



Rail Accident Investigation Branch

Rail Accident Report



Track worker struck by a train at Stoats Nest Junction 12 June 2011

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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Track worker struck by a train at Stoats Nest Junction, 12 June 2011

Contents

Summary	5
Introduction	6
Preface	6
Key definitions	6
The accident	7
Summary of the accident	7
Organisations involved	8
Location	8
External circumstances	8
Train involved	8
Staff involved	10
Events preceding the accident	11
Events during the accident	14
Events following the accident	14
Consequences of the accident	16
The investigation	17
Sources of evidence	17
Key facts and analysis	18
Background information	18
Identification of the immediate cause	21
Identification of causal factors	22
Identification of underlying factors	34
Observations	37
Summary of conclusions	39
Immediate cause	39
Causal factors	39
Underlying factors	39
Actions reported as already taken or in progress relevant to this report	40
Previous recommendation relevant to this investigation	42
Learning point	43

Recommendation	44
Appendices	45
Appendix A - Glossary of abbreviations and acronyms	45
Appendix B - Glossary of terms	46

Summary

At 05:28 hrs on Sunday 12 June 2011, train 1U11, a passenger service running from Gatwick Airport to London Victoria, travelling at about 60 mph (96 km/h), struck a member of railway staff at Stoats Nest Junction on the main line between London and Brighton, about one mile (1.6 km) south of Purley station. The person who was struck was one of a team of ten people carrying out maintenance work on the track, and he was seriously injured. There was no damage to the train or infrastructure.

The track worker who was struck did not move to a position of safety and remained in the path of the train as it passed the site of the work. Although one of the lines at the site had been returned to use shortly before the accident, having been closed as part of a possession, work continued in the vicinity of that line, and no measures were put in place to protect personnel from the passage of trains on that line.

The RAIB has made one recommendation to Network Rail relating to the implementation of processes intended to deter managers from undermining the safety related duties of other staff.

Introduction

Preface

- 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 or liability, or carry out prosecutions.

Key definitions

- 3 Metric units are used throughout this report, except for speeds and locations, which are given in imperial units in accordance with industry practice. Where appropriate, the equivalent metric value is also given.
- 4 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report). These are explained in appendices A and B.
- 5 The terms 'up' and 'down' in this report are relative to the direction of travel. The up lines are normally used by trains travelling from Gatwick Airport towards London. The down lines are normally used by trains travelling from London towards Gatwick Airport.
- 6 All mileages in this report are measured from a zero datum point at London Bridge station, except where otherwise stated.

The accident

Summary of the accident

- 7 At 05:28 hrs on Sunday 12 June 2011, train 1U11, the 05:00 hrs Gatwick Airport to London Victoria service, was approaching Stoats Nest Junction, between Coulsdon and Purley, in the London Borough of Croydon (figure 1).

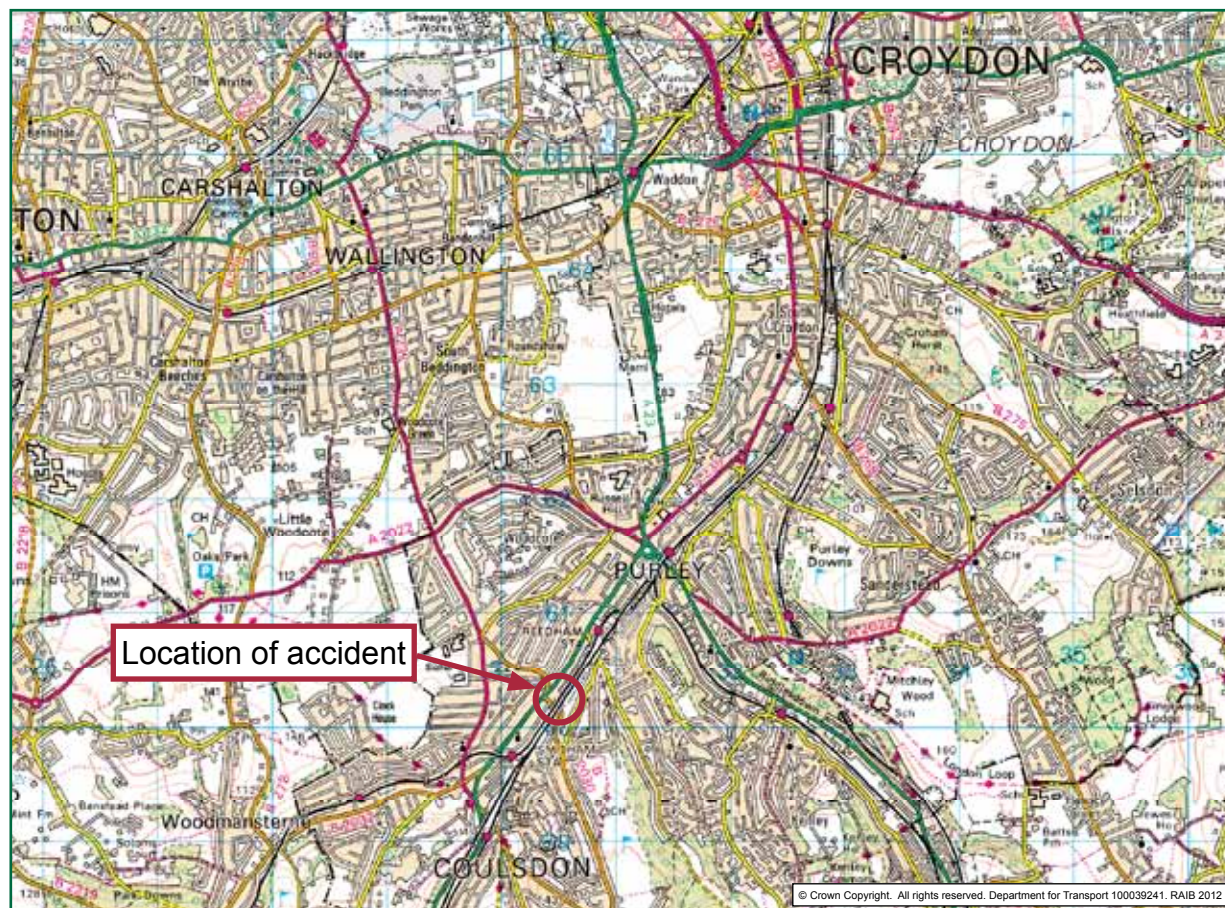


Figure 1: Extract from Ordnance Survey map showing location of accident

- 8 The train was formed of a single five-car class 442 *electric multiple unit*, operated by Southern.
- 9 The train was travelling at approximately 60 mph (96 km/h) when it struck a track worker who was standing adjacent to the line on which the train was running. The train narrowly missed five other track workers who were also very close to that line.
- 10 The signals for the line on which the train was running were showing green, and the train was authorised to run at the permitted speed for that line.
- 11 The driver brought the train to a stop and reported the accident to the signaller.
- 12 The track worker received serious injuries to his head, shoulders and abdomen.

Organisations involved

- 13 Network Rail owns, operates and maintains the railway infrastructure, and employed all the members of the track gang.
- 14 Southern Railway Limited (trading as Southern) operated the train involved in the accident as part of its Gatwick Express services, and was the employer of the train driver.
- 15 Network Rail and Southern Railway Limited freely co-operated with the investigation.

Location

- 16 Stoats Nest Junction is located at 14 miles 20 *chains*, on the route between London Victoria and Gatwick Airport, approximately 3.5 miles (5.6 km) south of Croydon.
- 17 The route through Stoats Nest Junction is *quadruple track*, consisting of a pair of fast lines and a pair of slow lines. A series of *crossovers* connect the fast and the slow lines. There are also an additional two adjacent tracks, on the route to Tattenham Corner (figure 2).
- 18 *Third rail DC electrification* on the route is controlled from the electrical control room at Brighton.
- 19 The accident occurred on the up slow line, which is used by trains travelling towards London that have come via Redhill station.
- 20 The signalling on the route through Stoats Nest Junction is controlled from the signal box at Three Bridges (at 29 miles 28 chains).
- 21 From approximately 0.9 miles (1.4 km) south of Stoats Nest Junction, the maximum permitted speed on the up slow line is 80 mph (129 km/h). From approximately 0.85 miles (1.35 km) north of Stoats Nest Junction, the permitted speed reduces to 60 mph (96 km/h).

External circumstances

- 22 The accident took place during daylight. On the day of the accident, sunrise was at 04:42 hrs.
- 23 The weather was dry and clear, and the sun was low in the sky.

Train involved

- 24 The train involved in the accident was a five-car Class 442 (Wessex) electric multiple unit. The train was built by British Rail Engineering Limited, at Derby in 1989. At the time of the accident, it was leased to Southern by Angel Trains Limited.
- 25 When constructed, the train was fitted with a four-way horn. This was able to emit either a high or low pitch tone, at either a loud or soft volume (paragraph 138).

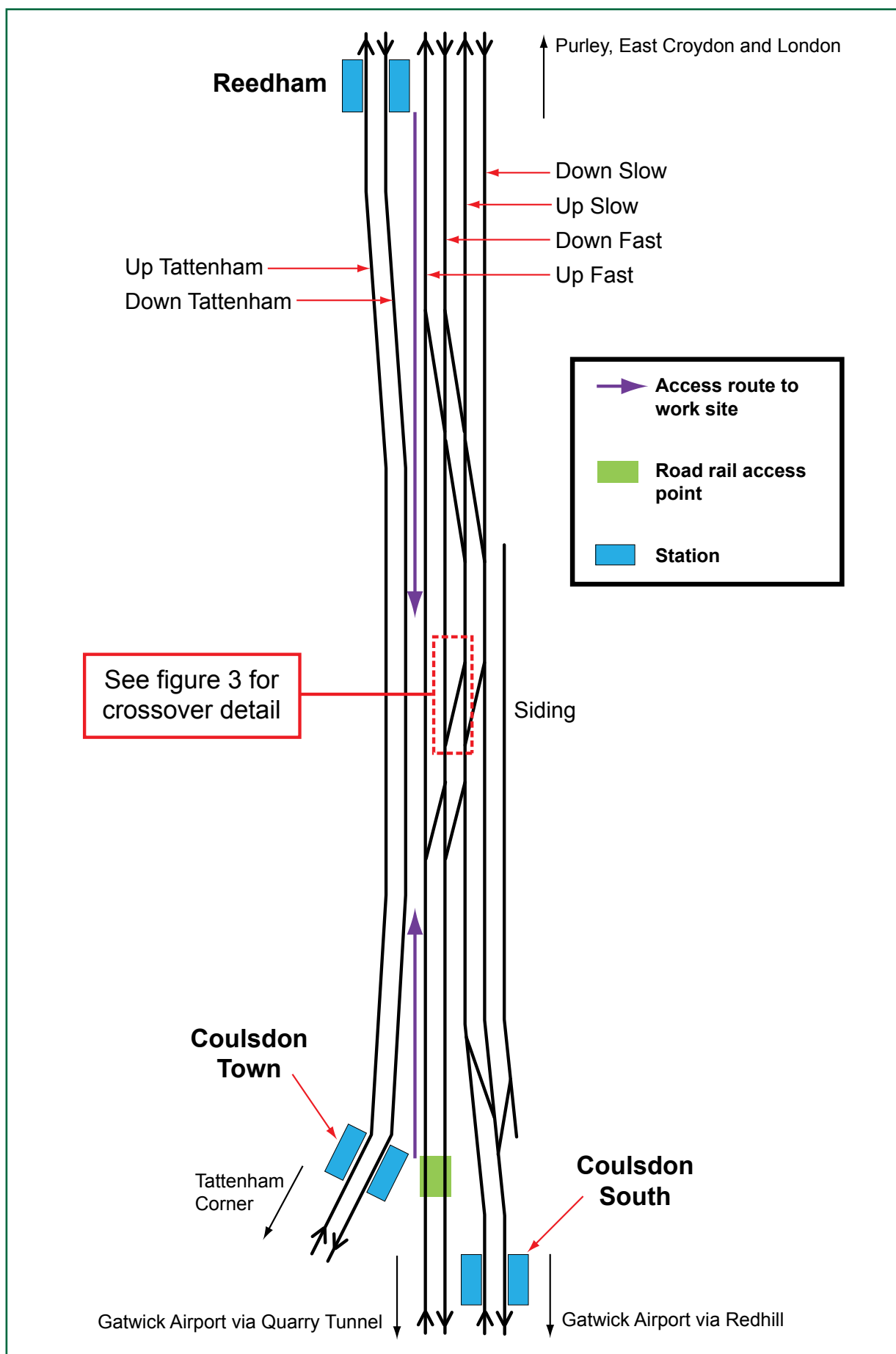


Figure 2: Track layout at Stoats Nest Junction

- 26 The train had been provided with *forward facing closed circuit television* (CCTV), but this was defective at the time of the accident, and no footage could be recovered.

