RAIB
Rail Accident Investigation Branch

Rail Accident Report

Serious injury sustained by a signal technician at Kennington Junction 23 May 2008

Department for Transport

Report 29/2009
v2 December 2009

This investigation was carried out in accordance with:

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

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

Change control	Date of change	Page no.	Paragraph no(s).	Description of change
v2	01/12/09	Various	35, 81,139, 166, 176, 209d, footnotes 1 & 3, Recommendation 3	Minor textural changes throughout. Clarification of Recommendation 3

Serious injury sustained by a signal technician at Kennington Junction, 23 May 2008

Contents

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, liability or carry out prosecutions.

Key Definitions

3. All times given are for British Summer Time (BST).
4. Throughout the report the leader of the maintenance team is referred to as 'team leader'; whenever the team leader additionally assumed the responsibilities of the controller of site safety (COSS) that person is referred to as the 'team leader (COSS)'.
5. Throughout the report times and imperial distances are shown as follows:
   a. hh:mm for hours and minutes;
   b. hh:mm:ss for hours, minutes and seconds;
   c. distances are measured in miles and chains from the zero datum at Paddington station; and
   d. left-hand and right-hand refer to the position when looking ahead in the direction of travel.
6. Appendices at the rear of this report contain the following:
   - abbreviations in Appendix A; and
   - technical terms (shown in *italics* the first time they appear in the report) in Appendix B.

Summary of the Report

Key facts about the accident

7. At 21:47 hrs on 23 May 2008, a passenger train travelling from Paddington to Oxford struck and seriously injured a signalling technician who was working on a set of *points* at Kennington Junction, Oxfordshire. As a result of the injuries received, the technician later had one leg amputated. There was no damage to the train or railway infrastructure.

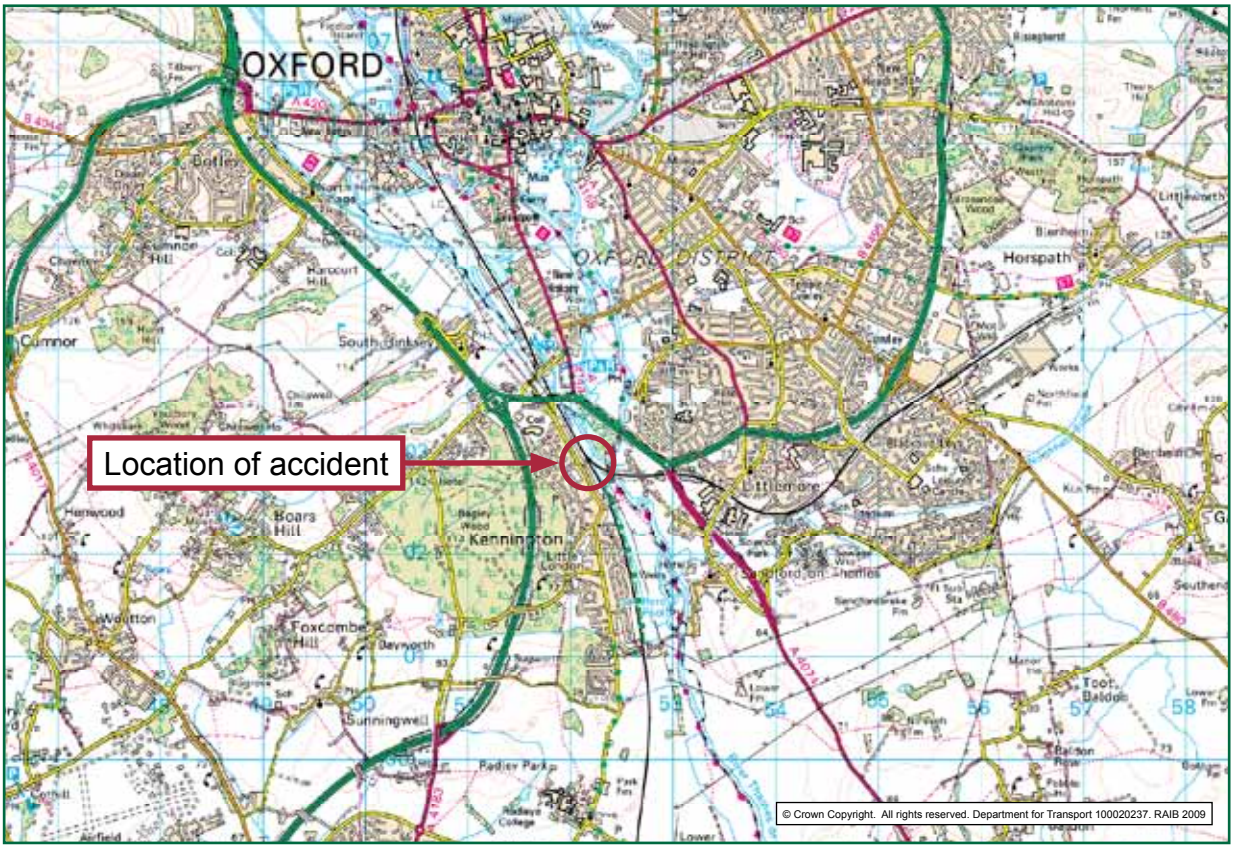

Figure 1: Extract from Ordnance Survey Map showing location of accident

Immediate cause, causal and contributory factors, underlying causes

8. The immediate cause of the accident was that the signalling technician failed to move to a *position of safety* when the lookout warned of an approaching *up* train. Shortly afterwards he was struck by an approaching *down* train.

9. Causal factors were:

   a. the need to adjust the rods of the *point machine*;

   b. the team leader (COSS) not maintaining a safe system of work by permitting work to continue when the light deteriorated;

   c. working in the dark; and

   d. the team leader not maintaining a safe system of work by handing back control of the points to the signaller when the team leader and his assistant were not in a position of safety.

10. Contributory factors were:
    a. the perceived need of the maintenance team not to delay trains;
    b. the assistant in the maintenance team not moving to a position of safety when a warning about an up train was given;
    c. the maintenance technicians' conditioning into a less urgent reaction to a lookout's warning as a result of the general practice of not moving to a position of safety when a moving train was sighted on an adjacent track;
    d. the team leader (COSS) not identifying that the team should go to a position of safety for any train moving towards them; and
    e . the lookout and assistant not challenging the COSS when working conditions changed due to darkness.
11. Underlying causes were:
    a. the lack of a timely and efficient method of protecting staff undertaking work that could endanger the safety of trains;
    b. the managerial acceptance of *Red Zone* working for *facing point lock tests*; and
    c. the lack of clear guidance in the Rule Book, COSS Handbook and other publications about safe working practices when trains could pass on adjacent lines.

Recommendations

12. Recommendations can be found in paragraph 225. They relate to the following areas:
    - investigating the adoption of alternative working methods when undertaking work such as facing point lock tests;
    - providing improved guidance on what method(s) of *protection* can be used for specific maintenance activities and when T2 and T12 protection may be used; and
    - providing improved guidance on the meaning of such terms as 'affect the safety of the line', 'affect the safety of train working'; and 'affect the normal passage of trains'.

The Accident

Summary of the accident

13. At 21:47 hrs on Friday 23 May 2008, a freight train (4O97) from Birch Coppice to Southampton Maritime approached Kennington Junction, on the up line between Oxford and Didcot. Two signalling technicians were working on the down line in poor light conditions and were warned of its approach by the lookout, but continued working. The passage of the train then prevented the lookout seeing a second train approach the technicians on the down line (Figures 2, 3 and 4).
14. A short while later the 20:51 hrs passenger train (1D73) from Paddington to Oxford, travelling at 89 mph (143 km/h), within the permitted speed limit, struck and seriously injured one of the technicians.

The parties involved

15. The track in the area of Kennington Junction, between Oxford and Didcot is owned, maintained and operated by Network Rail.
16. Network Rail employed three signal technicians, one of whom acted as a lookout, who formed the work group involved in the accident, as well as the supervisors, managers and planners referred to in this report.
17. The passenger train was operated by First Great Western, and the train driver, who was also a driving instructor, was an employee of that company.
18. The freight train was operated by Freightliner, and the driver was a Freightliner employee.
19. All members of the work group and the train drivers were in good health, had passed the appropriate railway health checks and held the necessary competencies for performing their duties.

Location

20. The railway between Oxford and Didcot runs in a nominal north – south direction. It is a busy, non-electrified, two track main line with *3-aspect signalling,* used by both passenger and regular freight services.
21. Kennington Junction (61 miles 14 chains) is located midway between Oxford and Radley stations. It provides the connection from the main line through Oxford to the freight only Cowley branch. Immediately north of the junction, and integrated with the junction pointwork, are two *goods refuge loops*, one on each side of the main line (Figures 3 and 4). They have connections to Hinksey Yard which is a complex of sidings used for engineers' trains.
22. The highest permitted speed on the Up and Down Oxford lines at Kennington Junction is 90 mph (144 km/h).

23. The highest permitted speed over the *crossover* between the up and down lines, and to and from the goods loops and the Cowley Branch is 25 mph (40 km/h). The crossover points on the Down Oxford line where the accident occurred have identification number 207A.

Figure 2: Aerial view of the accident site (image courtesy of Google Earth)

24. All signalling, and the authority to work on points, is provided from Oxford signal box.

25. The line north of Kennington Junction is straight and flat with no obstructions to affect the *sighting* of approaching trains. To the south of the junction the line curves gently, with an average radius of about 4 km, to the right. It is bounded by hedges and some trees which limit the sighting of approaching trains.

26. The land to the east of the junction is pasture running down to Hinksey Stream (a tributary of the River Thames) less than 100 m distant. To the west the line backs onto extended gardens of housing on a residential road. The junction area is quiet with little background noise.

External circumstances

27. The evening of 23 May 2008 was clear and warm. Sunset, which marked the beginning of twilight, was at 21:05 hrs, *civil twilight* ended at 21:47 hrs (the time of the accident). Cloud cover was present at the time of the accident and heavy rain was forecast for later that night.

28. Visibility between 20:30 hrs and throughout twilight was good. At the time of the accident, sighting by the track workers of the long range headlights fitted to every train was not limited by weather conditions.

The trains

29. The 3-coach class 165 passenger train (1D73) was formed of unit 165111 with vehicle 58926 leading. This class of suburban train was built between 1990 and 1992 by British Rail Engineering Ltd and has a maximum speed of 90 mph (144 km/h). It is fitted with an *on-train data recorder* which records a wide range of information, including the train speed, the position of the driver's traction and braking controls and the operation of the warning horn. It is also fitted with forward and rearward facing video recording equipment.

30. The freight train (4O97) was formed of a class 66 locomotive 66592 and 24 container wagons, most of which were loaded with containers. It travelled through Kennington Junction at about 40 mph (64 km/h) as recorded by the on-train data recorder.

The track

31. At the time of the accident the signalling technicians were undertaking a routine facing point lock test on 207A points at Kennington Junction (see Appendix F for information about points and facing point lock tests). The point machine on which the test was being performed is type HW2000 manufactured by Alstom (formerly GEC) and installed in 2006; they are highly reliable and are in common use throughout Network Rail. It is located on the down *cess* side of the track.

Events preceding the accident

32. A 3-man signalling maintenance team from Oxford comprising two technicians (a team leader and his assistant) and a lookout booked on duty at about 20:00 hrs. The team leader collected paperwork left for him and observed that a note had been written on the office white board confirming his plan to undertake facing point lock tests at Kennington Junction that evening. He then visited the signaller and advised him what he wanted to do at Kennington Junction; the signaller replied that there would probably be a suitable *margin*[1] between trains in which to do this work.

33. On his return to the offices used by the signal maintenance department, the team leader told his assistant and lookout that he wanted to get to Kennington Junction as soon as possible, and to do the facing point lock tests on three or more point ends while it was still daylight.

[1] The Rule Book RGS GE/RT8000 and Network Rail publications regularly refer to work that 'does not affect the normal passage of trains' (e.g. Rule Book Module T1A section 3.2), or activities that can be carried out 'between trains without detriment to safety and train working' (e.g. Network Rail company standard NR/SP/SIG/10064 General Instructions to staff working on S&T equipment, section NR/G1/001). A 'margin' is the colloquial term commonly used by maintenance staff and signallers to describe this period when work can be undertaken without causing train delays. No protection of track workers is provided by the procedures.

