, distant Intermediate, site machine or touch)			
Name	Sentinel Card No.	Location	Role

Calculation of Required Warning Time and Sighting Distance				
	Up Trains		Dn Trains	
Time Needed to Stop Work and Down Tools	5	sec	5	sec
Time Needed for everyone to reach position of Safety	5	sec	5	sec
Add 5 seconds if lookout is looking out in both directions	5	sec	5	sec
Add 5 seconds if working alone (without lookout)		sec		sec
Add 10 seconds (minimum time to be in position of safety)	10	sec	10	sec
Total Warning Time Needed	25		25	
Linespeed	90		90	
Warning Distance Needed	1100		1100	
Sighting Distance Available	1100		1100	

How was Sighting Distance Calculated?	
Does Sighting Distance available equal or exceed Warning Distance Needed?	<input checked="" type="radio"/> yes / no if yes, appoint lookouts and proceed
If no, appoint distance Lookout(s) to achieve necessary sighting and add an extra 5 seconds for each additional Lookout	sec
Does new Sighting Distance available equal or exceed new Warning Distance Needed?	yes / no if yes, appoint lookouts and proceed
Has a lookout(s) been appointed and identified to the group?	yes / no
Method of Warning	HORN

Declaration (each member of the group to sign to confirm they have understood the briefing)			
Signature	Sentinel Card No	Signature	Sentinel Card No
This Plan was prepared by			

COS/IIWA DECLARATION: I have made the above arrangements and am satisfied that all members of the work group understand the safe system of work.

Signature

Additional Hazards Identified by Planner

National Hazard Directory Details

Please note the following hazard distances are in miles and yards, and are for indication purposes only. Please verify the information provided against the actual hazard directory if required, as this information may be subject to rounding errors.

Territory	ELR	Location	Hazard	Pos	Line	Start	End
Previous Page Limit							
Southern	VTB3	Gatwick Airport Platform 2	Red Zone Working Prohibited		Up Slow	26.0880	26.1144
Southern	VTB3	Gatwick Airport Platform 3	Red Zone Working Prohibited		Down Slow	26.0880	26.1144
Southern	VTB3	Gatwick Airport Platform 4	Red Zone Working Prohibited		Up Main/Fast	26.0880	26.1144
Southern	VTB3	Gatwick Airport Platform 5	Red Zone Working Prohibited		Down Main/Fast	26.0880	26.1144
Current Page							
Southern	VTB3	Gatwick Airport	Aircraft Noise		All/Multiple Tracks	26.1100	27.0219
Southern	VTB3	Gatwick Airport	Restricted Clearance	Left Hand Side		26.1161	26.1161
Next Page Limit							
Southern	VTB3	Gatwick Airport	Aircraft Noise		All/Multiple Tracks	26.1100	27.0219

Pages of the Sectional Appendix covering Gatwick Airport and Tinsley Green Junction

Appendix F

PAGE 1/171 SOUTHERN REGION SECTIONAL APPENDIX-TABLE A PART 1 APR 01

LOCATION	MILEAGE	RUNNING LINES & SPEED RESTRICTIONS	SIGNALLING & REMARKS
S0500 - VICTORIA TO BRIGHTON			
Gatwick Substation	26m 46ch		<p>TCB THREE BRIDGES (T) DC BRIGHTON</p> <p>NRN CSR 097 65</p> <p>DPL 34 UPL 34</p> <p>Permissive working authorised on UPL (both directions), down and up slow platform lines (both directions), down and up fast platform lines and UPL.</p> <p>Down and Up Slow platform lines and UPL, are reversible.</p> <p>* Note: 319 stock only can travel at 100 mph.</p> <p>1 Up fast 2 Down fast 3 Up slow 4 Down slow 5 Up platform loop 6 Down platform loop</p>
GATWICK AIRPORT	26m 47ch		
	26m 58ch*		
	26m 66ch*		
	26m 76ch*		

Data Ref. B1846-05 REV. B
Diag. Ref. 1846C171

PAGE 1/172 SOUTHERN REGION-SECTIONAL APPENDIX-TABLE A PART 1 APR 01

LOCATION	MILEAGE	RUNNING LINES & SPEED RESTRICTIONS	SIGNALLING & REMARKS
S0500 - VICTORIA TO BRIGHTON			
TINSLEY GREEN JN	27m 34ch		<p>TCB THREE BRIDGES (T) DC BRIGHTON</p> <p>NRN CSR 097 65</p> <p>* Note: 318 stock only can travel at 100 mph.</p> <p>1 Up fast 2 Down fast 3 Up slow 4 Down slow 5 Up loop</p>
	27m 77ch		
	28m 73ch*		

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Department for Transport.

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