Staff involved

- 27 The driver of the train involved in the accident had more than twelve years driving experience, and had driven this type of train since its introduction to Gatwick Express services at the end of 2008. He had spent the last seven years of his career driving Gatwick Express services, and was familiar with the Victoria to Gatwick Airport route.
- 28 The track gang working at Stoats Nest Junction comprised the assistant section manager (track), the section manager (track), two *controllers of site safety* (COSS), and six other track workers.
- 29 The injured person was employed as an assistant section manager at East Croydon permanent way depot. He had worked in the railway industry for about nine years and had been an assistant section manager for around four years prior to the accident. He had transferred to East Croydon, from Tulse Hill depot, about two months before the accident.
- 30 The section manager had worked in the railway industry for 37 years, with 12 years service as section manager at East Croydon depot. The section manager is the father of the assistant section manager, but there is no evidence that this relationship played a part in the accident.
- 31 One controller of site safety (COSS) was involved with work on a damaged *crossing* at Stoats Nest Junction (paragraph 81). He had joined Network Rail two and a half years before the accident, and had been qualified as a COSS for about a year. He had been mentored in the COSS role by the section manager.
- 32 The other COSS was overseeing *road-rail vehicles* (RRVs) being used for lifting and transporting materials (paragraph 81). He had joined the railway ten years before the accident.
- 33 The entire *work site*, encompassing both the above work activities, was under the control of an *engineering supervisor* (ES) who was located at Purley station at the time of the accident. The engineering supervisor had worked in the railway industry for 20 years, with the last 10 of those years in the role of Team Leader¹.
- 34 The work activities were taking place in an *engineering possession*. This possession was under the control of the *person in charge of possession* (PICOP), who was located at East Croydon depot at the time of the accident. The PICOP had worked for Network Rail since 2002.
- 35 Also involved in the work at Stoats Nest Junction, but not at the time of the accident, were two RRV operators, two welders and a signalling and telecommunications (S&T) team.

¹ The role of a 'Team Leader' is defined in Network Rail Guidance Note NR/GN/MTC/MG0226 (Infrastructure maintenance restructure – Guidance on the track and off track organisation) as follows: 'Direct, organise and motivate the team so that work is undertaken safely, efficiently and to the relevant standards. Undertake and direct inspection, faulting, maintenance and renewal work as allocated'.

Events preceding the accident

The track gang

- 36 The maintenance organisation at East Croydon depot had planned to replace the crossing of 1666A points, which was cracked, on the night of 11 June 2011. These points form part of a crossover between the down fast and up slow lines at Stoats Nest Junction (figures 2 and 3). This work was to be done during an engineering possession. Details of the possession arrangements are given in paragraphs 69 to 74.
- 37 The track gang met initially at East Croydon permanent way depot around 23:00 hrs on 11 June, collecting tools and materials before setting off to prepare the possession and the electrical isolations required to make the work site safe (paragraph 75).
- 38 The possession and electrical isolations for the up and down fast lines were fully in place by approximately 01:15 hrs. The up slow line was added to the possession and isolated by approximately 01:55 hrs.
- 39 Initially, the gang removed the rail fixings and cut out the cracked crossing section, in preparation for lifting out and replacement.
- 40 Two RRVs were used to bring the replacement crossing piece to site, from near Purley, along with two lengths of *closure rail* that had been cut to length to accommodate the new crossing assembly (figure 3).
- 41 During installation of the crossing, the track gang found that the crossover closure rail had been cut too short during the first part of the shift. As a result, they had to locate another length of rail, cut it to length and bring it to the site for installation. This, in conjunction with a delay in getting the possession, meant that it was no longer possible to weld this closure rail in position within the time available. At the start of the work, the gang decided to use clamps for the closure rail joints.
- 42 This closure rail was part of the crossover between the up fast and down slow lines. The track gang were clamping the crossover closure rail joints in place, with the intention that they could be welded at a later date.
- 43 The other rail joints on the crossing, and on the down fast closure rail, were welded as planned.
- 44 Shortly before 04:30 hrs, the process of removing the electrical isolations and amending the possession was started, in preparation for returning the up slow line to traffic as scheduled at 05:15 hrs.
- 45 At 04:47 hrs, the engineering supervisor spoke to the COSS responsible for the work at the crossing, to advise him that the up slow line was due to be handed back and to establish whether personnel were clear of that line. The COSS told the engineering supervisor that he was not at the work site, because he had been sent to collect equipment associated with the speed restriction (paragraphs 114 and 115). The engineering supervisor subsequently liaised directly with the assistant section manager, regarding the status of work at Stoats Nest Junction, and with the PICOP, who was responsible for handing the line back to the signaller for use by normal services.

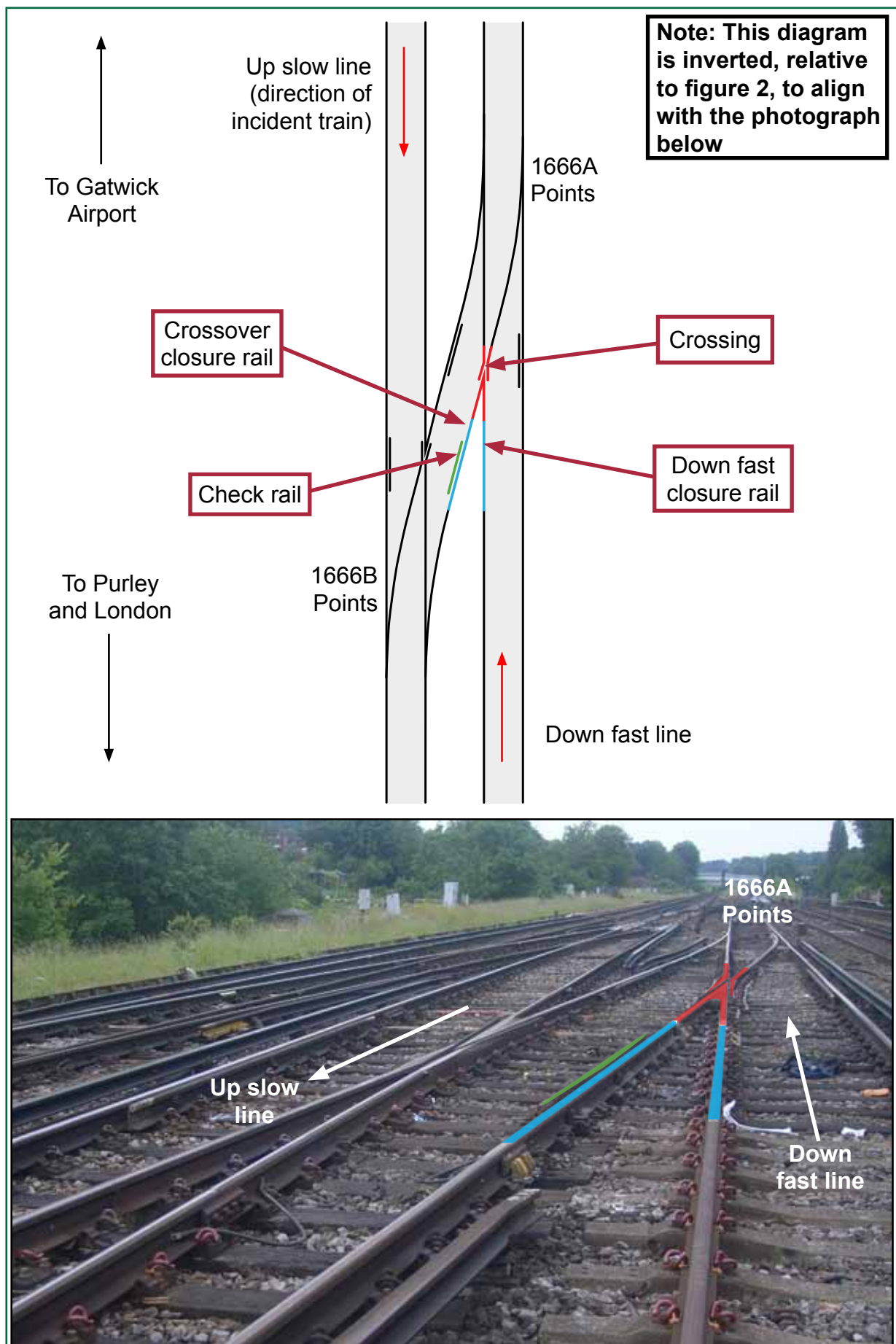


Figure 3: Crossover detail at Stoats Nest Junction

- 46 During this time, work continued on the crossing and on the crossover closure rail, between the down fast line and the up slow line. This meant that personnel were working in the space between the down fast and up slow lines.
- 47 At 05:09 hrs, the engineering supervisor spoke to the assistant section manager who told him that the up slow line was ready to hand back. The engineering supervisor then spoke to the PICOP at 05:10 hrs to advise him that the work site was clear and the line was available to hand back.
- 48 At 05:13 hrs, at the request of the PICOP, the assistant section manager operated *hook switches* (manually operated switches associated with isolating sections of conductor rail), as part of returning the up slow line to service (paragraph 107).
- 49 At 05:17 hrs the PICOP contacted the Three Bridges signaller to hand back the up slow line for traffic.
- 50 A recording of the forward (and rear) facing CCTV of a passing train, on the down slow line, shows that work was still ongoing on the crossover closure rail, at 05:24 hrs. Personnel were still present in the space between the up slow line, which was now returned to traffic, and the down fast line, which was still blocked. One person was in the *four-foot* of the up slow line, which was open to traffic (figure 4).



Figure 4: CCTV images of the work site at 05:24 hrs

The train

- 51 The driver of the train involved in the accident started his shift at London Victoria station at 21:15 hrs. He drove two return services to and from Gatwick Airport, then completed one round trip to Stewarts Lane depot. He then drove the 03:45 hrs service from London Victoria to Gatwick Airport. This involved passing Stoats Nest Junction, southbound, on the down slow line.
- 52 The driver then drove the train back from Gatwick to Redhill, as the 05:00 hrs service to London Victoria (retimed from 04:35 hrs, due to the engineering works).

- 53 At 05:08 hrs the train was held in the platform at Redhill (figure 6), at a red signal. Having read his *notices*, the driver was expecting to be met by a *pilotman* so that the train could proceed to Purley in the up direction on the down slow line, under *single line working*. For this reason, the driver contacted the signaller at Three Bridges, to establish whether he was awaiting authority from a pilotman. The signaller advised him that the up slow line was in the process of being handed back, and that he would be using the up slow line when the signal cleared, with no pilotman authority required.
- 54 At 05:22 hrs, the signal cleared to green, and the driver took the train forward on the up slow line. He accelerated the train to a maximum of 87 mph (140 km/h) at Merstham Tunnel, before decelerating for a speed restriction approaching Coulsdon South station.
- 55 After Coulsdon South station, the driver adjusted the train's speed to 77 mph (124 km/h). He started to apply the brakes as he approached Stoats Nest Junction, and checked his schedule card to confirm that he did not need to stop at Purley. The actions of the driver on the final approach to Stoats Nest Junction are described in paragraphs 133 to 135.