34. The team travelled to Kennington Junction in a Network Rail van with the team leader driving; he later acted as the COSS and was the person who was injured. En-route there was a brief discussion about completing the RT9909 'Record of site safety arrangements and briefing form' (colloquially known as the *RIMINI form*) which already contained some printed safety information (a copy of this form was printed whenever facing point lock tests were to be undertaken at Kennington Junction). This form provides the record of what safety arrangements were to be used and who would be involved. All members of the team had previously worked at Kennington Junction and the safety arrangements had been briefed many times before. The team leader (COSS) advised that there was nothing unusual on this occasion.

35. To protect themselves, the team planned to work under Red Zone procedures (paragraph 88) as had been detailed on the partially pre-planned RIMINI form. This used a lookout to warn of trains moving towards the site of work. The team leader (COSS) had not planned to use T2 or T12 protection. In order to protect trains, the signaller planned to set signals to danger so that the points could be operated manually by a technician using a winding handle inserted into the point machine (paragraph 140).

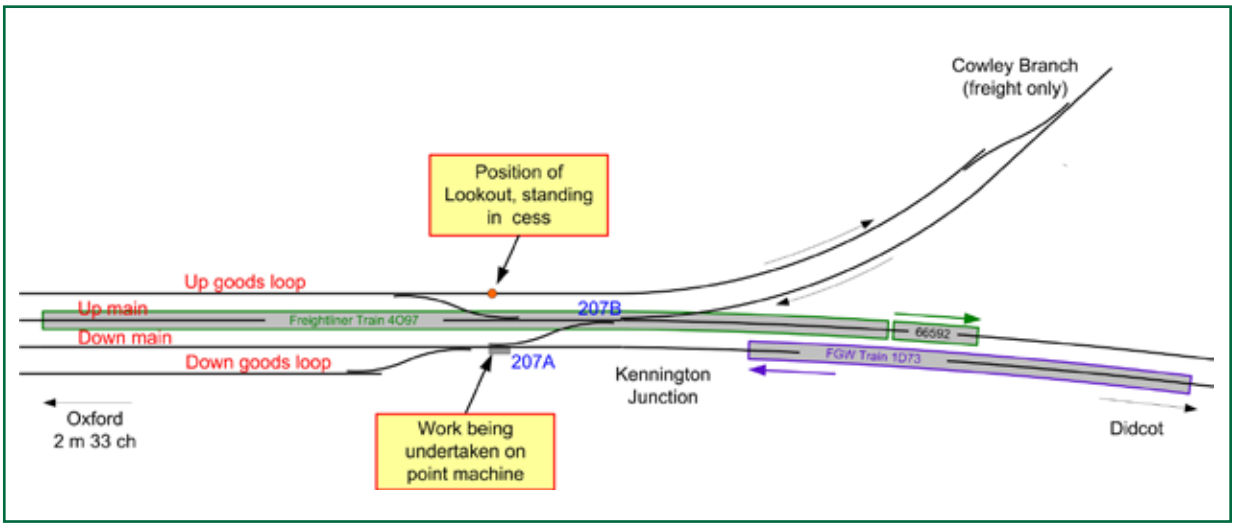

Figure 3: Track layout in the vicinity of Kennington Junction

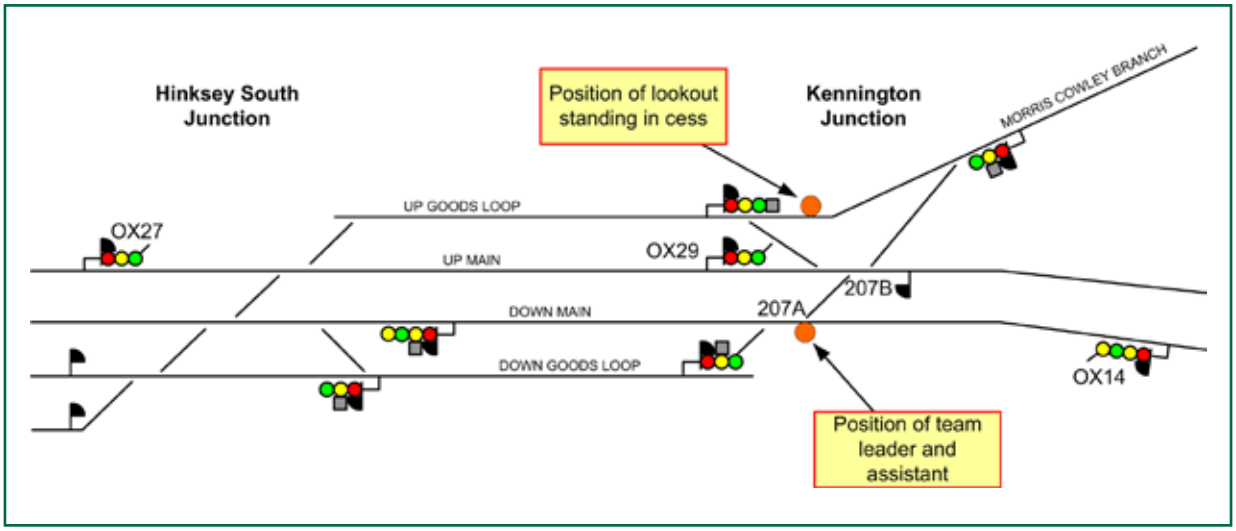

Figure 4: Track diagram showing signals used to protect the site of work

36. The team arrived at Kennington Junction at about 21:00 hrs when it was still daylight, and left their van close to the junction points. They planned to begin work by undertaking the facing point lock tests on the crossover between the up and down lines (207A and 207B points).

37. Whilst the team leader and his assistant were unloading tools from the van the lookout went to the other side of the line and took up his duties in the customary place for work on 207 points. He was not instructed by the team leader (COSS) where to stand or given any other instruction. He stood at various times in the cess or *4 foot* of the up goods loop from where the best possible sighting of approaching trains on the down line could be obtained. However, a passing up train would cut off the lookout's line of sight for the down line.

Figure 5: View from the lookouts position of the line towards Didcot (Photo courtesy of Network Rail)

38. At 21:16 hrs the team leader used his mobile phone to contact the signaller and requested permission to start work. When trains were clear of the site of work, the signaller responded by placing to danger signal OX14 on the down line and signals OX27 and OX29 on the up line (Figure 4) so as to prevent trains passing the site of work. He placed *reminder devices* (colloquially known as *collars*, see Figure 12 in Appendix F) on the controls for those signals and then advised the team leader (COSS) that work could commence.

39. Initially the team leader and assistant removed the covers of the point machine so that they could monitor its internal operation. The assistant then inserted a winding handle into the point machine so that the switch rails could be moved manually. The presence of the handle also cut out the remote operation of the points by the signaller and thus ensured that the team were protected from injury due to the *switch rails,* or the connecting rods and internal parts of the point machine moving under instruction from the signaller. The team leader then began to undertake the facing point lock test for the *normal,* or straight through, position of the points using his assistant to wind the handle and thus move the switch rails back and forth as required.

Figure 6:207A point machine. The down line is closest to the camera (Photo courtesy of Network Rail)

40. At 21:21 hrs, with only part of the test completed, the signaller requested that points be handed back so that a train could pass. The assistant wound the points back to their original position and the team leader then confirmed to the signaller that they had handed control back to the signaller. Both technicians then moved to a position of safety in the cess. The covers on the point machine were not replaced.

41. At 21:24 hrs the team leader requested a further period in which to continue the test which the signaller provided. Soon after, the test unexpectedly failed with the switch rails in the *reverse* position (in this position the points were set for a route between the up and down lines). The team leader and his assistant were then faced with the task of adjusting one or more of the rods linking the point machine to the rails (Appendix F). They commenced this activity immediately.

42. At 21:28 hrs the team leader requested extra time from the signaller in order to complete the adjustments. The signaller declined this request as a train was already approaching signal OX14 on the down line. After the points were wound back to the normal position and the handle removed, the team leader advised the signaller that the points were now under signaller control. The two technicians then moved to a position of safety in the cess. Concurrently the lookout reportedly observed a train almost coming to a stand at OX14 signal.

43. At 21:33 hrs the team leader requested further time to complete the adjustments. This was declined by the signaller as two trains were scheduled to pass. The team leader advised the signaller that the points had failed the facing point lock test in the reverse position, that they were having trouble completing the adjustment, and that they would need more time.

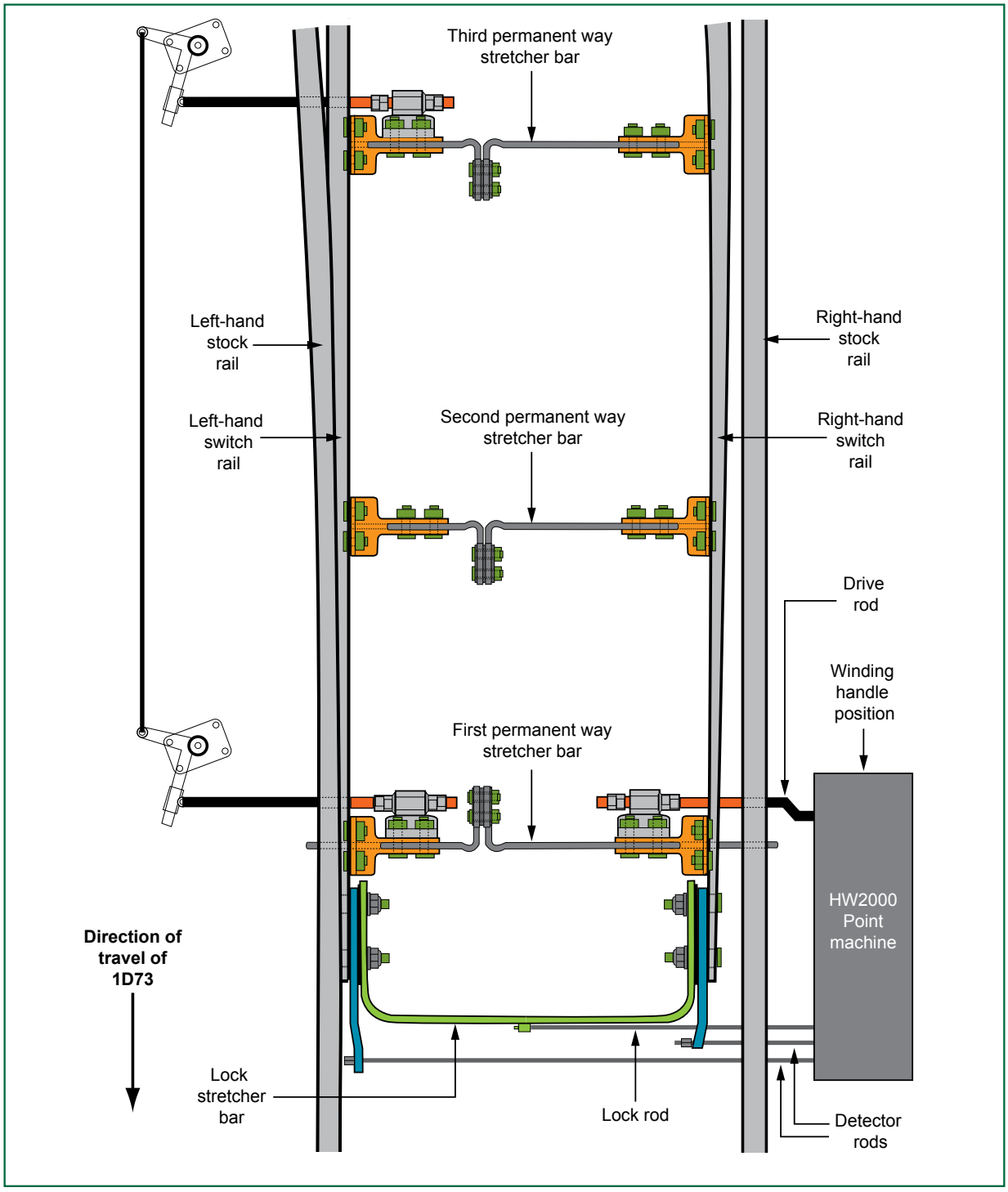

Figure 7: Schematic diagram showing the parts of 207A points and the associated point machine.

44. Even though the test had failed for the reverse direction, this would not affect the safety of trains running directly between Oxford and Didcot; they would pass over the points in the *trailing* direction whilst they were set normal.

45. Photographic and witness evidence shows that with dark clouds overhead, the light had begun to fade. Whilst waiting for the trains to pass, the team leader and assistant returned to the van to collect a torch and some additional tools. The lookout crossed the line, gave his torch to team leader and provided some guidance about how best to adjust the rods to correct the failure. The lookout then returned to his lookout position.

46. At 21:38 hrs the team leader requested another period in which to work on the failure; the signaller declined as one train was still scheduled to pass though the area.

47. Following the passage of that train the team leader contacted the signaller again at 21:41 hrs. The signaller replied that he could grant a short period of time, but only for a couple of minutes. The light had now deteriorated to a level that was insufficient for close working and the team began to use the torches.

48. Whilst the team continued work on 207A points, southbound freight train 4O97 approached Hinksey South (immediately before Kennington Junction) at slow speed under *cautionary aspects* from the signals. The driver reportedly concluded that the train might be routed into the up goods loop before reaching Kennington Junction.

49. The team continued to work using the light from the torches; one was placed on the ground while the other was held by the team leader. At 21:45 hrs the signaller telephoned the team leader as more than the allotted time had passed. The call rang for 14 seconds before being answered by the team leader. Whilst answering the call, the technicians successfully completed the test and handed back control of the points to the signaller; however, the point machine side covers had not been replaced.

50. When train 4O97 was about 366 m (400 yards) away from signal OX27 (61 miles 62 chains) the signaller removed the reminder devices from his controls and set the route through Kennington Junction. Signal OX27 cleared from red to green and the driver then began to accelerate his train for its journey to Didcot.

51. At 21:46 hrs, by which time darkness was descending, the lookout noticed the headlight of a train approaching from the Oxford direction. He shouted a warning about it and identified that it was on the up line. The team leader and his assistant, who were working on the down line, reportedly answered 'OK', but made preparations to replace the covers on the point machine. The lookout reported that he did not see them move away from the line.

52. The driver of train 4O97 noticed several track workers in the vicinity of Hinksey Yard or Kennington Junction and sounded the warning horn. The lookout turned towards the train and acknowledged the warning by raising his arm. However, the technicians continued with their work on the down line. The driver noted that they were in a safe position with regard to the passage of 4O97.

53. As train 4O97 began to pass, the lookout lost sight of both the technicians who were working in the vicinity of the points on the down line. At 21:47:30 hrs the lookout reportedly saw light reflected off the ends of containers on train 4O97 and concluded that a down train was also passing through the junction.

Events during the accident

54. During the passage of train 4O97 the team leader was in the process of putting covers back on the point machine. He was crouching down over the point machine close to the cess side rails with his back towards approaching down trains. The assistant was standing nearby and was reportedly searching the *ballast* near the cess for the padlock for the main cover. He was positioned so that any approaching down train reached him first.

55. Passenger train 1D73 was approaching Kennington Junction, from the south. Its on-train data recorder logged the speed of the passenger train at 85 mph (136 km/h) through Radley, the previous station, and then at 89 mph (143 km/h), near the speed limit of the line, on the approach to Kennington Junction. As the train rounded the left-hand curve as viewed in the direction of travel, travelling within the speed limit, the driver observed two people near to, or on the down line. The on-train data recorder shows that the horn was blown twice when the train was about 200 m from them. Reportedly neither the team leader nor his assistant heard this warning.

56. The assistant became aware of the second train on the down line as it passed him. He shouted a warning to the team leader, but there was insufficient time for the team leader to move out of danger.

Consequences of the accident

57. The team leader was struck by the train. As a result of the injuries he received, he later had a leg amputated.

58. The assistant and lookout were not injured.

59. No damage was sustained by the train or infrastructure.

Events following the accident

60. As 1D73 passed through Kennington Junction the driver applied the brake and brought the train to a stand 650 m from 207A points. He reportedly concluded that the train might have hit one of the people.

61. At 21:48 hrs the driver of 1D73 made an emergency call on the *cab secure radio* to the signaller at Oxford signal box. He advised that some staff had been working on the track when they came into view and that he thought he had hit one of them.

62. Almost simultaneously, the signaller received an emergency call from the signal post telephone on signal OX29; the assistant reported that a member of his maintenance gang had been hit by a train.

63. The signaller immediately placed signal OX57 to danger to prevent any other train from entering the Oxford signal box control area. At 21:49 hrs the signaller rang the *route controller* at Swindon to advise them about the accident; the route controller reminded the signaller to call the emergency services for an ambulance.

64. The ambulance arrived on site at 22:10 hrs after which paramedics attended the injured team leader; he was removed to hospital at 22:30.

65. At 23:12 hrs, 1D73 was authorised by the signaller to continue its journey to Oxford. The up line was reopened to traffic at 23:14 hrs; the down line was reopened six minutes later.

The Investigation

Investigation process and sources of evidence

66. The RAIB obtained evidence from the following:

- witness interviews;
- on-train data recorder;
- post-incident inspection records for train 1D73;
- signal box records and voice recordings;
- maintenance history for the infrastructure;
- medical records;
- staff training and competency records;
- planning paperwork for the maintenance activities; and
- Rule Book, Network Rail company standards and other instructions.

Key Information

Train service

67. The line between Oxford and Didcot is a main artery for freight services between the midlands and north of England and the south. Many of these trains run at night when there are fewer passenger services. During the day the majority of trains are local and cross-country passenger services, although some freight trains do run.

68. At certain times of the day the train service runs near to the capacity of the line.

Train headlights

69. All trains display a high intensity headlight that is visible in clear daylight and in hours of darkness for at least 25 seconds[2] when the train is approaching at its maximum permitted speed. For the class 165 units this equates to a distance of 1 km and for class 66 locomotives 840 m. The headlights had no bearing on the accident.

Unit 165111

70. Following the accident, unit 165111 was examined by the First Great Western Link engineering team who found no problems with the braking systems, marker and headlights, horn or visibility through the windscreen and no safety systems had been isolated. No adjustments or corrective actions were deemed necessary before the unit was released for further service.

71. The on-train data recorder shows the time and location that the horn was sounded twice (paragraph 55 and Figure 8), also the braking commands and the profile of train speed.

72. Still frames from the forward and rearward facing CCTV recordings were provided by First Great Western (Figures 9, 10 and 11). Whilst of a low resolution they show the position of the signal maintenance team's van, the passing freight train and the two technicians immediately before and after the accident.

207A Points

Working environment

73. Routine inspection and maintenance is undertaken on points to ensure that they remain in an acceptable condition; details are given in Appendix F.

[2] Railway Group Standard GM/RT2483 Visibility Requirements for trains, clause B4.1.2. 'An approaching train running at its maximum design speed needs to be visible on straight and level track for at least 25 seconds in order to allow people (for example track workers) on or near the line time to move to a position of safety.'

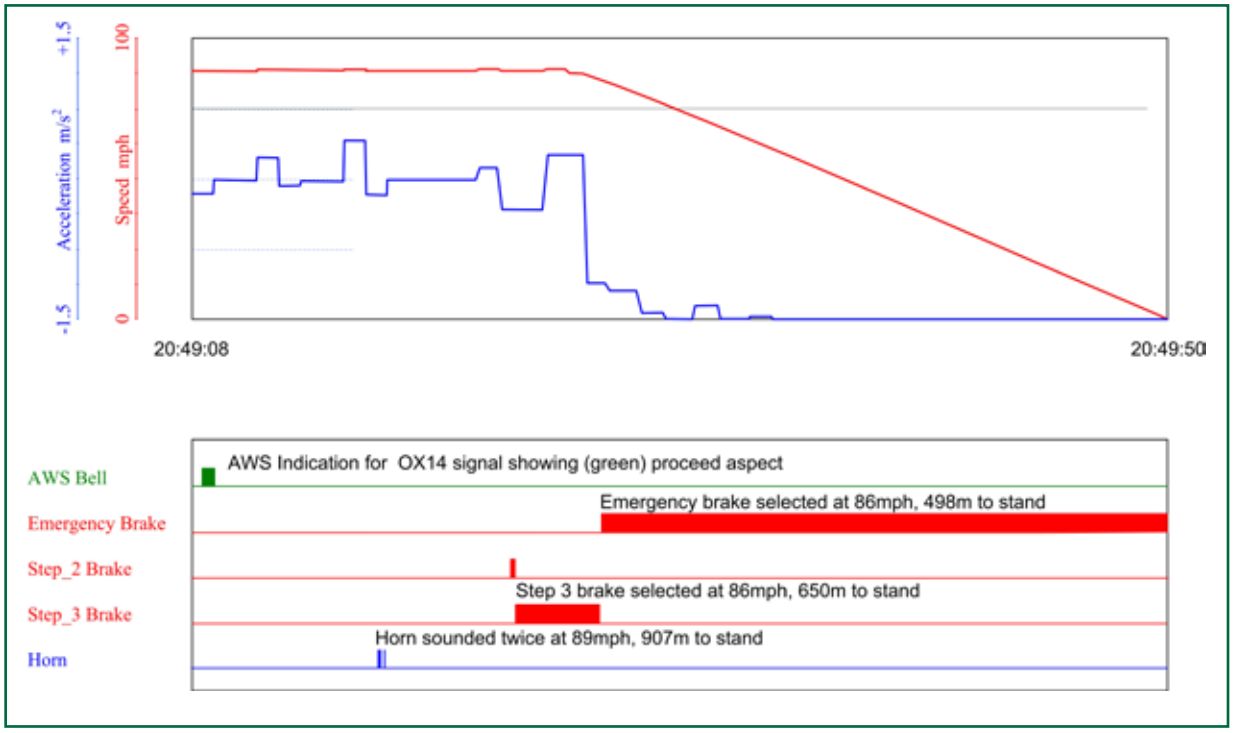

Figure 8: Diagram showing the key elements recorded by the OTDR

Figure 9: Still frame of the forward facing camera - Distant view. The picture is taken facing Oxford with the down line visible (from centre bottom). The orange Hi-Vis jackets of the technicians can be discerned just to the left of the points and the outline of the freight train on the up line can be seen (lower right quadrant). (image courtesy of First Great Western)

Figure 10: Still frame of the forward facing camera - Immediately before the accident. The two technicians can be seen working with a torch (left-centre bottom). (image courtesy of First Great Western)

Figure 11: Still frame of the rearward facing camera - Immediately after train had passed 207A points. The down line from London can be seen in the centre of the picture; the freight train is still present on the up line to the left of the picture. The Hi-Vis vest of the assistant (lower right), the illuminated torch (centre bottom) and the outline of the technicians' van (centre) can be seen. (image courtesy of First Great Western)

Previous move over 207 points

74. Prior to the accident, train 6C43, the 21:04 hrs Hinksey Yard to Westbury was the last one to pass over the crossover formed by 207 points at 21:12 hrs, just prior to the accident; this train was routed from the down goods loop to the up line. The signalling system would have confirmed that 207A points were set for the correct route, but would not have been able to detect that the locking of the switch rails met all the dimensional tolerances checked by the regular facing point lock tests (Appendix F).

Planning of maintenance and inspection

75. Network Rail mandates that point maintenance and inspection work should occur within defined intervals. It is left to local supervisors and the team leaders to manage the work so that it is completed on time and in compliance with the appropriate rules and procedures. Witness evidence and maintenance records show that a regular sequence of work is not often achieved in the Oxford area, because the signalling technicians also undertake fault rectification, which can disrupt planned work so that planned possessions and protection are lost (see also paragraph 141 onwards).

76. Network Rail compiles statistics about work that becomes overdue. The data for the Oxford area signal maintenance teams were not significantly different to those for other areas. Typically 14% of the planned work could be overdue by up to six days at any time.

77. The Kennington area is a difficult one for planned maintenance because of the intensity of the train service. The timetable has not been planned to permit specific periods when maintenance may be carried out and as a result much maintenance and inspection is carried out when it is practical between passing trains. The Rule Book and associated documents detail how Network Rail staff can undertake this work safely (paragraph 88 onwards).

78. For the day of the accident, the acting supervisor had left a note on the whiteboard in the Network Rail offices in Oxford that advised that the facing point lock tests at Kennington were due.