Events during the accident

- 56 The train approached Stoats Nest Junction at 05:28 hrs.
- 57 The track gang continued to work around the crossover closure rail, in the space between the down fast and up slow lines. They did not acknowledge the approach of the train, by raising their arms, or move to a *position of safety*. Figure 5 shows the crossover closure rail, in relation to a train passing on the up slow line.
- 58 Two of the gang were crouched down with their backs to the up slow line, and were narrowly missed by the *bogies* of the train as it passed. Two others were slightly further from the up slow line. The approximate location of these four track workers is highlighted in figure 5.
- 59 The assistant section manager was standing in the space between the down fast and up slow lines, beyond the crossover closure rail, talking to the section manager who was standing to his left. Both of them had their backs towards the train as it approached.
- 60 The train hit the assistant section manager at around shoulder height, and he was thrown forwards and to the left, onto the down fast line. The section manager was not hit by the train.
- 61 At the time of impact, the train was travelling at approximately 60 mph (96 km/h).

Events following the accident

- 62 The driver heard a thud, and applied the emergency brake to bring the train to a stop. He contacted the signaller to advise him of the impact, believing that he might have hit a track worker. A member of the track gang also contacted the signaller to advise him of the accident.

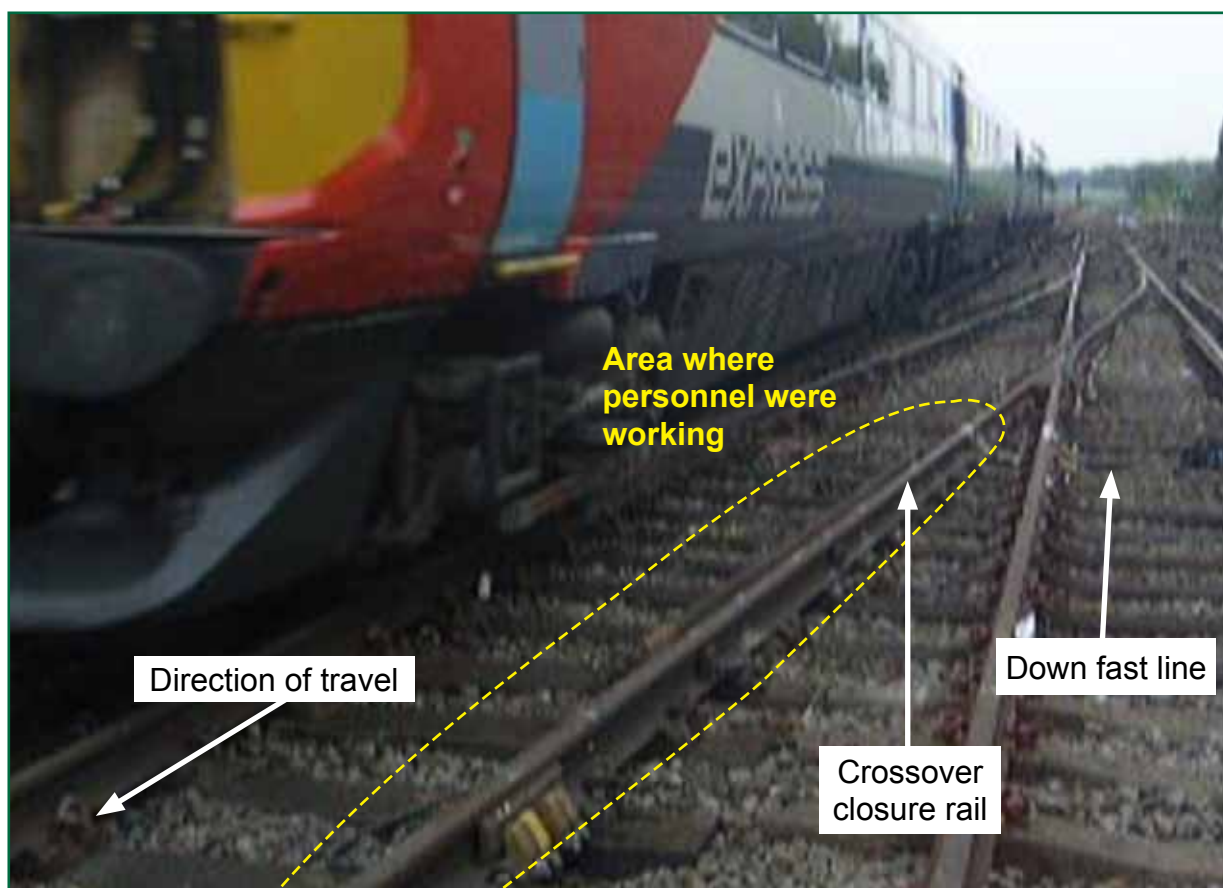


Figure 5: Similar train passing the work site on the up slow line

- 63 After some time, staff accompanying a passing RRV, who were going to assist the paramedics to reach the site, informed the driver that someone had been hit. The driver passed this information to the signaller. A few minutes later, the driver confirmed to the signaller that he was able to take the train to Purley, despite being shaken by the accident. The train arrived at Purley at 05:56 hrs, where the passengers were detrained. The driver then took the train forward, empty, to East Croydon, where another driver took over the train at 06:02 hrs. The driver was drug tested by his employer, in accordance with normal railway practice, after arrival at London Victoria. He was also breathalysed by British Transport Police. The tests found no signs of drugs or alcohol.
- 64 The rail incident officer (RIO), a Network Rail employee, arrived on site at 06:40 hrs, and told the remaining track gang members to finish off the outstanding work on the crossover closure rail, between the down fast and up slow lines. However, this instruction was rescinded a few minutes later, so that the up slow line could be returned to service. Under the supervision of the RIO, the track gang collected the remaining tools and equipment onto a rail trolley and removed them from the site.
- 65 After the accident, all the members of the track gang were tested for drugs and alcohol, as is routine in Network Rail following such an incident, with the exception of the injured assistant section manager, and the section manager, who had accompanied him to the hospital. The tests found no signs of drugs or alcohol, with the exception of that for the engineering supervisor. The engineering supervisor, who was tested three days after the accident, gave a positive test result for recreational drugs and he subsequently resigned from Network Rail.

Consequences of the accident

- 66 The assistant section manager was seriously injured as a result of the impact with the train. He suffered injuries to his head, shoulder and torso and was taken from the site to hospital, under the supervision of paramedics. Despite the serious nature of the injuries to his shoulder and head, he recovered sufficiently to be considered fit for full work duties without any medical restrictions.
- 67 Five other persons narrowly escaped being hit by the train, as they were working within two metres of the running line on which the train passed, and were unaware of its approach.

The investigation

Sources of evidence

68 The following sources of evidence were used:

- witness interviews and statements;
- analysis of information from train and signalling data recorders and on-train CCTV;
- records for the work activity;
- weather reports; and
- a review of previous RAIB investigations that are relevant to this accident.

Key facts and analysis

Background information

The possession

- 69 The work at Stoats Nest Junction on the night of 11-12 June 2011 was being carried out under a three part² possession of the lines between Purley and Balcombe Tunnel Junction (figure 6).

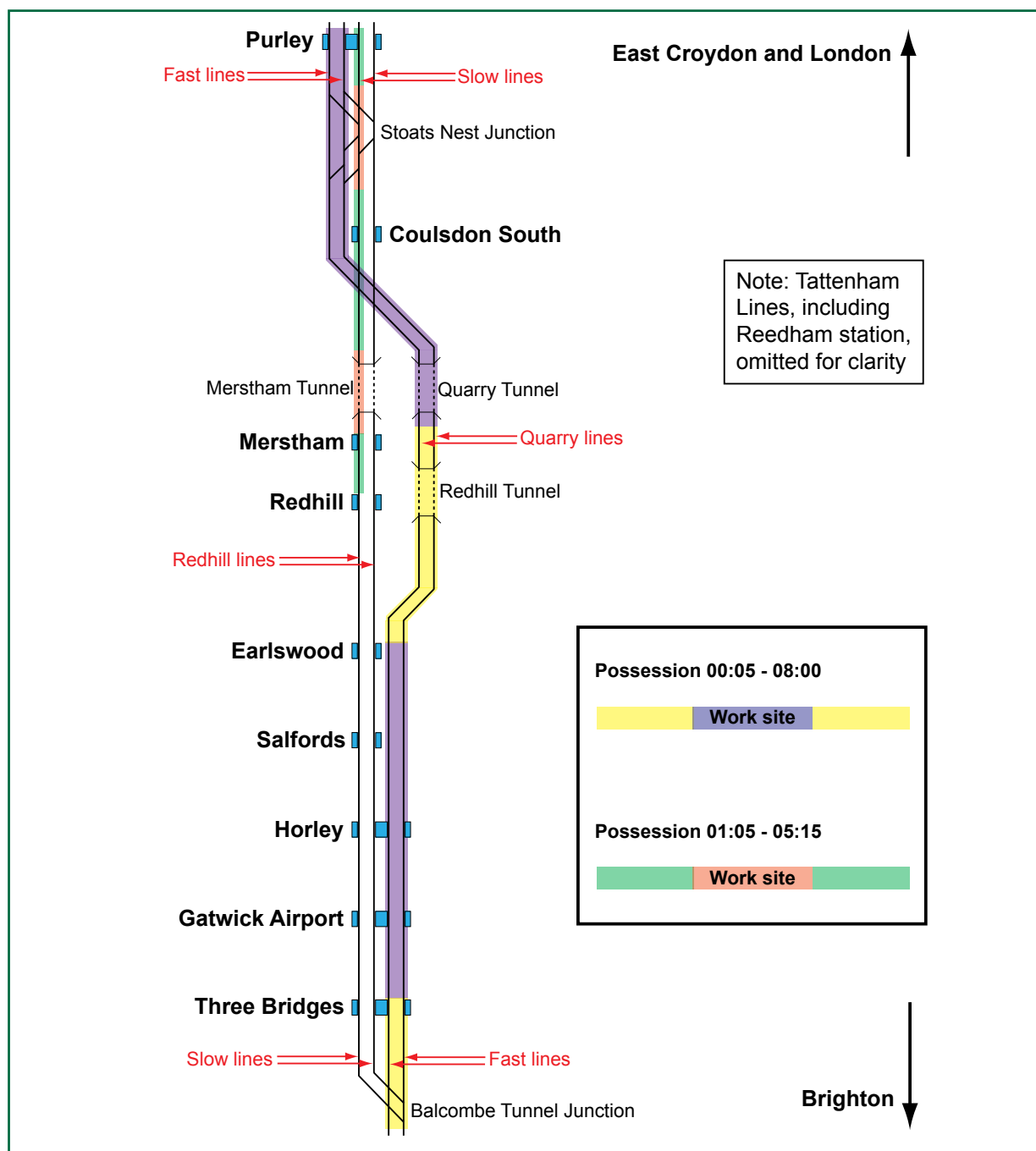


Figure 6: Simplified layout of the possessions

² This means that the possession consisted of three discrete stages, during each of which different lines were blocked to rail traffic.