79. The preparation of the RIMINI form was undertaken by the works scheduler at Didcot who responds to requests from the Signal Maintenance Assistant or team leaders at Oxford. The Network Rail computer based Safe System of Work Planning System (SSoWPS) then generates the necessary paperwork which is passed back to the Signal Maintenance Assistant for checking. The process relies upon the Signal Maintenance Assistant or team leaders supplying all the relevant local knowledge about the intended activity, and upon the works scheduler challenging any obvious omissions or errors. The SSoWPS does not have any inbuilt processes that check or challenge Red Zone activities.

Staff competence

The team leader

80. The team leader (COSS) had worked on the railway for about 25 years. In 1998 he commenced working for Amey plc at Didcot, undertaking signalling maintenance; he moved to Oxford as a signalling technician a short time later. In 2000 he became a team leader within the signal maintenance department. He later became an employee of Network Rail when it decided to undertake its own maintenance activities, rather than to employ contractors.

81. The team leader (COSS) was certified by Network Rail to undertake COSS and lookout duties until August 2009. He had successfully completed a number of technical courses on signalling, including facing point lock tests on HW2000 point machines; his last assessment was in June 2007 and was valid for two years. He had previously undertaken facing point lock tests on 207 points on 11 May 2008, and prior to that in excess of ten times.

82. In the week prior to the accident the team leader had a rest day on Sunday 18 May and was on leave on Monday 19 May. He then worked day shifts between 06:00 hrs to 14:00 hrs on Tuesday 20 May and Wednesday 21 May. On the day immediately prior to the accident he had been rostered for a rest day but worked between 07:00 hrs and 15:00 hrs. His journey to and from work normally took about 50 minutes.

83. The team leader has no significant recall of events immediately prior to the accident, although during his recovery he has been able to remember some events relating to previous days.

The assistant

84. The assistant had worked on the railway for just in excess of five years. He was relatively inexperienced in signal maintenance, having transferred to the Oxford area from other duties with Network Rail about three months before the accident. He was qualified by Network Rail to act as a COSS and lookout; his last assessment was in July 2007 and was valid for two years.

85. On the day prior to the accident he had requested to work a rest day; during that day he and the team leader undertook some routine maintenance that did not require a lookout.

The lookout

86. The lookout first started work with British Rail in 1968 and had remained as a railway company employee since then. He was an experienced track worker and had previously undertaken signal maintenance and faulting duties at Oxford. Although he retained his signalling competencies, for personal reasons in recent years he had opted to restrict his duties to that of a lookout. His last medical assessment by Network Rail was in May 2007 and was valid for four years. His track safety assessments were last undertaken in 2007 and were due for renewal in September 2009. He had worked at Kennington more than twenty times, both undertaking facing point lock tests whilst a technician, and later as a lookout.

87. On the day before the accident, the lookout was on rest day and did not work.

Rules for working on the railway

Safe systems of work

88. The Rule Book for the Network Rail system Railway Group Standard GE/RT8000 Module T7 describes two systems of work when undertaking activities *on or near the line*. These are defined as follows:

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

89. Network Rail has a policy that work activities on or about the line should take place in a Green Zone whenever reasonably practicable. However, to create a Green Zone it is necessary to arrange for there to be no train movements through the site of work. To ensure that trains cannot approach, the site of work must be located within a *possession* or given other protection that will ensure workers are not placed at risk from the movement of trains.

90. A possession is a total blockage of a line for the normal passage of trains in accordance with arrangements described in module T3 of the Rule Book (Appendix G). Witness evidence indicates that possession working is not regularly adopted for facing point lock tests within the Oxford maintenance area. Reasons given for this were the detailed forward planning that was necessary, the additional administrative complexity involved in booking possessions, and the likelihood that a significant proportion would not be used due to maintenance teams being redirected towards fault rectification work.

91. Module T7, section 3.1 of the Rule Book, includes a list to assist in the selection of the safe system of work; three Green Zone and five Red Zone methods are included (Appendix G).

Planned safety arrangements at Kennington Junction

92. The safety arrangements were partially pre-planned on a copy of the RIMINI form (paragraph 34). A small amount of information had been completed by the works scheduler before it was made available to the COSS. The information included was of a generic nature and specified the location, point numbers and line speed; the planned safe system of work for access, egress and whilst carrying out the work, was listed as 'Red Zone with lookout(s) only or by IWA' (Individual Working Alone). The number of lookouts was not stipulated. No restrictions were listed about light, time of day or curvature of the line and no other hazards were identified.

Sighting distance

93. The *sighting distance* from the 4 foot of the up goods loop or the cess adjacent to it was 870 m for trains on the up line and 740 m for trains on the down line. These distances relate to the position when the full front of the train can be viewed. The distance when a partial cab or the high intensity headlight could be viewed would be greater. In order to provide a 20 second *warning time* the required sighting distance for trains travelling at line speed (90 mph or 144 km/h) at Kennington Junction is 850 m.[3]

[3] From Rule Boook Module T7, section 12 and guidance contained in RS/502 COSS Handbook

Risk profile

94. Appendix D shows data on accidents relating to track workers. Fifteen track workers have been killed in accidents over the last five years, twelve through being struck by a train.

95. Track workers are subject to levels of risk well in excess of the average for all workers in the railway industry. Data in the Rail Safety & Standards Board's (RSSB) Annual Safety Performance Report for 2008 shows that the fatality rate for track workers (3.05 per year) is three times that of a train driver.

96. The trend in staff fatalities has shown a steady improvement since the nationalisation of the railways in 1948, the average staff deaths in the ten–year period to 1958 was one hundred and sixty three per year, the equivalent figure for the ten–years to 1988 was twenty six. In the last five years the number of track worker major injuries has reduced from fourteen in 2004 to eight in 2008. However, the number of track worker major injuries caused by being hit by trains has increased, one each being recorded in 2005 and 2006, two in 2007 and four in 2008.

Previous occurrences of a similar character

Trafford Park, 26 October 2005, RAIB report 16/2006 published 25 August 2006[4]

97. At 09:28 hrs the driver of the 09:26 hrs Manchester to Liverpool passenger service sounded the train horn to warn three workers standing in the 4 foot of the down line at Trafford Park West Junction. Without giving acknowledgement of the warning, one person moved to the down cess, whilst the other two moved to the space between the up line and the platform loop. Shortly afterwards a second train travelling at 82 mph (135 km/h) approached on the up line and struck and fatally injured one of the track workers.

98. The accident occurred because a safe system of work had not been set up; no lookout protection or other warning methods were in place.

99. Recommendation 8 includes the following: 'Network Rail must ensure the selection, training and performance assessment regime achieves and maintains the prescribed standard of performance required of the COSS'. It also recommends that a review is required which should consider the development of a new monitoring process to ensure that an individual's on-the-job performance routinely achieves the prescribed level.

100. Recommendation 9 states: 'Network Rail should consider further work and the expansion of the current programme of research into understanding the causes of rule violation, in direct contravention to the training people have received to include track safety skills'.

[4] All RAIB investigation reports are available at: www.raib.gov.uk

101. To address recommendation 8 Network Rail has implemented a project addressing the 'Role of the COSS' (see paragraph 217). The Office of Rail Regulation (ORR) reports that this includes measures to address the issues described in this report. Network Rail has also advised that it has sufficient information to understand the issues of rule violation and that they will not be conducting further research to address recommendation 9; two current programmes of work will address recommendation 9. The ORR has accepted Network Rail's response in respect of these two recommendations and is monitoring Network Rail's work to improve the consistency of COSS behaviour under its other powers.

Tinsley Green, 17 March 2007, RAIB report 43/2007 published 18 December 2007

102. At 09:33 hrs the driver of the 08:55 hrs Brighton to Watford passenger service, reported to the signaller that a number of track workers had dived clear of his train with only seconds to spare. The incident occurred as the train was being routed from the up fast line towards the up platform loop via a series of high speed crossovers.

103. The accident occurred because the COSS did not take into account the possibility of trains being routed from the up fast line to the up platform loop on which the team were working. The team had not moved to a position of safety when an apparently 'non-threatening train' approached.

104. Recommendation 2 states: Network Rail should update the COSS Handbook[5] and associated training material with the objective of ensuring that staff that are qualified to act as COSS are fully aware of the hazards associated with working in a Red Zone at locations beyond facing points and can set up appropriate safe systems of work (paragraphs 191 and 192). Included in the revised documentation should be a clear definition of the term 'approaching train'. The issue of an approaching train is discussed further in paragraph 184.

105. To address recommendation 2, Network Rail has updated the COSS requirements and COSS examination, and has proposed changes to the COSS Handbook to the RSSB. Network Rail considers that it has done sufficient to close the recommendation; the ORR is considering this at the current time.

Ruscombe, 29 April 2007, RAIB report 04/2008 published 28 February 2008

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

107. The accident occurred because the welder did not move to a position of safety, but continued to undertake a weld repair to the points even though it is likely that he had been warned both by 'touch' and verbally of the approaching train.

108. Recommendation 1 states: Network Rail should update the COSS Handbook and associated training material with the objective of ensuring that staff that are qualified to act as COSS are fully aware of the hazards associated with working in a Red Zone at locations beyond facing points and can set up appropriate safe systems of work. Included in the revised documentation should be a clear definition of the term 'approaching train'. The issue of an approaching train is discussed further in paragraph 184.

[5] The COSS Handbook is published by RSSB

109. To address recommendation 1, Network Rail has updated the COSS requirements and COSS examination, and has proposed changes to the COSS Handbook to the RSSB. Network Rail considers that it has done sufficient to close the recommendation; the ORR is considering this at the current time.

Leatherhead, 28 August 2007, RAIB report 19/2008 published 23 October 2008

110. At 09:54 hrs a train from London arrived for its planned stop in the down platform at Leatherhead station. As it slowed, the driver sounded the horn for a group of track workers on the junction just south of the station. They acknowledged the warning and continued their work. As the train departed the lookout sounded a warning. One of the track workers, who had acknowledged the lookout's warning, continued working and was seriously injured when the train struck him. A short time later a train in the opposite direction passed through the junction.

111. The accident occurred because the group of track workers did not stop work and did not move to a position of safety when the down train approached.

112. Recommendation 2 states: Network Rail should review the inspection arrangements for *switches and crossings* (S&C) throughout its network, especially at junctions where sighting is restricted by curvature or train speeds are high, so that the staff carrying out the inspection are adequately protected, considering for example:

- S&C inspection in non-traffic hours, or other Green Zone arrangements;
- provision of suitable lighting to enable inspection in Green Zone in darkness; and
- train operated warning systems.

113. Recommendation 3 states: Network Rail should review the arrangements for protection of patrolling staff and others whose work involves moving along the line, throughout its network so that adequate warning time to move to a position of safety is always available.

114. Recommendation 4 states: Network Rail should review its arrangements for the assessment and monitoring of staff who have to set up safe systems of work, so that there is regular confirmation that they are making appropriate arrangements, particularly for work which moves along the line.

115. Recommendation 6 includes the following: Network Rail should revise the standards and procedures for the inspection of S&C … so that:

- S&C inspection takes place in Green Zone conditions.

116. Network Rail has reported that its actions are complete for recommendations 2 and 3. The implementation of recommendations 4 and 6 remains open.

Grosvenor Bridge, 13 November 2007, RAIB report 19/2009 published 18 July 2009

117. At 14:00 hrs on 13 November 2007, train 2A32, the 13:00 hrs Maidstone East to London Victoria, struck a track worker undertaking track inspection on the Up Chatham Fast line on Grosvenor Bridge south of London Victoria station.

118. The accident occurred because the COSS moved away from the line under lookout protection and toward an adjacent line on which a train was approaching.

119. Recommendation 1 states: Network Rail should propose a change to the Rule Book, in accordance with the Group Standards code, so that all members of a work group have the responsibility to ensure that they receive a full briefing prior to signing the COSS form.

120. Recommendation 2 states: In order to reduce the risk to track workers, Network Rail should review their programme for provision of automatic warning systems for Red Zone track inspections and if practicable should implement a programme to accelerate the introduction of appropriate systems for multi-track areas.

121. Recommendation 4 states: In order to verify their effectiveness, Network Rail should monitor recently introduced processes that will show whether an individual's on-the job performance routinely achieves the prescribed level with regard to safety. If necessary these processes should be enhanced.