- 70 Parts one and three of the possession included the up and down fast³ lines between Purley (13 miles 21 chains) and Balcombe Tunnel Junction (31 miles 8 chains). Part one was scheduled to extend from 00:05 hrs to 01:05 hrs, with part three extending from 05:15 hrs to 08:00 hrs.
- 71 Part two of the possession covered the period between parts one and three, from 01:05 hrs to 05:15 hrs. This included the same section of the fast lines, but added the up slow line between Purley (13 miles 21 chains) and Redhill (22 miles 21 chains, referenced from London Charing Cross⁴).
- 72 Throughout all parts of the possession, the down slow line remained open, and was used by trains in both directions, under single line working.
- 73 Within the possession there were several planned work sites to accommodate a number of different work activities. These included tamping, stoneblowing, and weld repairs to the rail head.
- 74 The work site associated with the crossing work extended from Purley (13 miles 21 chains) to Quarry Tunnel (18 miles 71 chains) on the up and down fast lines, and between 14 miles 0 chains and 14 miles 40 chains (in the vicinity of Stoats Nest Junction) on the up slow line (figure 6).
- 75 The procedure for setting up a possession, work site and isolation, in an area with third rail electrification, includes the elements below. The procedure is reversed when the line is handed back for use by normal services:
- arranging for signals to be set to prevent trains from entering the possession;
 - installing possession limit boards and detonators, marking the limits of the area under the PICOP's authority;
 - arranging for the electrical controller to turn off the traction current using remotely-operated circuit breakers;
 - opening hook switches to isolate sections of conductor rail;
 - arranging for the electrical controller to reclose the circuit breakers to restore traction current to areas which are not subject to the isolation;
 - testing the isolation and applying *earth straps*;
 - setting up work site marker boards, marking the limits of the area under the engineering supervisor's authority;
 - issuing by the engineering supervisor of *conductor rail permits* to COSSs; and
 - COSSs signing the engineering supervisor's paperwork to acknowledge authority to work, and receipt of the conductor rail permits.

Personnel responsibilities

- 76 The entire three part possession from Purley to Balcombe Tunnel Junction was under the control of the PICOP. The PICOP liaised with the electrical control operator and the signaller in setting up the possession.

³ Between Stoats Nest Junction and Earlswood, the two pairs of lines are designated as the Quarry and Redhill lines, while elsewhere they are designated as the fast and slow lines respectively (figure 6). In the text of this report, they are referred to as the fast and slow lines throughout.

⁴ Note that on the slow (Redhill) lines, between locations 17 chains north of Coulsdon South station and 19 chains north of Earlswood station, Network Rail location mileages are referenced from London Charing Cross station.

- 77 Throughout the night's work, the PICOP was located at East Croydon depot. He was in telephone contact with the two engineering supervisors for the work sites within the possession, the signaller at Three Bridges, and the Electrical Control Room (ECR) operators at Brighton and Selhurst.
- 78 There were two engineering supervisors whose roles were to co-ordinate work within, and access to, their respective work sites. One engineering supervisor was in control of the work site associated with the crossing replacement at Stoats Nest Junction, as well as a short work site on the up slow line at Merstham Tunnel and other work on the fast lines between Purley and Quarry Tunnel. A second engineering supervisor was overseeing a work site between Earlswood and Three Bridges, on the fast lines. Both of the engineering supervisors liaised with the PICOP to set up the possessions and isolations required to protect the work sites.
- 79 The engineering supervisor for the crossing work site at Stoats Nest Junction was located at Purley at the start of the possession and at the time of the accident. As this was the northern end of the possession, he was able to oversee the setting up and removal of both the work site protection and the isolations at Purley. From there he was also able to control access of rail maintenance vehicles, such as the tamper and the stoneblower, to both the possession and the work site.
- 80 During the night, some time after 01:00 hrs, the engineering supervisor travelled to the Stoats Nest Junction work site to add the up slow line to the possession. He returned there some time before 04:30 hrs after overseeing some railhead welding work at Coulsdon South. The engineering supervisor then removed the earth straps from the up slow line conductor rail at both ends of the Stoats Nest Junction work site, before returning to Purley to remove the up slow line work site protection. His removal of the earth straps and protection from the up slow line was in preparation for the resumption of train services on this line that was planned for 05:15 hrs.
- 81 Two controllers of site safety (COSS) were appointed in connection with the work at Stoats Nest Junction. One of these was associated with the site work involved in removal of the defective crossing and replacement with the new one. The second COSS was associated with the operation of the RRVs involved in lifting and transportation of the crossing and rails to the work location. The role of the COSS is to protect the safety of persons in the work group from the risk of being struck by trains and from the risk of electric shock, by ensuring that a safe system of work is implemented, and maintained, at all times when personnel are on or near the line.
- 82 The crossing replacement work at the site was being directly supervised by the East Croydon assistant section manager, who was present at the site. The assistant section manager was also the line manager for the track workers at the site. The assistant section manager and all but one of the track gang had signed the form that was held by the COSS who was overseeing the crossing replacement work. By signing this form, they acknowledged and recorded that they were aware of the safe system of work and had been briefed, as is required by Network Rail standards and the Rule Book.

- 83 The East Croydon section manager, who was the assistant section manager's line manager, was also present at the site. Although this was not his normal role, the section manager had the relevant competence to oversee the *tandem lifting* with the RRVs, and had stood in for another staff member who was unavailable. Although not in direct control of the work on the crossing, the section manager liaised with the assistant section manager in progressing the work. The section manager had signed the form completed by the COSS who was overseeing the RRVs, to acknowledge and record that he was aware of the safe system of work and had been briefed.

Work during the possession

- 84 At the start of the night, one of the track gang cut two lengths of rail for use as the closure rails. During installation, the track gang found that the crossover closure rail was too short. The COSS associated with the operation of the RRVs located and cut a new length, and it was brought to the site using an RRV and lifted into position.
- 85 By this time the welds on the down fast line closure rail (figure 3) were under way, and the track workers were preparing to clamp the crossover closure rail into position so that the up slow line could be handed back on schedule. Although this meant that the crossover would only be able to be used at low speed, the fact that it normally had a 25 mph (40 km/h) speed restriction meant that this would cause no disruption.
- 86 It is likely that if the original crossover closure rail had been the correct length, it would have been secured in place earlier, and the work would not have overrun beyond 05:15 hrs, the time when the up slow line was due to be handed back to the signaller for the passage of trains.

Identification of the immediate cause⁵

87 The track workers were working too close to a line that was open to traffic.

- 88 As the train approached the work site on the re-opened up slow line, work activities were still taking place in the space between the up slow line and the down fast line. The people working on the crossover closure rail were doing so in a location where they were not safe from being struck by trains.
- 89 Although only one person was struck by the train, five others were only narrowly missed by the train.

⁵ The condition, event or behaviour that directly resulted in the occurrence.

Identification of causal factors⁶

System of work

- 90 **No safe system of work was in place to protect staff from train movements on the up slow line, after that line had been returned to traffic. This was a causal factor.**
- 91 At the time of the accident, the up and down fast lines were still under possession. However, the up and down slow lines were both open to traffic, although no trains had passed over the up slow line since that part of the possession had been handed back.
- 92 Four members of the track gang were working on the crossover closure rail, between the down fast and up slow lines. One of these was drilling holes in the crossover closure rail, to allow re-attachment of the *check rail*. The other three were securing the clamps to the crossover closure rail joints, to hold them in place until they could be welded at a later date.
- 93 The assistant section manager was standing in the space between the down fast and up slow lines, and the section manager was probably standing beside him, closer to the down fast line.
- 94 The recording from the forward facing CCTV on the previous train that passed on the down slow line (figure 4) also shows that one member of the track gang had been standing in the four-foot of the up slow line at 05:24 hrs. This was seven minutes after it had been handed back to the signaller for the resumption of services, and three minutes after the train involved in the accident had set off from Redhill towards Stoats Nest Junction on that line.
- 95 These activities meant that work was going on within 2 metres of an open line and six people were within, or very close to, that distance from the running line.
- 96 Handbook 7 of the railway rule book (Railway Group Standard GE/RT8000/HB7 - General duties of a controller of site safety) specifies that if personnel are required to work within 3 metres of an open running line then certain precautions are required. Depending on the circumstances, these can be taking a *line blockage*, erection of barrier fencing, or the use of a *site warden* to warn persons who move too close to a running line. The rule book also permits a system of work based on the use of an equipment based warning system, or a lookout, to warn of approaching trains so that staff can move to a position of safety in good time.

⁶ Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

- 97 Network Rail standard NR/L2/OHS/019 (Safety of people working on or near the line) specifies the hierarchy of safe systems of work that needs to be considered. This places line blockages as the first option, followed by barrier fencing, site warden protection and equipment based warning systems if a line blockage is not available or if the time required to take a line blockage would be disproportionate. The use of lookouts is always regarded as a last resort, to be used only if other measures are not available or would take a disproportionate time to set up. The safe system of work is normally defined by the personnel planning the work, but this can be changed by the COSS if they decide that this system of work is inadequate. It is the responsibility of the COSS to implement and maintain a safe system of work at site, and to brief the arrangements for this to the work group (paragraph 118). The COSS was not on site at the time the up slow line was handed back (paragraph 45).
- 98 It would have been possible to retain the possession on the up slow line until the work had been completed or until the work site had been made safe and the group had moved to a position of safety. This would have been the safest option, under the hierarchy, but could have caused disruption to services. It would also have been possible to relinquish the possession and modify the safe system of work to take line blockages of the up slow line.
- 99 The use of either barriers or a site warden requires a minimum clearance between the area of work and the nearest running line. These methods of protection were not possible, because the work was taking place between the down fast and up slow lines, with insufficient clearance from the open line.
- 100 Because the work had not been planned to take place next to a running line, equipment based warning systems would not have been an option as none were available at the site.
- 101 It would have been possible to appoint lookouts to provide the track gang with warning of any approaching trains, allowing them time to stop work and move to a place of safety. Sufficient qualified staff were available on site for a lookout to be appointed. However, this was not done when the up slow line was handed back.
- 102 None of the track gang working on the crossover closure rail recognised that the up slow line had been handed back to traffic. Witness evidence shows that they were aware of the time that it was due to be handed back, but all have stated that they assumed that they would be informed when it was handed back and that the system of work would be changed if required.
- 103 Witness evidence shows that no-one alerted the gang that the line had been handed back, or briefed them of any alterations to the system of work to accommodate this change. As a result, they continued to work on the crossover closure rail as if the up slow line was still closed. This meant that they were unaware that they were at risk from trains running on the adjacent line. The first indication they had that the line was open was the sound and air movement produced by the train involved in the accident as it passed (paragraph 154).

- 104 It is very likely that the assistant section manager and the section manager were aware that the engineering supervisor and the PICOP had started the process to hand back the up slow line on schedule. This is because they had been involved in the following hand back activities:
- both instructed that the earth straps be removed (paragraph 105);
 - the assistant section manager confirmed that he had no objection to the hand back (paragraph 106); and
 - the assistant section manager operated the hook switches (paragraph 107).
- 105 Witness evidence shows that the engineering supervisor met the assistant section manager and the section manager shortly before 04:30 hrs, and the assistant section manager and section manager directed the engineering supervisor to start the process of handing back the up slow line by removing the earth straps (paragraph 80). At this time, the engineering supervisor knew that the work at Stoats Nest Junction was not yet complete.
- 106 The engineering supervisor contacted the assistant section manager at 05:09 hrs to ask if he could hand back the up slow line as scheduled, and there is evidence that indicates that the assistant section manager confirmed that he could do so. As a result, the engineering supervisor believed that he had an assurance from the assistant section manager, who was in control of work at the work site, that the line was safe to hand back. This assurance should have come from the COSS, who the engineering supervisor knew was not at the work site (paragraph 128).
- 107 The engineering supervisor called the PICOP at 05:10 hrs to inform him that the line was clear to hand back. The PICOP also spoke to the assistant section manager to instruct him to operate hook switches at the site at 05:05 hrs and 05:13 hrs, before the line was handed back to the signaller at 05:17 hrs (paragraph 47). The PICOP's understanding that the possession was no longer needed to protect the safety of personnel at Stoats Nest Junction did not change as a result of the call at 05:13 hrs.
- 108 The awareness of the managers on site that the COSS was absent, and their response to that situation, is considered at paragraph 123.
- 109 The COSS was not present at the site when the up slow line was returned to traffic, and no replacement had been appointed. This was a causal factor.**
- 110 The COSS for the work on the crossing first saw the possession paperwork when he booked on at East Croydon depot at 23:00. This identified which lines were due to be blocked, and when. From this the COSS set up a safe system of work for the period while the up slow line was blocked. No work was required to take place beyond the rail of the up slow line that was closest to the down fast line (figure 3). This meant that personnel would remain more than 3 metres from the nearest rail of the open down slow line. As specified in Handbook 7 of the railway rule book (Railway Group Standard GE/RT8000/HB7 - General duties of a controller of site safety), this meant that no additional special protection measures, such as lookouts or site wardens, were needed.

- 111 Witness evidence indicates that the COSS briefed all the members of the track gang on the lines that were open, and the expected reopening of the up slow line later in the possession. This was done when the gang assembled at East Croydon depot.
- 112 All but one of the track gang members had signed the COSS's paperwork to acknowledge receipt of the briefing and their awareness of the safe system of work at the work site (paragraph 82). Witness evidence shows that the section manager, assistant section manager and track workers were aware, from the briefing, that the up slow line was due to be returned to traffic at 05:15 hrs.
- 113 No briefing was given at the start of the possession as to the safe system of work that would be required after the up slow line was handed back. However, because the work was expected to have been completed by then, this was not perceived to be necessary. The track workers stated that they expected to be briefed about the amended safe system of work when the up slow line was handed back, if the work had not been completed by that time.
- 114 At approximately 04:30 hrs, the section manager asked two of the track workers to remove the TSR (Temporary Speed Restriction) *boards* and *temporary magnets* associated with a speed restriction related to the cracked crossing on the down fast line. This involved removing equipment that was located near Coulsdon Town station (approximately 650 metres south of the crossover), and near Purley station (approximately 1300 metres north).
- 115 One of these track workers then asked the COSS to go with them to assist with the heavy equipment. The COSS understood that this request had come from the section manager. However, the section manager was unable to recall any events from around this time, so it is not possible to confirm if he made this request.
- 116 The COSS complied with the request, and went with the two track workers to remove the speed restriction equipment. This involved travel by van to Purley, East Croydon depot, and back to Coulsdon Town station.
- 117 The up slow line was handed back at 05:17 hrs, while the COSS was away from the work site. The accident happened at 05:28 hrs, as the COSS was walking back towards the site from Coulsdon Town station, with two other track workers.
- 118 Handbook 1 of the railway rule book (Railway Group Standard GE/RT8000/HB1 - General duties and track safety for track workers) states:

“The only occasion when you can go on or near the line without a COSS, is when you are walking alone. You must never work alone unless you are a COSS or IWA⁷” and

“Any work done on the lineside must not affect or go within the area called on or near the line⁸ unless a controller of site safety (COSS) is present and has given permission for the work to take place” and

“You must not go into the area called on or near the line with another person unless you are with a COSS. The COSS must then stay with you while you are there.”

⁷ *Individual Working Alone.*

⁸ On or near the line is defined as being within 3 metres (10 feet) of a line, if there is no permanent fence or structure between you and the line, or on the line itself.

- 119 As this was a gang of personnel working on the line, the rule book requires there to be a COSS present at all times. As a result, the COSS should not have agreed to leave the site without having made alternative arrangements for the COSS role to be taken on by another qualified person. Similarly, no-one should have asked the COSS to leave the site to carry out other duties, as the rule book does not permit the gang to remain on or near the line without the COSS being present.
- 120 The COSS believed that the section manager had asked him to go off site to do another task. This meant that he believed his senior manager had asked him to do something that was contrary to his COSS role. However, because the section manager had mentored him in the role of COSS, and was his senior manager, he did not question whether the section manager had the authority to make this request. As a result he complied with the request and left the site.
- 121 This COSS was normally chosen by the section manager, when he was planning the work, to take on the COSS role. Witness evidence indicated that this COSS was unlikely to question instructions given by more senior management.
- 122 After the COSS had left the site, the assistant section manager and section manager were still in charge of the work activity. However, they took no steps to ensure a continuation of the duty of the COSS to provide a safe system of work (paragraph 81). Formally changing the person undertaking the COSS role would have required the COSS to tell the track gang who was to be the replacement COSS, and for him to hand over the conductor rail permits to the new COSS. The new COSS would also have had to sign in on the certificate held by the engineering supervisor before taking over, while the old COSS would have to sign out on the same paperwork after the handover.
- 123 It is possible that the assistant section manager and section manager were aware that the COSS had left the work site, and that no-one had taken over the COSS role on site. The hand back activities involving the assistant section manager and the section manager (paragraph 104) should not have taken place without the COSS briefing the gang at the crossing. As the assistant section manager and the section manager were both at the crossing, they should have noted the absence of a briefing and then appreciated that the COSS was absent.
- 124 If the assistant section manager and the section manager were aware of the COSS's absence, they should not have permitted work to continue until the COSS returned or until the role had been taken over by another person with the appropriate competence. Although there was a COSS associated with operation of the RRVs, it may have been impractical for him to take over the responsibility for the crossing work as well, as his existing responsibility required him to be with the RRVs as they moved to and from the work site. An option would have been for either the assistant section manager or section manager to take the COSS role themselves.

125 The engineering supervisor was aware that the COSS was not carrying out all his safety responsibilities and had left the site, but did not establish who was then responsible for the safe system of work. This was a causal factor.

126 Control of the safe system of work used at Stoats Nest Junction was the responsibility of the COSS. The rule book required the engineering supervisor to liaise with the COSS to ensure that personnel were clear of the line at the time the up slow line was being handed back. Handbook 12 of the railway rule book (Railway Group Standard GE/RT8000/HB12 - Duties of the engineering supervisor (ES)) states:

“When each IWA/COSS no longer needs to be on or near the line, or they are sure the work may safely continue without the protection provided by you, the IWA/COSS will tell you and sign your engineering supervisor’s certificate.”

127 Shortly before 04:30 hrs, the assistant section manager and section manager directed the engineering supervisor to start removing the earth straps (paragraph 104). Although the engineering supervisor and the COSS were at the work site, and the engineering supervisor could see that the work was unfinished, he did not seek the agreement of the COSS before removing the straps. Network Rail Work Instruction NR/WI/ELP/3091 (DC Electrified Lines Working Instructions) required the engineering supervisor to retrieve the conductor rail permit from the COSS and to sign it to confirm receipt. If the COSS had surrendered the conductor rail permit, he should then have briefed the track workers that the conductor rail was to be considered as live, and of any associated changes to the safe system of work.

128 There is evidence that the engineering supervisor telephoned the COSS from Purley, at 04:47 hrs, after removing the earth straps on the up slow line, to ask if it was safe to start handing the line back. The COSS told him that he was no longer on site, as he had been sent by the section manager to remove the speed restriction equipment (paragraph 115). Although the engineering supervisor thought that this was unusual, he did not question this because he understood that the assistant section manager and section manager, who were his line managers, were at the work site and in charge.

129 The engineering supervisor then telephoned the assistant section manager, who was at the work site, at 04:50 hrs and 04:55 hrs. Just after this, the engineering supervisor saw the COSS as he arrived at Purley station with the speed restriction equipment that had been removed (paragraph 116). The COSS signed the *engineering supervisor’s certificate*, confirming return of the conductor rail permit and that the possession was no longer required, marking the time as 04:55 hrs. However, the COSS did not complete the section on the engineering supervisor’s certificate to declare that the crossing work was complete, or if it was still continuing under new protection arrangements, as he was required to do. The COSS did not know whether the work was complete, because he was not at the work site.

- 130 The engineering supervisor called the assistant section manager again at 05:09 hrs, and there is evidence that indicates that he received confirmation from the assistant section manager that the line was clear to hand back (paragraph 106). Neither the assistant section manager nor the section manager was able to recall any of their actions relating to handing back the line. As a result, it is not possible to establish whether the assistant section manager understood that the engineering supervisor was expecting him to fulfil the COSS role in ensuring that a safe system of work was maintained after the line was handed back.
- 131 The engineering supervisor was aware that the safety arrangements at Stoats Nest Junction were not in accordance with procedures, because he was aware that the COSS was not at the work site (paragraph 128). However, the engineering supervisor knew that the assistant section manager was at the work site and that he had the seniority and competence to ensure a safe system of work. The engineering supervisor saw no reason to question the authority of the assistant section manager, and the section manager, who were his line managers and appeared to be in control of the work activity and actively participating in handing back the line.

Driving the train, and use of the horn

132 The track workers did not hear any warning from the train as it approached. This was a causal factor.

- 133 The signals for the up slow line, on which the train was travelling, were showing green. The train was running close to the *line speed* of 80 mph (128 km/h) after passing Coulsdon South station. On approaching Stoats Nest Junction, the driver applied the brakes, bringing the speed down to 60 mph (96 km/h) by the time the train reached the accident location (paragraph 148).
- 134 At 05:28 hrs, and approaching Stoats Nest Junction, the train driver saw some track workers standing close to the line on which his train was running. This was the gang working at the crossover.
- 135 The driver believed that the track workers were aware of the proximity of the running line, and that they were clear of it. He stated that he sounded the train horn on the soft setting to warn them of his train's approach. This cannot be verified because the *on train data recorder* (OTDR) is not configured to record operation of the horn, and because none of the witnesses recall hearing a horn.
- 136 The most likely explanation for the track workers at the work site not hearing any horn warning is that the soft volume horn would have been masked by the machinery noise at the work site (paragraph 157).
- 137 The most likely reason for the track workers that were walking back to the work site not hearing any horn warning is that the train had already passed them when the soft volume horn was sounded, and it would have been masked by the sound of the train (paragraph 160).

Horn Volume

- 138 The class 442 units are fitted with a four-way horn lever (figure 7). This allows the driver to sound two different horn tones in the loud volume setting, by moving the lever forwards and backwards. A further two tones in the soft volume setting can be sounded by moving the horn lever left and right.

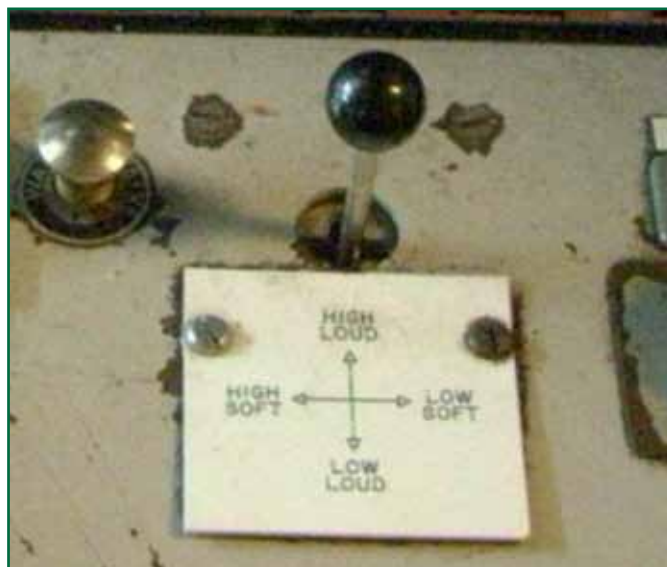


Figure 7: Train horn lever

- 139 The train driver believes that he sounded the horn using the soft volume level, when he sighted the track gang close to the line. The driver stated that he used the soft volume level because he was close to the track workers at the time, and believed that they were clear of the train. However, because the OTDR on the train does not record horn use (paragraph 135), there is no evidence to confirm whether the horn was sounded, the timing of any horn use or its volume.
- 140 The relevant rule book module (Railway Group Standard GE/RT8000/TW1 - Preparation and movement of trains: General) is explicit on the requirements for using the horn when personnel are on or about the line. It states in section 10.2 (using the warning horn):
- “You must sound the horn to warn anyone who is on or near the line on which you are travelling. Give a series of short, urgent danger warnings to anyone who is on or dangerously near the line who does not:
- acknowledge your warning by raising one arm above the head, or
 - appear to move clear out of the way of the train.”
- In addition it states:
- “To give a warning to anyone on or near a running line - high and low tones - use the loud setting.”
- 141 The only situation in which the rule book allows use of the soft volume horn, when one is available, is “to give a warning when in a depot or siding”. The use of the soft setting of the horn, on a running line, was therefore not in accordance with the requirements of the rule book.
- 142 Some modern rolling stock only has one volume setting (loud), so there is no facility to sound the horn at a soft volume. This means that the driver does not have to consider whether the use of the loud or the soft horn is appropriate. The class 442 units are the only passenger trains operated by Southern to have the soft horn facility.