122. Recommendation 5 states: In order to reduce the risk to track inspection staff, Network Rail should propose a change to the Rule Book and the COSS Handbook, in accordance with the Group Standards code, that amends the procedures for Red Zone working with lookout protection in a multi-track area to:

- clearly define an approaching train; and
- clarify the criteria for setting up a safe system of work, including the circumstances that require pre-planning. Consideration should include:
  a) the practical capabilities of lookouts;
  b) the possibilities for human error and its consequences;
  c) the ability to identify the track a particular train is using;
  d) the likelihood of multiple train movements;
  e) the complexity of track layout;
  f) the nature of the work being undertaken; and
  g) the size and disposition of the work group for continued observation by the lookout.

123. Recommendation 6 states: In advance of any change to the Rule Book and COSS Handbook under Recommendation 5 and to provide clear and unambiguous safety instructions and/or guidance, Network Rail should either eliminate the current practices used in relation to staff not moving to a position of safety but remaining in a location where they do not believe they are in danger from a train moving towards their site of work, or should introduce formally risk assessed alternatives for setting up a safe system of work in a multi-track area. The risk assessment should consider the topics listed in Recommendation 5.

124. No feedback has yet been received about these recently published recommendations.

Acton West, 24 June 2008 RAIB report 15/2009 published 18 June 2009

125. Three track workers were waiting for permission to push two rail-mounted grinding machines from the up relief line east of the crossovers at Acton West Junction towards Ealing Broadway station. A passenger train ran from the up main line through the crossovers and struck the machines. Nobody was injured in the accident, but the train suffered damage to the braking system and a punctured fuel tank.

126. The accident occurred because the grinding machines were placed on the up relief line at Acton west on a section of line that was open to traffic.

127. Recommendation 1 states: The intention of this recommendation is to reinforce existing arrangements within Network Rail for COSS packs to be prepared and implemented by staff with adequate geographical knowledge of the locality. Network Rail should:

    a. re-brief the requirements (now in standard NR/L2/OHS/019) for the COSS pack to be prepared and checked by individuals who have geographical knowledge of the relevant area and for COSSs to have geographical knowledge of the area in which they are to work;

    b. take steps to achieve compliance with the requirements defined in 1a; and

    c. conduct a compliance audit after a suitable period of time to confirm that these requirements defined in 1a are being implemented satisfactorily.

128. Recommendation 2 states: The intention of this recommendation is to:

    - promote the involvement of the 'end-user' in designing the paperwork that they use on site;
    - secure the COSS's involvement in the planning of the safe system of work that they will implement on site; and
    - achieve a consistent and user-friendly appearance for the COSS pack (including the RT9909 form).

    Network Rail should, in its current project to overhaul the RIMINI planning process:

    a. involve those who will use the information on site in developing a revised format for the COSS pack (and the RT9909 form);

    b. include a role for the COSS in the planning of their safe system of work; and

    c. improve the format of the COSS pack (and the RT9909 form), with particular emphasis on the clarity and consistency of information presented, including, but not limited to:

        - consistency in the method for identifying key locations such as the site of work, limits of possession and access points;
        - clarity over the information that is required in each section of the new forms;
        - the option of identifying in the COSS pack where access to site can be achieved by walking lineside as opposed to on or near the line; and
        - the use of diagrams and maps to show key locations and their relationship with each other.

129. No feedback has yet been received about these recently published recommendations.

Analysis

Identification of the immediate cause[6]

130. The immediate cause of the accident was the team leader not moving to, and remaining in a position of safety when he was warned that a train was approaching on the up line.

Identification of causal[7] and contributory[8] factors

The maintenance team

131. All the staff on site were qualified for the work they were undertaking and their certification was in order. There is no evidence to indicate that their familiarity with the site led them to adopt working methods that were any different on this occasion, except with regard to working in the dark.

132. There is no evidence that fatigue, medication or concerns about matters in their personal life played any part in the accident.

The train

133. The data recorder fitted to the unit 165111 showed that it was travelling within the speed limit and that the horn and brakes were used appropriately (paragraphs 55 and 60).

134. The train's average deceleration rate of 1.21 ms^{-2} (12.3% g) was in excess of the specified minimum performance for train braking[9].

135. The tests performed by Great Western Engineering Link showed that there were no defects with the train.

136. The forward and rearward facing CCTV recordings were of significant benefit during the investigation. Whilst of a low resolution they show the position of the two technicians, the van and the passing freight train immediately before and after the accident (Figures 9, 10 and 11). They also confirm that the technicians were using torches.

137. The driving, performance and condition of the train were neither causal nor contributory to the accident.

The points

138. The design, operation and performance of the points were neither causal nor contributory to the accident.

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

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

[8] Any condition, event or behaviour that affected or sustained the occurrence, or exacerbated the outcome. Eliminating one or more of these factors would not have prevented the occurrence but their presence made it more likely, or changed the outcome.

[9] Railway Group Standard GM/RT2044 Braking System Requirements and Performance for multiple Units, Figure 3, Curve A3, enhanced 30% for emergencies (section 5.4.1).

139. The condition of the points had deteriorated from the previous inspection on 11 May 2008 and it was this which caused them to fail the facing point lock test in the reverse position. Whilst this was not expected, deterioration of point condition due to changes in the track bed, rails, rail fixings, and sleepers is not an unusual event; the facing point lock test is regularly undertaken to manage the effects of these changes. Deterioration of the condition in the stretcher bars, drive detection and lock rods and the point machine itself is less likely. The reason for the deterioration was not explored as part of the investigation. The need to adjust the rods of the point machine, although not considered as exceptional, was a causal factor in the accident.

Site safety

Maintaining signals at danger

140. The team leader had previously advised the signaller that they were intending to undertake facing point lock tests. These tests can cause signals to change from a green to a red or yellow aspect in front of an approaching train. As a minimum this is exceedingly undesirable for the train driver who may need to respond by applying the emergency brake; more significantly it could pose a safety risk to the railway through passing a signal at danger. Consequently the signaller undertook that signals either side of Kennington Junction would show a red aspect at all times whilst the work was being undertaken. This action had the benefit of providing additional safety protection for the technicians on the track. However, the primary means of protection were the warnings that would be given by the lookout. The signaller correctly placed reminder devices round the pushbuttons controlling the signals as a prompt that they should not be used.

Working between trains

141. The timetable between Oxford and Didcot provides very few defined periods when engineering work can take place (see Appendix D for Green Zone working opportunities). Only a period between 00:00 hrs and 05:00 hrs provides Green Zone working opportunities. However, working in hours of darkness requires lighting of the worksite and more onerous arrangements for protection of the track workers than during daylight. Consequently maintenance work that can affect the passage of trains either has to be planned into possessions, or it has to be undertaken in a Green Zone using T2 or T12 protection (see Appendix G), or within a Red Zone with protection usually provided by lookouts.

142. Irrespective of what method of working is adopted the COSS is required to complete the RIMINI form before starting work (paragraph 92). When Red Zone working with lookouts is used, no forms need to be completed by the signaller. The only additional record that has to be kept is an entry in the signaller's train register to record the FPL testing which lists the location and the time when the work starts and finishes.

143. Red Zone working, and T2 and T12 Green Zone protection are all able to take place without stopping the normal train service. Part of the work activity involves setting up the safe system of work; in the case of T2 and T12 protection this will involve *blocking the line* for which the signaller and COSS need to co-operatively complete a form[10]. For the signaller, the time taken to complete the form is dependent upon other duties, such as setting routes for trains elsewhere in the area covered by the signal box and communicating with train drivers and other operating staff. Thus, for a busy section of line with short periods between trains, the time to complete the form can be significant; five or more minutes are not uncommon. Witness evidence indicates that there is thus a disincentive to use T2 and T12 protection if another less time consuming method, such as Red Zone working, can be employed.

144. Although some activities can be pre-planned with timetable allowances or advanced notice, much regular maintenance is undertaken through agreement between the signaller and team leader so that the work does not delay trains.

145. Neither the Rule Book, the COSS Handbook nor Network Rail publications provide any guidance on how the COSS and the signaller should manage work being undertaken between the normal passage of trains. This agreement is usually simple to arrange and the need for instructions is commonly accepted by staff as unnecessary.

146. Working between the passage of trains has been used since the earliest days of the railways to enable a wide range of activities to be undertaken. When used incorrectly for work that impairs the safety of the line the process has caused serious accidents and loss of life[11].

147. When protecting signals have been set to danger, the practice of working between the passage of trains is considered by Network Rail not to provide adequate protection of track workers. Network Rail company standard NR/SP/SIG/10064 'General Instructions to staff working on S&T equipment' section NR/G1/B001, sub-section 2 states 'Rule Book module T1A is all about protecting trains. It does not give staff any protection at all'; Rule Book module T1A provides the authority to work between trains (Appendix G).

148. Network Rail and the Rail Safety and Standards Board are continuing to develop working methods that will reduce the exposure of track workers to the risks from moving trains; however, much Red Zone track work between the passage of trains continues to take place.

149. Obtaining a period in which to work requires the co-operation of the signaller who is under management instruction to keep train delays to a minimum through a work incentive scheme. Permitting maintenance staff to undertake work on a line in which signals are kept at danger thereby puts the signaller's work performance at risk whenever maintenance activities are not completed on time.

[10] RT3181 Line Blockage Form.

[11] e.g. Staplehurst, 9 June 1865 when Charles Dickens was injured. 10 people were killed and 40 injured when the track foreman and his gang, working between the timetabled passage of trains failed to replace two rails on a bridge in time for the passage of the 14:38 hrs Folkestone to London express.

150. Although maintenance staff are also required to keep train delays to a minimum, their focus is more on the response to equipment failures which can delay many trains for considerable periods of time. They are not subject to the same immediate management pressures about individual train delays, especially if they are of only several minutes duration.

151. Maintenance staff are nevertheless aware of the problems they can cause for a signaller if they do not finish the work on time. Repeated failures by a maintenance team will make a signaller very wary of providing short periods when signals are held at danger. Consequently maintenance teams experience self-induced pressure to finish work within the time allotted by the signaller.

152. A work environment thus exists whereby signallers are wary of providing blocks of time when the train service cannot run and maintenance teams are very wary of over-running the time allotted by the signaller.

153. Witness evidence indicates that the self-imposed imperative of the technicians to ensure that the train service was not delayed probably affected the team leader's decision to hand back control of the points to the signaller before the point machine covers had been replaced. The technicians' wish not to delay trains was thus a contributory factor in the accident.

Number of lookouts

154. Any facing point lock test on an HW2000 style point machine undertaken on a double track main line crossover under Red Zone with lookout protection methods requires a minimum of three people; two to undertake the test and one to act as lookout.

155. Where a single lookout cannot gain sufficient sighting of approaching trains to give the prescribed warning time, then the Rule Book allows more lookouts to be used. This is commonly implemented where the track is curved and lineside features restrict the line of sight. The method of calculating the warning time is defined in the Rule Book in module T7 section 11.

156. Travelling towards Oxford, the line curves gently to the left immediately before it reaches Kennington Junction. In order to see an approaching down train and provide the necessary warning time, the lookout needs to be positioned on the up side of the line. This was the position used by the lookout; it also provides adequate sighting for up trains, but has the obvious hazard that the lookout's line of sight of the down line can be cut off by a passing up train. In those circumstances, staff working on the track should go to a position of safety when a train approaches from either direction.

157. It would have been practical to use more that one lookout for work at Kennington Junction, all of whom could remain on the down side of the line. However, this would not allow the work to continue any faster because the points would still need to be wound to their correct position and further activity suspended due to the protection provided by the signalling system (Appendix F).

158. The use of a single lookout with everyone in the team retiring to a position of safety when any train approached was thus a method of undertaking the work that was compliant with the requirements of the Rule Book for the protection of staff. It is however a method that is more prone to human error than other methods of protection permitted by the Rule Book. The use of this method in daylight was neither causal nor contributory to the accident (but see paragraph 176).

Placing the lookout

159. The Rule Book states that the COSS has the responsibility of telling the lookout where to stand to look for approaching trains. When the maintenance team arrived at Kennington Junction the lookout automatically went to the position where he had the best possible view of approaching trains on both the up and down lines; it was the place that had been used on previous visits to the site. The team leader (COSS) and his assistant both had confidence that the lookout would fulfil his duties correctly. Whilst there was an infringement of the rules by the team leader (COSS) not instructing the lookout where to stand, the lookout was nevertheless in the correct place. The lack of involvement by the team leader (COSS) in placing the lookout is neither causal nor contributory.

160. The measured sighting distances for the down line are slightly less than those required for a line speed of 90 mph (144 km/h) when observation of the full front of the train is considered. The distances for a partial view of the train are greater, but are more difficult to quantify and assess. The effect of partial sighting of the train is thus not considered to be causal nor contributory to the accident.

Working in the dark

161. Although the Rule Book module T7 section 9.7b[12] identifies the requirements for using lookouts in a tunnel or during darkness or poor visibility, it does not attempt to guide the reader on what is considered to be darkness and what is not. The time when the ambient light reaches a level when it would not be safe or practical for work to continue is left to the COSS to determine; different types of work, in diverse locations and circumstances require different levels of illumination. Rule Book module T6 section 3.6d provides all staff with the duty to move to a position of safety and to make the COSS aware of their concerns regarding the safety of the working arrangements.

162. A legal definition of darkness does exist; it starts at the end of civil twilight. On 23 May 2008 that was at 21:47 hrs, exactly the same time as the accident.

163. Witness evidence and the video record captured by train 1D73 indicates that cloud cover caused the ambient light to be at a low level immediately prior to and at the time of the accident.

164. The lack of detailed guidance in the Rule Book about darkness is neither causal nor contributory.

[12] 'You must only rely on lookouts to give the warning in or near a tunnel or during darkness or poor visibility if:

- a *pee wee* system is in use, or
- the speed of approaching trains is restricted to 20 mph, the lookouts have been properly positioned and distant lookouts are not needed to get the required sighting distance, (an emergency or temporary speed restriction must be imposed, if necessary), or
- the work is within a worksite in a possession and you have made the arrangements as shown is section 10 of this module.

….. during darkness, poor visibility or if the site of work is in or near a tunnel, you must not rely on lookouts to give the warning.'

165. When the ambient light level began to fall the Rule Book requires Red Zone working with lookouts to cease unless additional facilities are available to assist in warning about approaching trains. None of these additional facilities were available to the team. There is no evidence to show whether the team leader (COSS) overtly considered whether the team should continue working or not in the failing light; he did, however, continue working. Had the team leader (COSS) decided to cease work under Red Zone procedures and move to a position of safety as soon as the ambient light level fell to the point when torches were required, he would have needed to book the points out of use for facing moves. In these circumstances the team would not have been on the track when train 1D73 arrived. The action of the team leader (COSS) to continue working in the poor light conditions was a causal factor in the accident.

166. Had the work been undertaken fully in daylight, when an up train approached the lookout would have had the opportunity to see that the technicians were not moving to a position of safety and could thus have given a further urgent warning. If this had been ignored, a decision by the team leader to remain on the track and to hand back the down line to signaller control, would have removed the last barrier to prevent a train from approaching the site. This might have resulted in a similar accident.

167. The lookout was reportedly uncomfortable about work continuing in the falling light conditions, although he did recognise that he could easily see the headlights of approaching trains. The assistant who was also a COSS had reportedly not experienced working in the dark with lookout protection before. Neither felt that they should challenge the team leader (COSS) about completing the work in the dark, thus infringing the rules[13]. Not bringing their concerns to the attention of the team leader (COSS) was a contributory factor in the accident.

Warnings and moving to a position of safety

168. During the journey to Kennington Junction the team leader (COSS) had correctly identified the cess on either side of the track to be a position of safety. Both the assistant and the lookout had both been to the site before and knew the safety arrangements well.

169. The Rule Book module T6 section 5.1 requires that all staff working on the track should retire to the nominated position of safety when a warning is given about a train that is moving towards them. Evidence given to the RAIB shows that with adequate sighting, a general practice exists whereby staff do not move clear of a track when a train that does not present a hazard to them approaches on an adjacent line. This was highlighted in reports of accidents at Tinsley Green (report 43/007), Ruscombe (report 04/2008), Leatherhead (report 19/008) and Grosvenor Bridge (report 19/2009). Where a passing train would limit the lookout's sighting then staff should move to a position of safety and remain there until the lookout confirms to the COSS that good sighting exists again. Neither the Rule Book, COSS Handbook nor Network Rail Publications address this matter (see also paragraph 184).

[13] The last paragraph of Section 2.3 in Module G1 of the Rule Book states: 'You must tell your supervisor, manager or Operations Control immediately you see, or become aware of, anyone else not carrying out rules, regulations or instructions correctly.'

170. Immediately before the accident the lookout shouted a warning to the team members about the approaching freight train. This is an infringement of the rules which require the warning to be given by horn or whistle and supplemented, if necessary, by shouting. However the lookout's voice was adequately loud for the warning to be heard and both the team leader and his assistant responded by shouting 'OK' or similar. That too was an infringement of the rules which requires a hand to be raised to acknowledge the warning. However, neither of these infringements was causal or contributory to the accident as a warning was clearly given and received. The lookout believed that this warning would remind both the team leader and the assistant that the lookout's view of the down line would now be restricted and that they should move to a position of safety.

171. Following the initial warning the lookout concentrated on the approaching train which then sounded its horn. The lookout acknowledged this correctly by raising his arm; however, he was reportedly unable to see the other two team members properly due the light levels and could not determine if they were either in, or moving to a position of safety. He could see that they were not in the 4-foot and were still near the point machine, but he could not determine whether either was still in a hazardous position. This was as a direct consequence of the decision to continue working in the dark. Consequently he was not aware of the need to issue an urgent safety warning by giving a series of short sharp blasts on his horn, or whistle, as required by the Rule Book when staff do not immediately move to a position of safety[14]. Working in the dark was thus a causal factor in the accident.

172. When the lookout's warning was received the assistant, who was also certificated as a COSS, did not move to a position of safety. Had he done so he might have noticed that the team leader had remained working on the points; he might then have provided a second warning to the team leader. The assistant not moving to a position of safety is thus a contributory factor in the accident.

173. It is possible that the team leader forgot that he was working in an area where the lookout would lose his sight of a down train when an up train was passing. It has not been possible to validate this because the team leader cannot recall any detail about events leading immediately before the accident. Nevertheless, the general practice by the team of not moving immediately to a position of safety when a train approached on an adjacent track, may have conditioned the team leader and the assistant into a less urgent reaction to the lookout's warning. This is a contributory factor in the accident.

Actions of the COSS

174. Although there was a brief discussion about the safety arrangements during the road journey to Kennington Junction, this did not fulfil the requirements for the team leader (COSS) giving a full briefing to his team. Although a copy of the RIMINI form was available it was not subsequently completed by the team leader (COSS) on arrival at the site or signed by the two other members of the team.

[14] Rule Book Railway Group Standard GE/RT8000 Module T6 Section 7.6b

175. One part of the risk control measures was that the team leader (COSS) and his assistant should go to a position of safety whenever a train approached on either the up or down line. Declaring this requirement may have increased awareness of the hazards at Kennington Junction and may have prompted the two technicians to move to the cess when train 4O97 approached. The lack of instruction by the team leader (COSS) that the team should go to a position of safety for any approaching train is a contributory factor in the accident.

176. The team leader (COSS) did not maintain a safe system of work when conditions changed, both through working when lighting levels deteriorated (paragraph 160) and by not moving to a position of safety when an up train cut off the lookout's view of the down line after control of the signalling system had been handed back to the signaller. Not maintaining a safe system of work is a causal factor in the accident.

Identification of underlying factors[15]

Protection of track workers

177. The information used by the SSoWPS was generated by requests and information provided by the Signal Maintenance Assistant or local team leaders at Oxford. Although there was the opportunity for the Works Scheduler at Didcot to challenge the information provided, this was only done if obvious mistakes or errors existed. There was no automatic process in operation, either at the human or computer levels to challenge Red Zone working, or the details attached to it.

178. When specific maintenance activities were to be undertaken the appropriate RIMINI sheets were printed automatically at Oxford. For the first issue of a new sheet they would be reviewed by the Signal Maintenance Assistant; their content would subsequently be used by each COSS involved in that work, who would have the opportunity to feed back any comments. The details of protection and the hazards identified would thus be checked by the same people who had provided the original information.

179. When T2 or T12 protection is involved the signaller and COSS have to co-operatively complete the RT3181 Line Blockage form prior to the signaller placing protecting signals to danger (Appendix G). Work is not allowed to start until the form is fully complete and the signaller issues an authority number for the work.

180. There are restrictions on the use of T2 and T12 protection. T2 protection may be applied under a number of procedures, each referenced by a separate identity number[16]. T2X protection would not be appropriate for the planned work at the beginning because it was not of an emergency nature; later it could not be used because the work would additionally 'affect the safety of trains'. T12 has an overall provision prohibiting activities that 'affects the safety of trains'.

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

[16] T2-A Using track circuit operating devices, T2-D Disconnecting signals or routes, T2-H Using Handsignallers or detonator protection, T2-T Placing the block indicator to 'Train on line', T2-X For emergency use only using signals placed to danger.

181. For work that is difficult to schedule accurately, working between trains in a Red Zone with lookout protection is the method of choice for maintenance teams at Oxford; it is simple and quick to set up, with no paperwork to complete other than completing the RIMINI form. Because facing point lock tests involve moving the switch rails there is a possibility that the safety of trains could be endangered. That risk is minimised by the signaller holding signals at danger and thus preventing trains from approaching the points under test. Whilst that action protects the trains, it is not recognised as providing any protection to track workers (paragraph 147). Protection of staff on the track is provided solely by the lookout.

182. No evidence has been found of any comprehensive risk assessment or overt management consideration, at either a local level or nationally, that addresses both the maintenance and operational issues for undertaking facing point lock tests. Additionally no evidence was found that any local management activities were in place to challenge the default situation of using a Red Zone protection with lookouts with signals maintained at danger. The lack of those management activities has provided the route by which maintenance technicians and signallers have found working methods that address their own immediate needs. Thus the lack of an officially published, practical and risk assessed menu of acceptable methods for the use of planners and other staff for the protection of staff and for ensuring the safety of trains, applicable to regular maintenance activities such as facing point lock tests, is an underlying factor of the accident.

183. No evidence has been found, either at a local or national level, of measures to address the immediate difficulties experienced in providing Green Zones in the Oxford area, or for providing enhanced methods of protection within a Red Zone. Whilst Network Rail has a policy that work activities on the line should take place in a Green Zone whenever reasonably practical (paragraph 88), the application of this policy does not appear to have made any significant difference to working methods at Oxford for many years. Witness evidence indicates that in recent years there has been some deterioration in the ability to provide Green Zones due to increasing freight traffic and the utilisation of a *clock-face timetable* for passenger trains. Thus the ongoing managerial acceptance of Red Zone working for activities such as facing point lock tests, without any form of independent checking of the safety arrangements, is an underlying cause of the accident.

Moving to a position of safety

184. There is no clarity in the Rule Book, or in the COSS Handbook, as to the definition of an ‘approaching train’, and when a lookout might or might not sound a warning. Safety posters published by Sentinel in 2003 and distributed to Network Rail premises up until about 2007 are still displayed in some locations; they give the following instruction *‘On or near the line when a train approaches? Move to a position of safety, clear of all lines’.* No definition of an ‘approaching train’ was given on the poster.

185. Prior to this accident the RAIB has reported on several instances of track workers on the main line network not going clear of all lines. In each case the workers remained at, or only retired to, the minimum distance from a train which was thought not to pose a risk. RAIB publications on accidents at Tinsley Green (report 43/2007) and Ruscombe (report 04/2008) relate to locations where facing points permitted a train to move from one track to an adjacent one. The RAIB report on the accident at Leatherhead (report 19/2008) relates to a location at a junction. Recommendations 1 and 4 in the report on the fatality at Ruscombe and recommendation 3 of the near miss at Tinsley Green addressed the issue of approaching trains in the vicinity of facing points.

186. The RAIB report into the staff injury at Grosvenor Bridge (report 19/2009) identified the pitfalls of the lookout not sounding a warning when a train moved towards track workers on an adjacent line when points were not involved.

187. The above reports highlight the conditions where a warning from the lookout about a train approaching on an adjacent line might be crucial to the safety of track workers:

- where the topography results in a train blocking the lookout's sighting distance to other trains that could pose a danger to the staff on the line where they were working;
- where a passing train could block the route between the site of work and the position of safety;
- where points would permit the train to cross from another line directly towards the site of work; and
- where staff can inadvertently 'stray' into an adjacent open line.