- 143 On the class 442 units it is possible to further vary the loudness of the horn, in the soft volume setting, by restricting the movement of the lever. If the horn lever is moved only part way, the loudness of the soft volume horn can be reduced. However, this is difficult to achieve, and it is unlikely that the driver would have controlled the horn volume in this way.
- 144 RAIB measurements of a typical class 442 horn show that both loud volume tones produce a sound pressure level of approximately 121 dB(A), when recorded at a position 5 metres in front of the train (as described in Railway Group Standard GM/RT2482 – Audibility requirements for trains). The equivalent measurements for both soft volume tones were approximately 106 dB(A).
- 145 Prior to 2005, railway group standards required the sound pressure at 5 metres to be between 120 dB(A) and 125 dB(A) for trains with a maximum speed of up to 160 km/h (100 mph). After a revision of the standards in 2007, the sound pressure of a warning horn, measured at a distance of 5 metres, was required, for new trains, to be between 101 dB(A) and 106 dB(A). This shows that, in respect of the sound pressure levels measured at 5 metres, the loud volume horn was compliant with the pre-2005 standards, and exceeded the values required by the current standard. In addition, the soft volume horn was compliant, in respect of the sound pressure levels, with the requirements of the current standard for warning horns on new trains.

Timing of the horn use

- 146 Because the train's schedule had been altered by the use of the up slow line, instead of single line working on the down slow line, the driver was uncertain if his train had to stop at Purley. Because the train had been planned to run in the up direction on the down slow line, the driver suspected that it may have had a scheduled stop at Purley to drop a pilotman off. Because the pilotman was no longer required, the driver had to check to see if a Purley stop had been scheduled for any other reason. This check required the driver to look down at his schedule card.
- 147 Witness evidence, and RAIB analysis of the OTDR data, suggests that this check was made some time between Coulsdon South station and Stoats Nest Junction. The train speed is seen to be steady at 76 mph (122 km/h) after Coulsdon South station, which is 4 mph (6 km/h) below the line speed. The driver then applied a little power, about 900 metres before the accident location, to bring the train closer to line speed.
- 148 Approximately 550 metres (18 seconds) before the impact, the driver applied the brakes, bringing the speed down ahead of the 60 mph (96 km/h) restriction at Purley. This brake application was about 50 metres after the first opportunity at which the driver would have had a clear view towards Stoats Nest Junction (in ideal conditions). Evidence from a driver trainer indicates that the brake application was approximately 350 metres earlier than the normal braking point required to stop the train at Purley, and 1250 metres earlier than would have been required to slow the train to pass through Purley without stopping. Figure 8 shows the train's speed profile on the approach to Stoats Nest Junction as well as the speed profiles for normal services stopping at, or passing through, Purley.

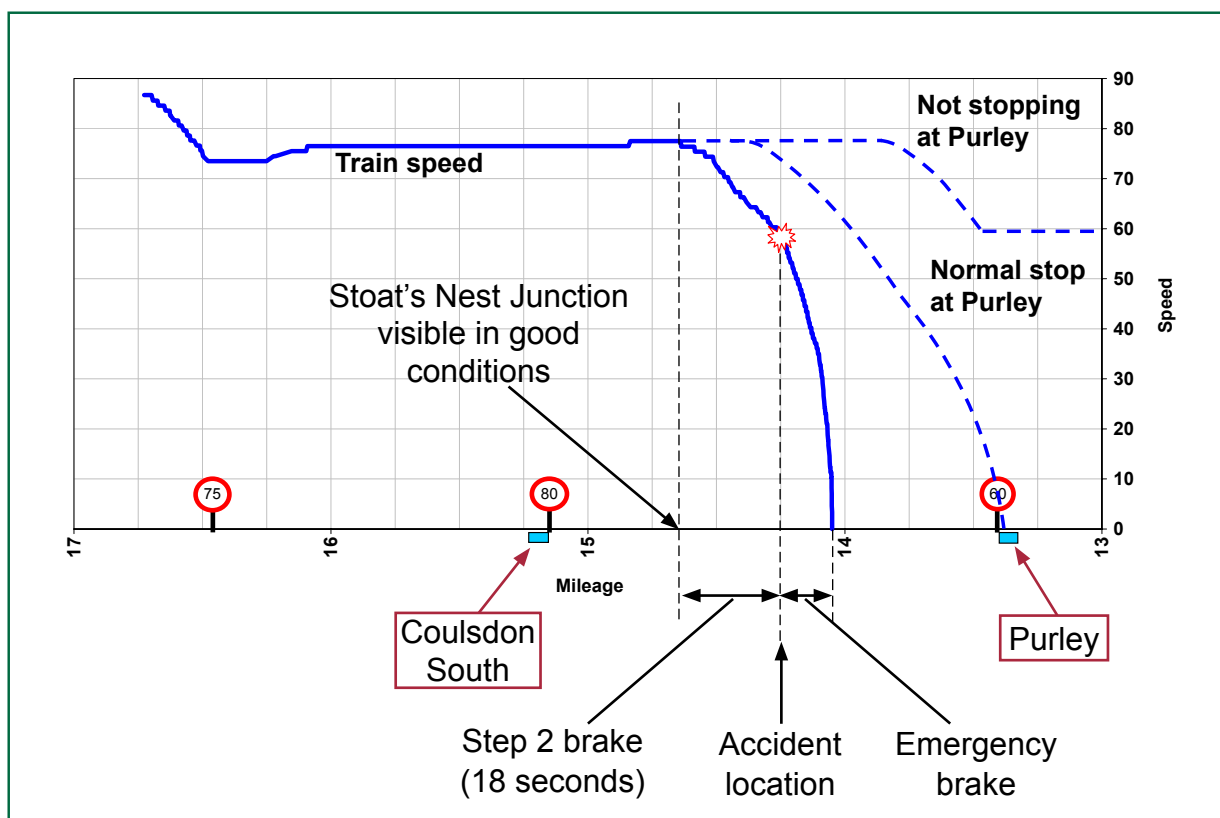


Figure 8: Train speed and line speeds

149 The driver believed that he only saw the track workers for a short time before the accident, and that the accident occurred approximately 500 metres before Stoats Nest Junction. As a result it is not possible to be certain of the driver's actions on the approach to Stoats Nest Junction, or of the timing of him sounding the horn.

150 A possible sequence of events that is consistent with the available evidence is given below:

- Approximately 550 metres (18 seconds) before the work site, the driver realised that he might have been scheduled to stop at Purley (paragraph 146).
- He applied the brake as a precaution, giving himself time to check his schedule card to see if a stop was necessary.
- Checking the schedule card could have distracted him from observing the track gang during the first part of the 18 seconds between applying the brakes and the accident.
- About 250 metres (9 seconds) before the accident site, the train passed the group of three track workers who were walking back to the site (paragraph 159), but the driver did not recall seeing them. It is thus probable that the driver looked back up from the schedule card after he had passed this group, and then saw the track gang at the crossing.
- Allowing approximately 2 seconds for the driver to recognise the track workers' presence, it is likely that he sounded the horn when the front of the train was less than 200 metres (7 seconds) from the track workers at the crossing. This also means that the horn is likely to have been sounded when the front of the train was more than 50 metres (2 seconds) past the group who were walking back to the work site.

- Because the track workers at the crossing did not hear the horn, it is also likely that the horn was sounded when the train was still at least 100 metres (3.5 seconds) away from them (paragraph 157).
- 151 Because the driver's perception was that the track gang were close to, but clear of, the line he gave a single burst of the horn between 7 and 3.5 seconds before the accident, to alert them to the presence of the train. The rule book also required the driver to sound short blasts on the horn if the track workers did not acknowledge his initial warning (paragraph 140), but the driver would have had to allow two or three seconds for the acknowledgement to be given. Allowing for this additional time, it is likely that the driver did not have time to implement the rule book requirement for sounding short blasts on the horn before the accident.
- 152 Another possible factor was that, when the train was approaching Stoats Nest Junction, the sun was out and was low in the sky. The train was moving at a heading of 35 degrees east of north, while the sun was at a bearing of 67 degrees east of north and only 5 degrees above the horizon. This means that the low sun was in the driver's forward vision, and could have affected the conspicuity of personnel on the track ahead. It has not been possible to determine if this affected the driver's ability to distinguish the track workers during the approach to Stoats Nest Junction.
- 153 The line approaching the accident site is straight. In ideal conditions the track gang could have been seen from an approaching train at a distance of approximately 600 metres. However, on the day of the accident, the prominence of a track gang on the line would have been greatly reduced because of the low, bright sun in the driver's forward vision.

Audibility of the horn

- 154 Witness evidence indicates that the track gang did not hear the train horn. This is reinforced by the fact that the gang did not acknowledge the approaching train by raising their arms, or move as the train approached, and were taken by surprise as it passed by.
- 155 As the train passed, four of the gang were working on the crossover closure rail, between the down fast and up slow lines (figure 4). Three of them were securing clamps to the rail joints that had not been welded. This involved use of a petrol driven nut runner. The fourth was drilling holes in the crossover closure rail to allow attachment of the check rail. This involved use of a petrol powered drill. As a result, all four were in close proximity to noisy power tools as the train approached.
- 156 The assistant section manager and the section manager were standing in, and adjacent to, the space between the down fast and up slow lines, several metres towards Purley from the crossing. This means that the power tools were between them and the approaching train, and the RRV, with its engine running, was adjacent on the up fast line.

- 157 RAIB measurements showed that sound pressure levels from the soft tone horns of a class 442 unit, at a position 100 metres ahead of a train, were between 66 dB(A) and 72 dB(A). The datasheet for the petrol powered nut runner used at site indicates that it produces a noise level of about 87 dB(A), at a distance of approximately 1 metre, when idling, increasing to over 100 dB(A) when working at high power. This shows that, for the people working at the crossover, it is very likely that the sound of the soft volume horn would have been drowned out by the noise from the power tools being used at the work site.
- 158 The COSS associated with operation of the RRVs was loading tools onto a trailer that was coupled to the RRV, adjacent to the accident site. The noise of the RRV would have added to that provided by the power tools being used on the crossover closure rail.
- 159 Three of the track gang members, including the COSS for the crossing work, were walking back to the work site from Coulsdon Town station, where they had parked (paragraph 117 and figure 2). They were approximately 250 metres from the work site when the train came past. None of these three gang members reported hearing the train horn, despite the fact that they were not in proximity to machinery. However, it is likely that the front of the train was more than 50 metres past them before the horn was sounded (paragraph 150).
- 160 RAIB measurements also showed that at a position 50 metres behind the train cab, the sound pressure level from the soft volume tones on a class 442 unit were less than 68 dB(A). RAIB measurements also show that the sound pressure levels of a passing train, measured at a position two track widths away (comparable to the position of the track workers walking back to site when the incident train passed) would have been between 85 dB(A) and 90 dB(A). This shows that, for the people walking back to the work site, it is very likely that the sound of the train passing would have drowned out the soft volume horn.

Fatigue

- 161 The driver had worked a total of 14 day shifts over the previous 15 days, finishing at 13:15 hrs on Friday 10 June, before working a night shift that commenced at 21:15 hrs on Saturday 11 June. His last rest day was four days prior to working this night shift. The HSE Fatigue and Risk Index Calculator⁹ shows that the driver's fatigue index was 31 at the time of the accident. This is below the night shift threshold for risk of sleepiness (good practice guidance suggests that this threshold is set at between 40 and 45)¹⁰.
- 162 The driver's equivalent risk index was 1.16 at the time of the accident. Industry good practice suggests that this threshold is set at 1.60.

⁹ The potential for fatigue arising from the above work pattern has been assessed using the Health and Safety Executive (HSE) Fatigue and Risk Index Calculator (version 2.2) available from www.hse.gov.uk. The output from the fatigue index is a measure of the probability of high levels of sleepiness, expressed as a value of between 0 and 100. The output from the Risk Index is in terms of the relative risk of an incident occurring, with the value of 1.0 representing an average risk of an incident for a Day/Day/Night/Night/Rest/Rest/Rest/Rest schedule on standard 12 hour shifts.

¹⁰ Health and Safety Laboratory report RSU/08/03, the Evaluation of the UK Rail Sector Initial Fatigue & Risk Index Thresholds (2008), proposes day and night shift thresholds for scores predicted by the Fatigue and Risk Index. The report found that night shift thresholds of 40 - 45 for fatigue and 1.6 for risk represented good practice at this time.

- 163 On the day of the accident (Sunday 12 June), the assistant section manager was working a night shift that had commenced at 23:00 hrs on Saturday 11 June, having previously worked a day shift on Friday 10 June. The shift pattern over previous days meant that his fatigue index was 39 at the time of the accident, whereas his risk index was 1.46. These were higher than for the driver, but were not abnormal for people working night shifts.
- 164 The increased fatigue risk associated with working the first night shift after a series of day shifts has been previously identified in RAIB investigations. The RAIB investigation into an uncontrolled freight train run-back in Cumbria in August 2010 examines this in greater detail (see RAIB report 15/2011), and identified that the fatigue and risk index model will tend to understate the risk associated with the first night shift.
- 165 It is not possible to say, from the above evidence, whether fatigue was a factor in the accident, but witness evidence did not suggest that any of the personnel involved were excessively fatigued.

Identification of underlying factors¹¹

166 The authority of the COSS was confused and undermined by the presence of more senior management on site. This adversely affected the implementation and maintenance of a safe system of work and is considered to be an underlying factor.

- 167 The rule book states that a COSS is responsible for ensuring that their group adopts a safe system of work. Those in this role are given the authority to stop work and withdraw everyone to a place of safety if the system of work is no longer in place or has become unsafe. The team leader has the responsibility to ensure that work is carried out to plan, while working within the constraints of the safe system of work enforced by the COSS.
- 168 In this accident, the COSS role was taken by a relatively junior member of staff, while that of team leader was taken by the assistant section manager (the line manager of the COSS), assisted by the section manager (paragraphs 82 and 83). This introduced potential conflicts between the authority of the COSS and that of the assistant section manager and the section manager.
- 169 As a consequence, the COSS did not feel it appropriate to question the need to leave the site (paragraph 115). Furthermore, he saw no risk in doing so, since the senior managers were apparently in charge. In addition, the engineering supervisor did not question the absence of the COSS from the site because he also understood that the senior managers were at the site and in control (paragraph 131). The engineering supervisor also did not question the non-involvement of the COSS when he was directed by the senior managers to start removal of the earth straps (paragraph 127).

¹¹ Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

- 170 It is important that both the COSS and the engineering supervisor are able to prioritise safety in fulfilling their roles. It is essential that a person who is appointed as COSS, or as an engineering supervisor, has personal attributes that allow them to assert the role's authority over other members of the gang, including over more senior staff.
- 171 The issue of safety leadership at site, and the relationship with more senior staff, has been a factor in a number of accidents in previous years.
- 172 On Wednesday 26 October 2005, a track worker was fatally injured at Trafford Park West Junction, near Manchester. The RAIB's report into this accident (Report 16/2006) concluded that the underlying cause was that the track safety skills accreditation system and operational safety rules did not consider people's attitudes towards safety or the inherent safety culture of the organisations for which they work.
- 173 On Sunday 29 April 2007, an 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. The accident occurred as the train was being routed from the down main line towards the down relief line via two high speed crossovers. The accident occurred because the welding team did not move to a position of safety. A significant factor was that the relationships and interactions within the team affected decision making with respect to safety. This was investigated by the RAIB and the related report, reference 04/2008, was published in February 2008.
- 174 An accident occurred at Washwood Heath on 6 March 2010, when a section of rail being moved at a site of work struck a passing train. This incident was the subject of RAIB report reference 01/2011 which was published in January 2011. There were no injuries. A factor in the accident was the behaviour of managers on site and the pressures they placed on the work team.
- 175 On 30 March 2010, a passenger service running from Stansted Airport to London Liverpool Street struck a member of railway staff at Cheshunt Junction in Hertfordshire. The person who was struck was carrying out maintenance work on the track. The track worker did not move to a position of safety when a train approached the junction. No satisfactory safe system of work had been established. A factor was the interaction between the COSS and the Team Leader in charge of the work. This was investigated by the RAIB and the related report, reference 06/2011, was published in March 2011.
- 176 Network Rail's national initiatives intended to address safety related behaviour of track maintenance staff had not yet reached the staff based at East Croydon depot. This is considered to be an underlying factor.**
- 177 If the existing staff behaviour elements of the national initiatives, relating to safety culture, had been progressed more rapidly, it is possible that the accident would have been avoided. The roles of Network Rail and the Office of Rail Regulation (ORR) are discussed in paragraphs 178 to 185.

The role of Network Rail

- 178 In February 2008, in response to the accident at Ruscombe (paragraph 173), RAIB recommended that Network Rail should carry out research into the impact of peer pressure, group communications and dynamics on safety decision making in work teams (paragraph 202). Network Rail considered that sufficient research already existed and so undertook a review of this research in the context of the Network Rail environment. Network Rail then progressed work on developing processes to assess the behaviours required of a COSS and a team leader (paragraph 197). This work became part of a wider national initiative dealing with safety culture.
- 179 In January 2011, in response to the accident at Washwood Heath (paragraph 174), RAIB recommended that Network Rail should extend the existing work on COSS and team leader behaviours to include training and assessment of existing staff (paragraph 202). This extension of existing work was needed to fully implement the recommendation from the Ruscombe accident.
- 180 Network Rail's work on team behaviours has been ongoing since the first recommendation was made in February 2008. Although some modifications had been made to the process for the selection and training of staff taking on new roles, the resulting training material, relevant to existing staff, had not yet been delivered at East Croydon, the home depot for the staff involved in the Stoats Nest Junction accident (nationwide roll out had only begun in May 2011). The processes for assessing the behaviour of existing staff and, where necessary, taking action to ensure appropriate behaviour, were still being developed when the accident occurred at Stoats Nest Junction. The range of training being developed and delivered to cover these areas is described in paragraph 199.
- 181 Witness evidence is that Network Rail prioritised work relating to selection of new COSSs over work relating to behaviours of existing staff. This was because resources were limited and because Network Rail specialists believed that this would have the greatest immediate effect on safety. The latter judgement was partly based on the belief that line managers within Network Rail would give greater immediate support to implementing changes for new COSSs. The progress of both these work streams was delayed by organisational changes being implemented within Network Rail during 2008/09.

The role of the ORR

- 182 The ORR has provided the RAIB with evidence of its activities related to track worker safety. This shows that between March 2008 and June 2011 the ORR had engaged with Network Rail to discuss the actions taken, or planned, to encourage safe behaviour. This engagement involved at least eight meetings with Network Rail to discuss areas of work that were designed to address behavioural issues. In addition, the ORR sent letters to Network Rail in March 2008, May 2010 and June 2010, each concerned with aspects of track worker safety.
- 183 The ORR reviewed Network Rail's proposed work streams and progress against the programme. In May 2010 the ORR sent a letter to Network Rail to express concern about the slow rate of progress and warned that the ORR would consider enforcement action if there was further slippage in the programme. In response, Network Rail provided further information about its activities in this area and confirmed that it considered its programme to be realistic. On this basis the ORR concluded that it was not appropriate to pursue enforcement action.

- 184 The RAIB recognises that effecting behavioural change across large organisations is complex, that the effectiveness of behavioural change initiatives should be evaluated, and that the ORR has been active in addressing the issue of track worker safety with Network Rail. However, the RAIB is concerned that it has taken the industry so long to address safety behavioural issues that were identified in a number of RAIB recommendations published since 2006 (paragraphs 197 to 199 and 202).
- 185 An apparent slow rate of progress of actions taken in response to RAIB recommendations has been identified in a number of current investigations (in particular, the investigation into the derailment of a freight train at Bordesley Junction on 26 August 2011). In its Annual Report for 2010, the RAIB raised a general concern about the number of accidents that are still occurring, despite the risk having been identified in an earlier RAIB recommendation. This will again feature in the forthcoming Annual Report for 2011. Consequently, the RAIB is currently in discussions with the ORR to understand the factors that may delay the implementation of safety improvements and the ways in which the RAIB, and the ORR in its role as safety regulator, may help to bring about a more rapid response by railway industry parties.

Observations¹²

Events after the accident

- 186 At approximately 07:00 hrs, and after the British Transport Police had attended, the Network Rail RIO gave the track gang permission to continue with the work to make the crossover closure rail safe. This was to ensure that the incomplete work did not result in disruption to services when trains restarted running.
- 187 The RIO then rescinded this permission on the advice of Network Rail control, so that the up slow line could be opened to traffic immediately, to prevent further disruption to traffic. However, he authorised the track gang to collect the tools and equipment from the site and transport them back to the vans using the trailer that was coupled to the RRV.
- 188 This meant that evidence from the accident site was removed or disturbed without the knowledge or permission of the RAIB. Regulation 8(6) of the Railways (Accident Investigation and Reporting) Regulations 2005 states:
- “An owner of railway property, a railway industry body, or a manufacturer or supplier of equipment, components or services to an owner of railway property or to a railway industry body, shall preserve all evidence over which he has control and which is, or which he reasonably considers may be, relevant to an investigation of an accident or incident of a type described in Schedules 1 or 4 by the Branch ... until the Branch has concluded its investigation, no longer requires the evidence or has determined that it will not conduct an investigation.”
- 189 The RAIB has processes in place to authorise the moving of evidence so that lines can be returned to service as soon as is practicable, without adversely affecting the accident investigation.

¹² An element discovered as part of the investigation that did not have a direct or indirect effect on the outcome of the accident but does deserve scrutiny.

190 The RAIB has written to Network Rail to remind it of its obligations under Regulation 8(6) of the Railways (Accident Investigation and Reporting) Regulations 2005.

On-train equipment

191 The train was fitted with forward facing closed circuit television cameras, so visual evidence about the events before the accident should have been readily available. On retrieval of the recordings, it was found that the CCTV had been faulty, so the footage could not be recovered. The CCTV system was installed when the units were first operated by Southern, in 2008. Southern acknowledged that there have been CCTV reliability problems across the class 442 fleet, and has implemented modifications, in conjunction with the system supplier, to address this.