188. Literal application of the rules such that track workers moved to the position of safety whenever a train approached, irrespective of what track it was on, would result in an increase in the time, and hence resources, necessary to carry out many types of work. Network Rail contends that unacceptable inefficiencies in the amount of useful work possible in Red Zones would result from such a literal interpretation of the Rule Book. A less restrictive interpretation could lead to staff remaining on the track where they perceived a train would not present a hazard to them.

189. For facing point lock tests it is also often necessary to return the points to their original position so that the interlocking can set the route along an immediately adjacent line (this is known as flank protection). When this occurs work effectively has to cease and this provides a useful prompt for the technicians to move to a position of safety.

190. No evidence has been found in published documentation including COSS training material or specific criteria to guide a COSS as to how to set up a safe system of work on multi-track lines when staff are not to move clear of all tracks. Such criteria would require that consideration is taken of:

- the practical capabilities of lookouts;
- the possibility of human error and its consequences;
- the ability to identify the track a particular train is using;
- multiple train movements;
- the need for a precise knowledge of the track layout between the sighting distance and the site of the work;
- nature of the work being undertaken; and
- the continued ability to observe that staff who stayed on the track did not move to a position where they became at risk of being struck when a train drew near on an adjacent line.

191. This matter is discussed in more detail and recommendations made in the report on Grosvenor Bridge (report 19/2009); consequently no recommendations are made in this report to address this matter.

192. The lack of definition of an approaching train, and the lack of guidance about setting up a safe system of work when trains can pass on an adjacent track, and the necessary actions of the lookout allowed working practices to develop that had not been subject to an appropriate risk assessment. The maintenance team thought that providing a warning about every train moving toward the site of work, and identifying the train as being on an adjacent track, was the safest option. This practice was applied irrespective of location; as a consequence it did allow a measure of complacency to develop about the need to move immediately to a position to safety and thus avoid a second train approaching. The lack of clear guidance to track staff in general through the Rule Book, COSS Handbook and other publications about safe working practices when trains could pass on adjacent lines is an underlying cause of the accident.

Response of others

193. The ambulance service responded in an efficient and timely manner following the emergency telephone call from the Oxford signal box.

194. The RAIB received the initial notification of the incident from the British Transport Police rather than from Network Rail's National Operations Centre (NOC). The NOC interpreted the Guidance to the Railways (Accident Investigation and Reporting) Regulations 2005 to mean that an immediate notification was not required under Schedule 2.2 (one serious injury). The RAIB considers that the accident should have been reported immediately under Schedule 1.9 (Accident or incident which under slightly different condition may have led to a death…).

Other factors for consideration

Rule Book modules T2 and T12

195. Direct witness evidence and informal commentary obtained from Network Rail Route Maintenance and Operating Managers indicates that there is some confusion about what work may be permitted under Rule Book modules T2 and T12. Some opinion was that it would be acceptable to use T12 procedures for facing point lock tests; another opinion was that when the ambient light failed the work should have continued under T2X protection. In fact neither option would be permitted because both would 'affect the safety of trains' (see also paragraph 201 for observations about what this phrase may mean). The lack of understanding and clear instruction from Network Rail management about the requirements of the Rule Book is a matter that could usefully be addressed.

Working in a red zone

196. Very little information was contained on the RIMINI form that would help a COSS to manage safety at the site. Some detail could be challenged as being incorrect, e.g. that the facing point lock tests were listed for one individual working alone under Red Zone procedures. Such a method would be impractical.

197. One of the essential risk control measures when working with one lookout at Kennington Junction was that the team leader and his assistant should go to a position of safety whenever a train approached on either the up or down line. This was not recorded on the pre-planned RIMINI form, nor was it entered later by the team leader (COSS). The RAIB was not able to find any evidence that local supervisors, managers or planners applied any process to confirm that the pre-planned RIMINI forms were sufficiently complete and that the information contained on them was correct.

198. There is a requirement for the COSS to set up a safe system of work under module T7 section 3 '*You are responsible for setting up the planned safe system of work*'. The RAIB was not able to find any evidence that the team leader (COSS) at Kennington Junction, or other COSS staff at Oxford who had worked at Kennington, had attempted to enhance the pre-planned generic RIMINI forms with suitable risk control measures. Consequently there was always a need to complete the form at the time that the work was undertaken. Witness evidence indicated that for repetitive work it was common practice (greater than 50%) for the form to be completed after the work had ended, thus indicating the likelihood of incomplete briefings.

199. Where repetitive work, such as facing point lock testing, is involved in an area where working time is severely restricted by the intervals between trains, the need for the COSS to repeatedly complete similar paperwork does not seem an efficient way of working. This however, was neither causal nor contributory to the accident because none of the paperwork was completed prior to work starting.

200. The inadequacy and errors in the paperwork do indicate that suitable initial preparation and subsequent monitoring of the pre-planned safety information on the RIMINI forms was not in place. Had sufficient preparation been undertaken in producing the RIMINI forms, supported by all COSS staff supplying feedback, then an adequately complete and correct form would possibly have been available. For repetitive work, the lack of a process to capture, update and review important safety information for the RIMINI form is a matter that could usefully be addressed.

Endangering the safety of trains

201. During the investigation the RAIB discovered a diverse set of opinions about what is meant in the Rule Book and associated publications by terms such as 'affect the safety of trains' and ' affect the safety of the line'. This varied from person to person, area to area and Network Rail territory to territory. The most common view was that it meant that there should be a continuous line of rails along which the train could travel without conflict with other trains (paragraphs 177 and 180 describe the relevance of this term to T2 and T12 protection). The RAIB has noted that in Network Rail's own report on the accident, it has advised its staff that T12 protection may be used to provide protection for facing point lock tests. This appears to be in conflict with the common understanding above (see Appendix G, paragraph G5).

202. Also during the investigation the RAIB discovered that the terms such as 'affect the safety of trains', 'affect the safety of the line' and 'affect the normal passage of trains' were often indiscriminately used. Neither the Rule Book nor Network Rail publications provided assistance in their definition and it was left to the reader to interpret them. Whilst the first and second terms clearly relate to safety, the third could refer to non-safety factors such as timekeeping. The lack of definitions, or their indiscriminate usage, does not enable a clear understanding to be obtained by staff and may lead them to an incorrect interpretation.

Automatic warning systems

203. Network Rail uses several warning systems that provide an automatic warning of the approach of a train; they include the Automatic Train Warning System (ATWS), Train Operated Warning System (TOWS) and Lookout Operated Warning System (LOWS). These are considered to be preferable to using a lookout alone (Appendix G, Table 1).

204. ATWS and TOWS provide an automatic warning of a train's approach. If ATWS, TOWS, or an equivalent system had been in use on the down line at Kennington Junction then the approach of a down train would have provided an independent warning to the technicians; the likelihood of the accident would thus have been significantly reduced.

205. LOWS requires the lookout to operate the system; the team's actions may have been different if a LOWS warning had been received because they would not have known from what direction the train was approaching, unless the lookout had shouted that information to them. Consequently they would have been more likely to have moved immediately to the cess.

206. All these systems require additional resources when they are used, either in the time needed to set them up or the number of people involved. This additional resource could only have been provided through management recognition of the issues involved.

207. For repeated maintenance activities that will be needed for the foreseeable future, such as point inspection and testing, the provision of a permanent system to warn locally of the approach of trains, and possibly to provide a simple means of obtaining protection cooperatively with the signaller, could be considered for new signalling schemes. Whilst retrofitting an integrated system to the existing infrastructure may not be cost effective, its provision during upgrading or replacement of the existing facilities may be practicable.

Conclusions

Immediate cause

208. The immediate cause of the accident was the team leader (COSS) not moving to a position of safety when the lookout issued a warning about an approaching up train.

Causal factors

209. Causal factors were:

a. the need to adjust the rods of the point machine (paragraph 139, no recommendation);

b. the team leader (COSS) not briefing and maintaining a safe system of work by permitting work to continue when the light deteriorated (paragraph 165, no recommendation);

c. working in the dark (paragraph 171, no recommendation); and

d. the team leader (COSS) not maintaining a safe system of work by not moving to position of safety when an up train cut off the lookout's view of the down line (paragraph 176, no recommendation).

Contributory factors

210. Contributory factors were:

a. the perceived need of the maintenance team not to delay trains (paragraph 153, no recommendation);

b. the assistant in the maintenance team not moving to a position of safety when a warning about an up train was given (paragraph 172, no recommendation);

c. the maintenance technicians' conditioning into a less urgent reaction to a lookout's warning by the general practice of not moving to a position of safety when a moving train was sighted on an adjacent track (paragraph 173, no recommendation);

d. the team leader (COSS) not clearly identifying that the team should go to a place of safety for any train moving towards them due to the possibility that the lookout may not be able to see an approaching down train when an up train was passing (paragraph 175, no recommendation); and

e. the lookout and assistant not challenging the COSS when working conditions changed due to darkness (paragraph 167, no recommendation).

Underlying causes

211. The underlying causes were:

    a. the lack of a timely and efficient method of protecting staff undertaking short duration work that involved the local movement of points (i.e. it would fall within the commonplace understanding of endangering the safety of trains) (paragraph 181 and 182, **Recommendation 1**);

    b. the managerial acceptance of Red Zone working for facing point lock tests (paragraph 183, **Recommendation 1**); and

    c. the lack of clear guidance in the Rule Book, COSS Handbook and other publications about what safe working practices should be implemented when trains could pass on adjacent lines (paragraph 192, no recommendation in this report).

Additional observations[17]

212. The widespread lack of understanding when T2 and T12 protection may be or should be used (paragraph 195, **Recommendation 2**).

213. For repeated work the lack of processes to capture important safety information for the initial issue and updating of the RIMINI form (paragraph 200, no recommendation in this report).

214. In the context of the rules in modules T2 and T12 of the Rule Book, the term 'affecting the safety of trains' is not defined in the Rule Book and is interpreted in different ways throughout Network Rail. There is also confusion between the terms 'affecting the normal passage of trains', 'affecting the safety of trains' and similar terms (paragraphs 201 and 202, **Recommendation 3**).

215. The lack of any automated warning system caused a reliance upon lookout protection (paragraphs 203 to 207, no recommendation in this report).

[17] 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.

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

216. Network Rail has introduced enhanced arrangements for briefing staff on the lessons to be learnt from serious accidents. As part of this activity it has made available a web-accessible animated review of the accident at Kennington Junction which identifies the key learning points identified from the Network Rail formal inquiry into the accident.

217. Network Rail has commenced work to review the methods used to monitor track worker and COSS compliance with safety rules and instructions with the aim of improving the effectiveness at identifying non-compliance with rules and procedures, and providing specific guidance to managers and supervisors on what to look for in staff safety and behaviour. The scope of the project addressing the 'Role of the COSS' is intended to improve all areas of COSS performance; selection, training, mentoring, assessment, team dynamics and surveillance. A draft Network Rail company standard is already available.

218. Network Rail has commenced an ongoing process to review the opportunities for Green Zone working within the Infrastructure Maintenance Delivery Unit at Swindon (responsible for the Oxford area) and has raised awareness of the Green Zone Access Guide.

219. Within the Infrastructure Maintenance Delivery Unit at Swindon, Network Rail has clarified the roles and responsibilities of staff involved in RIMINI planning such that they have the capability and opportunity to challenge proposed safe system of work.

220. The Didcot Signal Maintenance Engineer (responsible for the Oxford area) has been briefed on safety leadership responsibilities and the responsibility to undertake safety checks on track work.

221. The members of the maintenance team have been reminded of their safety responsibilities and the need to comply with published rules, including the need to move to position of safety when the lookout sounds a warning for an approaching train, and to stay there until it is safe to continue working.

222. The Infrastructure Maintenance Delivery Unit at Swindon has reviewed the arrangements for the issue of driving cab passes to managers and supervisors so that they may undertake supervisory checks of infrastructure assets on the work being done on them.

223. Signallers in the Thames Valley area have been reminded that T12 protection may be used for facing point lock testing (but see commentary on the use of T12 protection in paragraph 201).