Summary of conclusions

Immediate cause

192 The immediate cause of the accident was that the track workers were working too close to a line that was open to traffic (**paragraph 87**).

Causal factors

193 The causal factors were:

- a. No safe system of work was put in place to protect staff from train movements on the up slow line, after that line had been returned to traffic (**paragraph 90**).
- b. The COSS was not present at the site when the up slow line was returned to traffic, and no replacement had been appointed (**paragraph 109**).
- c. The engineering supervisor was aware that the COSS was not carrying out all his safety responsibilities and had left the site, but did not establish who was then responsible for the safe system of work (**paragraph 125**).

The RAIB is not making any new recommendations in relation to these factors, as the actions already taken and the recommendations made in previous investigations (**paragraphs 195 to 197**) cover these topics.

- d. The track workers did not hear any warning from the train as it approached (**paragraph 132, action taken paragraph 200**).

Underlying factors

194 The underlying factors were:

- a. The authority of the COSS was confused and undermined by the presence of more senior management on site. This adversely affected the implementation and maintenance of a safe system of work (**paragraph 166**).

The RAIB is not making any new recommendations in relation to this factor as the actions already taken and the recommendations made in previous investigations (**paragraphs 195 to 199**) cover this topic.

- b. Network Rail's national initiatives intended to address safety related behaviour of track maintenance staff had not yet reached the staff based at East Croydon depot. This is considered to be an underlying factor (**paragraph 176, Recommendation 1**).

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

- 195 After the accident, Network Rail, at Croydon and Brighton delivery units, carried out an audit of the planning and management of the safe systems of work for possessions over a single weekend. This audit focused on the planning of safe systems of work to be used by staff during work in possessions. It also examined the timeliness of the provision of this information to PICOPs, engineering supervisors and COSSs. The audit found no examples where safe systems of work had not been planned appropriately, and found only minor non-compliances with the completion of paperwork. The audit would not have identified circumstances (such as those leading to the accident at Stoats Nest Junction) where the safe system of work was compromised by staff at the worksite, unless this was reflected in the paperwork.
- 196 Network Rail issued a safety bulletin on 13 June 2011 to all maintenance areas, describing the Stoats Nest Junction accident. It also started to brief the initial circumstances of the accident to track staff in the Sussex route maintenance area on 14 June 2011. This briefing was also given to contractors on 26 June 2011. A further briefing reminder document was circulated to Sussex route maintenance staff on 1 August 2011, which included particular emphasis on the potential impact of managers on the roles of others within the work group. Training, delivered in October 2011 to section managers in Sussex route, also incorporated the lessons identified from Network Rail's initial review of the Stoats Nest Junction accident.
- 197 Partly in response to the RAIB recommendation made after the accident at Ruscombe¹³ (paragraph 202), Network Rail has been undertaking work aimed at identifying and, where necessary, improving safety related staff behaviour within COSS led work groups (paragraph 178). From April 2008 to December 2009, Network Rail identified the behavioural characteristics that were required for personnel to effectively act in the COSS role, and how these could be incorporated in the assessment and selection of new staff.
- 198 In January 2010, the separate work streams addressing COSS behaviours were brought together under the COSS Programme with a view to integrating them into Network Rail's processes. Revised selection criteria for new staff were implemented in December 2010. Work to extend this to cover assessment and development of existing COSSs was recognised to be much more complex, and is still being progressed at the time of this report.

¹³ The earlier RAIB recommendation resulting from the accident at Trafford Park had been rejected by Network Rail because it was considered to be very difficult to achieve a useful assessment of an individual's attitudes to safety, adherence to rules and inter-relational personal skills. Network Rail considered that it already had adequate processes for assessing staff performance.

- 199 The COSS programme recognised that control of safety at site was also affected by the behaviour of managers and Team Leaders, so additional work was carried out to develop and deliver training to them. Delivery of 'Managing Site Safety' training, which includes specific modules on behaviour and COSS/Team Leader responsibilities, started in May 2011, and Network Rail expect this to have reached all Team Leaders by December 2012. In addition, a number of safety culture improvement days have been delivered to both Network Rail staff and contractors. Separate 'Managing Safely' training for line managers, focusing on safety responsibilities, including a small module on behaviours, has been developed, and this is expected to be fully delivered during 2013.
- 200 Southern has taken steps to brief drivers on the use of the horn, as part of scheduled driver assessments. This includes an assessment of driver familiarity with the requirements of the rule book and the avoidance of the low volume setting when on the running line.
- 201 The section manager, the assistant section manager and the engineering supervisor are no longer employed by Network Rail.

Previous recommendation relevant to this investigation

202 The following recommendations were made by the RAIB as a result of previous investigations, which address factors identified in paragraphs 193 and 194. They are therefore not remade so as to avoid duplication. The responses of Network Rail and ORR to these recommendations are described in paragraphs 197 to 199.

Trafford Park (26 October 2005 - RAIB Report 16/2006)

Recommendation 8

Network Rail must ensure the selection, training and performance assessment regime achieves and maintains the prescribed standard of performance required of the COSS.

A review is required which should consider:

- at the selection stage, an assessment of the individuals's personal attitudes to safety, adherence to rules and inter-relational personal skills;
- an assessment prior to qualification, and if appropriate, post-qualification to more accurately reflect the performance required in the workplace;
- the development of a new robust monitoring process to ensure that an individual's on-the-job performance routinely achieves the prescribed level.

This work should also consider the circumstances where the normal working environment permits COSS to use some protection methods infrequently, and whether there is therefore a need to sub-categorise the skill, within COSS competency training and certification. The principles established may have application in the competency management process for other track safety skills; this should be looked into.

Ruscombe (29 April 2007 – RAIB report 04/2008)

Recommendation 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 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.

Washwood Heath (6 March 2010 – RAIB report 01/2011)

Recommendation 3

Network Rail should extend the work it is undertaking to improve the methods and criteria used when selecting staff to undertake safety leadership roles to include consideration of the training and assessment of those staff who are already qualified in those roles.

Learning point

203 The RAIB has identified a key learning point for the railway industry:

Learning Point 1

This accident forms an effective example for use in training material and briefings given to track workers and their managers, and for use in industry safety publications.

Recommendation

204 The following recommendation is made¹⁴:

- 1 *The intent of this recommendation is to achieve, as soon as reasonably practicable, full implementation of processes intended to ensure that managers do not undermine the safety related responsibilities of controllers of site safety.*

Network Rail should develop a time based programme which expedites the implementation of its existing activities designed to improve safety culture and qualities of safety leadership for:

- a. track maintenance staff; and
- b. their managers.

Activities covered by this programme should include steps to enhance the quality of safety leadership provided by the COSS, and to address the behaviour of managers when working on site such that this role of the COSS is not undermined.

¹⁴ Those identified in the recommendation, have a general and ongoing obligation to comply with health and safety legislation and need to take this recommendation 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, this recommendation is addressed to the Office of Rail Regulation to enable it to carry out its duties under regulation 12(2) to:

- (a) ensure that recommendations are duly considered and where appropriate acted upon; and
- (b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

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

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed Circuit Television
COSS	Controller Of Site Safety
DC	Direct Current
ES	Engineering Supervisor
IWA	Individual Working Alone
ORR	Office of Rail Regulation
PICOP	Person In Charge Of Possession
RIO	Rail Incident Officer
RRV	Road-Rail Vehicle
S&T	Signalling and Telecommunications
TSR	Temporary Speed Restriction

Appendix B - Glossary of terms

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

Bogie	A metal frame equipped with two or three wheelsets and able to rotate freely in plan, used in pairs under rail vehicles to improve ride quality and better distribute forces to the track.*
Chain	An imperial unit of length measurement that is equivalent to 22 yards.
Check rail	A rail provided alongside a running rail to give guidance to flanged wheels by restricting lateral movement of the wheels.*
Closure rail	A short length of running rail used to complete a track assembly, particularly between two switch and crossing units.*
Conductor rail permit	A paper form issued by the engineering supervisor to the COSS confirming that the electrical supply to a section of conductor rail has been isolated.
Controller of site safety (COSS)	A safety critical qualification demonstrating the holder's competence to arrange a safe system of work, ie protecting staff working on the line from approaching trains.*
Crossing	An assembly that permits the passage of wheel flanges across other rails where tracks intersect.*
Crossover	Two turnouts or single leads connected to permit movements between parallel tracks.*
Earth strap	A length of cable used to connect the conductor rail to earth (a running rail) during an electrical isolation.
Electric multiple unit	A train consisting of one or more vehicles (semi-permanently coupled together) with a driving cab at both ends and whose motive power is electricity supplied externally from overhead line equipment or conductor rails.*
Engineering possession	The closure of a specific section of line to railway traffic to allow engineering work to take place on the infrastructure in accordance with module T3 of the rule book.
Engineering supervisor (ES)	The person nominated to manage the safe execution of works within an engineering worksite. This includes arranging the marker boards, authorising movements of trains in and out of the work site and managing access to the site by Controllers of Site Safety (COSS).
Engineering supervisor's certificate	A paper form held by the engineering supervisor authorising the COSS to start work at a work site. The COSS signs this form to acknowledge receipt of the authority before starting work, and later to confirm that the authority, and any conductor rail permits, have been returned.

Forward facing CCTV	A camera system facing forward from the cab, recording the driver's view of the railway.
Four-foot	The area between the two running rails of the railway.
Hook switch	An electrical switch attached to a conductor rail that allows a sub-section to be electrically separated from another sub-section.*
Individual working alone (IWA)	A qualification which permits a person to work on or near the line within certain restrictions.*
Line blockage	Prevention of trains from moving on a portion of a railway line, by placing or maintaining signals at danger.
Line speed	The maximum speed at which trains may run when not subject to any other restriction.*
Notices	Documentation provided by Network Rail, or a train operating company, detailing engineering work, temporary speed restrictions or changes to schedules. An example of this is the Weekly Operating Notice.
On train data recorder	A data recorder collecting information about the performance of the train, including speed, brake control positions, etc.
Person in charge of possession (PICOP)	The competent person nominated to manage the safe establishment of the protection for a possession, access to the possession area by engineering supervisors (ES), establishment of work sites, liaising with the signaller, controlling the movement of trains to/from work sites, ensuring that protection is correctly removed, the possession is relinquished and the line handed back to the signaller at the due time.*
Pilotman	A member of railway staff whose duty is to ensure that trains are worked safely (one at a time) over a single line section during times of signal failure, emergencies or engineering work.
Position of safety	A place where it is safe to stand whilst a train is passing. This must be at least 1.25 metres from the nearest running rail, where the maximum train speed on that line is less than 100 mph.
Quadruple track	A section of railway where there are four parallel running tracks.
Road-rail vehicle	Any vehicle adapted to operate equally well on road and rail.*
Single line working	The temporary use of one track for traffic working in both directions.*
Site warden	A member of staff appointed to warn staff working near tracks that are open to traffic if they move outside their safe working area.

Tandem lifting	The simultaneous use of two machines (in this case road-rail vehicles) to lift a single large load.
Temporary magnet	A portable permanent magnet, placed between the rails, to trigger a warning sound in a train cab when it is approaching an emergency speed restriction or temporary speed restriction.
Third rail DC electrification	A general term used to cover the type of electrification that involves the supply of DC traction current to trains by means of a conductor rail laid along one side of the track, known as the third rail.*
TSR board	A sign on the trackside to advise drivers of a temporary speed restriction imposed for a short time, generally associated with engineering work, to guarantee safe passage of trains.
Work site	The area within a possession that is managed by an engineering supervisor. A work site is delimited by marker boards when engineering trains are present. It may contain many work groups, each controlled by a controller of site safety (COSS).*

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