Recommendations

Previous recommendations

224. The following recommendations were made by the RAIB as a result of investigations into other accidents. They are not remade so as to avoid duplication:

Track worker injury at Grosvenor Bridge on 13 November 2007 (RAIB report 19/2009)

Recommendation 1:

Network Rail should propose a change to the Rule Book, in accordance with the Group Standards code, so that all members of a work group have the responsibility to ensure that they receive a full briefing prior to signing the COSS form.

This recommendation addresses the factor identified in paragraph 209b.

Recommendation 2:

In order to reduce the risk to track workers, Network Rail should review their programme for the provision of automatic warning systems for Red Zone track inspections and if practicable should implement a programme to accelerate the introduction of appropriate systems for multi-track areas.

This recommendation addresses the factor identified in paragraph 215.

Recommendation 5:

In order to reduce the risk to track inspection staff, Network Rail should propose a change to the Rule Book and the COSS Handbook, in accordance with the Group Standards code, that amends the procedures for red zone working with lookout protection in a multi-track area to:

- *clearly define an approaching train;*
- *clarify the criteria for setting up a safe system of work, including;*
  - *the circumstances that require pre-planning. Consideration should include:*
    a) *the practical capabilities of lookouts;*
    b) *the possibilities for human error and its consequences;*
    c) *the ability to identify the track a particular train is using;*
    d) *the likelihood of multiple train movements;*
    e) *the complexity of track layout;*
    f) *the nature of the work being undertaken; and*
    g) *the size and disposition of the work group for continued observation by the lookout.*

This recommendation addresses the factor identified in paragraph 210b, c and d.

Collision between a passenger train and two rail-mounted grinding machines at Acton West on 24 June 2008 (RAIB Report 15/2009)

Recommendation 2:

The intention of this recommendation is to:

- *promote the involvement of the 'end-user' in designing the paperwork that they use on site;*
- *secure the COSS's involvement in the planning of the safe system of work that they will implement on site; and*
- *achieve a consistent and user-friendly appearance for the COSS pack (including the RT9909 form).*

Network Rail should, in its current project to overhaul the RIMINI planning process:

a. *involve those who will use the information on site in developing a revised format for the COSS pack (and the RT9909 form);*
b. *include a role for the COSS in the planning of their safe system of work; and*
c. *improve the format of the COSS pack (and the RT9909 form), with particular emphasis on the clarity and consistency of information presented, including, but not limited to:*
    - *consistency in the method for identifying key locations such as the site of work, limits of possession and access points;*
    - *clarity over the information that is required in each section of the new forms;*
    - *the option of identifying in the COSS pack where access to site can be achieved by walking lineside as opposed to on or near the line; and*
    - *the use of diagrams and maps to show key locations and their relationship with each other.*

This recommendation addresses the factor identified in paragraph 211e.

225. The following new safety recommendations are made[18]:

Recommendations to address causal and contributory factors observed during the investigation

1. *The intention of this recommendation is to develop and adopt suitable work methods to protect people from being struck by trains and which do not affect the safety of trains.*

   Network Rail should investigate the development and subsequent adoption of practical alternative working methods that will provide protection of staff when undertaking regular specific maintenance activities such as work on switches and crossings, and that will provide for the safety of trains. If practicable it should introduce these alternative working methods (paragraphs 181 to 182 and 207).

Recommendations to address other matters observed during the investigation

2. *The intention of this recommendation is to enable staff undertaking a specific maintenance activity to be clear about whether a particular form of protection that they wish to use provides for the safety of staff and trains. In particular it addresses the need to promote a better understanding of when T2 and T12 protection may be used and the restrictions imposed by the Rule Book and Network Rail instructions. It should encompass all forms of protection and regular maintenance activities including facing point lock tests and should clarify any issues relating to the 'safety of the track' and the 'safety of trains'*.

   Network Rail should introduce a system whereby staff undertaking a specific maintenance activity can obtain clear guidance that a particular form of protection is suitable and provides for the safety of staff and trains. It should include clear guidance on when T2 and T12 protection may and may not be used and their applicability to specific types of work which may affect the 'safety of the track' and the 'safety of trains'. (paragraphs 195 and 201).

continued

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

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

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

(b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

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

3. *The intention of this recommendation is to avoid doubt for those applying the requirements of the Rule Book.*

   Network Rail, in conjunction with the RSSB, should clearly define, as a minimum, what is meant by the terms:

   - 'affect the safety of the line';
   - 'affect the safety of trains';
   - 'affect the safety of train working'; and
   - 'affect the normal passage of trains' (paragraphs 201 and 202).

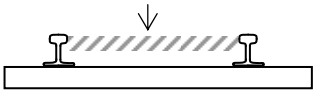
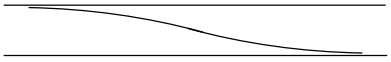
Appendices

Appendix A - Glossary of abbreviations and acronyms

ch	Chain (imperial unit of measurement equating to 1/80 of a mile) (20.12 m)
COSS	Controller of Site Safety
ORR	Office of Rail Regulation
RAIB	Rail Accident Investigation Branch
RIMINI	Risk Minimisation. The colloquial name for the RT9099 'Record of site safety arrangements and briefing form'
RSSB	Rail Safety and Standards Board
SSoWPS	Safe System of Work Planning System
S&C	Switches and crossings

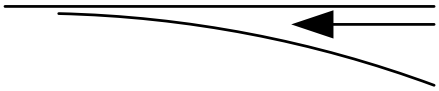
Appendix B - Glossary of terms

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

3-aspect signalling	A signalling arrangement which conveys movement authorities to train drivers by means of coloured lights; green (proceed), single yellow (caution) and red (stop).
4 foot	The area between the two running rails. 
Ballast	Crushed stone, nominally 48 mm in size and of a prescribed angularity, used to support sleepers, timbers or bearers both vertically and laterally.
Blocking the line, blockage (of the line)	Preventing trains from moving by placing or maintaining signals at danger with records kept by the signaller of form RT3181 Line Blockage Form.
Cab secure radio	A radio system provided to allow the signaller and train driver to communicate safety critical information as securely as if they were speaking on a land line such as a signal post telephone (SPT).*
Cautionary aspect	The yellow or double yellow aspect displayed by a signal that indicates to a train driver that the train may be required to stop at a signal ahead.
Cess	The part of the track bed outside the ballast shoulder that is deliberately maintained lower to aid drainage, provide a path and a position of safety.*
Civil twilight	In the morning civil twilight begins when the sun is six degrees below the horizon before sunrise; in the evening it lasts after sunset until the sun is six degrees past the horizon. Between these times, and subject to weather conditions, it is considered practically and legally light enough to work outside without the aid of artificial lighting. Streetlights will have come on before civil twilight ends.
Clock-face timetable	a) a Timetable arrangement whereby trains to a particular destination all leave a station at the same time past the hour throughout the day. b) a timetable where trains run at regular intervals (e.g. every 10 minutes).*
Collar	(See 'reminder device').
Crossover	Two points that permit train movements between adjacent lines. 
Down	In a direction away from London.*

Facing (direction)	The direction by which trains may be diverted from a single line to one or more diverging routes. 
Facing point lock test	A test, using gauges, which determines whether a switch rail on a set of points is: a) locked in the correct position against the stock (or fixed) rail and is not locked in an incorrect position; and b) detected as being locked in the correct position by the signalling system and is not detected in an incorrect position.
Goods refuge loop	A line off a main route, intended for use by goods or freight trains, which allows other trains to pass. It has points connecting the loop to the main route at both ends.
Green Zone	A safe place of work, free from trains, but on or near the line. Such an area can be created by: ● safeguarding, that is stopping all train movements by taking some form of possession; ● fencing the area off with blue netting or black and yellow tape; ● separating the area from the running line by 2 m (6’ 6”) and appointing a site warden to ensure all staff stay within the safe area; The opposite is a Red Zone.*
Margin	Used to describe an informal arrangement with a signaller to carry out work in the time between trains.*
Normal	For a set of points this is the default position, decided generally as being the position which permits the passage of trains on the most used route. The opposite is reverse.
On or near the line	A position on the track or within 3 m (9’ 10”) of the nearest rail. This excludes areas that are on the other side of a permanent fence or structure, even if it is less than 3 m from the nearest rail.
On-train data recorder	A data recorder fitted to trains collecting information about the performance of the train, including speed, distance travelled, traction and brake control positions, activations of horn, automatic warning system signals and drivers safety device.
Pee wee	A portable electronic system that gives a warning of an approaching train.
Point(s)	A mechanism forming part of the railway track that allows a train to be directed along one of several routes.

Point machine	A machine that moves the switch rails on a set of points. It usually incorporates the circuits for detecting the position of the switch blades, and the locking mechanism for maintaining their position.
Position of safety	A place far enough from the track to allow a person to safely avoid being struck by passing trains. On Network Rail infrastructure this is 1.2 m (4 feet) at speeds up to and including 100 mph.*
Possession	A period of time during which one or more tracks are blocked to trains to permit work to be safely carried out on or near the line.*
Protection	The action of ensuring the safety of staff working on or near the line by preventing trains from running.
Red Zone	An area not protected from train movements that is on or near the line and is too close to lines open to traffic to be a Green Zone. Red Zone working can only be used if there is no realistic alternative and is banned in some situations.*
Reminder device (collar)	A device used by a signaller to provide a reminder or prompt that a particular control should not be used.
Reverse	For a set of points this is the “wrong” position, decided generally as being position which permits the passage of trains on the least used route. The opposite is normal.
RIMINI form	The colloquial name for the Network Rail RT9099 ‘COSS Record of Arrangements and Briefing Form’ that records the arrangements for working on the track. It provides the opportunity for information about the location, hazards, working methods and details of protection to be recorded, including sighting distance and lookout arrangements. It also records the details of who is present and the reference number of their current competency certificate.
Route controller	The Network Rail person in overall control of train operations in the Great Western Territory.
Sighting (sighting distance)	The distance from a signal to a train which allows the driver to fully see a signal.
Switches and crossings	A generic term, usually abbreviated to ‘S&C’, to describe parts of the track where a train can take a diverging or converging route, or can cross over another route.
Switch rail	One of the movable rails in a set of points that allows a train to be directed along one of number of routes. When one switch rail is closed it abuts the fixed stock rail. The other switch rail will be positioned some distance away from the opposite stock rail.

T2 protection	A temporary stoppage of rail traffic as allowed for in Module T2 of the Rule Book.
T12 protection	A temporary stoppage of rail traffic for 30 minutes of less as allowed for in Module T2 of the Rule Book.
Trailing (direction)	The direction in which trains will converge on to a single route from two or more lines. 
Up	In a direction towards London.*
Warning time	The amount of time a particular group working on an open line require to stop work, make the site safe and move to a position of safety when warned of the approach of a train.*

Appendix C - Key standards referenced in this report

GE/RT8000	Rule Book
GM/RT2044	Braking System Requirements and Performance for Multiple Units
GM/RT2483	Visibility Requirements for trains
NR/L2/OHS/019	Safety of people working on or near the line
NR/PRC/MTC/SE0118	Safety Tours
NR/SP/SIG/10064	General Instructions to staff working on S&T equipment
RS/502	COSS Handbook

Appendix D - Green Time working applicable to Kennington Junction, Monday - Friday

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

	00:00-01:00	01:00-01:59	02:00-02:59	03:00-03:59	04:00-04:59	05:00-05:59	06:00-07:00	07:00-07:59	08:00-08:59	09:00-09:59	10:00-10:59	11:00-11:59	12:00-12:59	13:00-13:59	14:00-14:59	15:00-15:59	16:00-16:59	17:00-17:59	18:00-18:59	19:00-19:59	20:00-20:59	21:00-21:59	22:00-22:59	23:00-23:59
LOCATION					**Radley**																			
DD	L	L	L	M	H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	L
UU	L	L	M	L	M	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LOCATION					**Kennington Jn**																			
DD	L	L	M	M	H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	L
DGL	H	H	H	H	H	H	L	H	H	H	H	L	H	H	L	H	H	M	H	H	H	M	H	H
UU	L	L	M	L	M	L	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LOCATION					**Hinksey South**																			
DD	L	L	M	M	H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	L
UGL	H	H	H	H	H	H	H	M	H	L	M	H	L	M	H	M	H	H	L	H	L	L	H	H
UU	L	L	M	L	M	L	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LOCATION					**Hinksey North**																			
DD	L	L	M	M	H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	L
UGL	H	H	H	H	H	H	H	M	H	L	M	H	L	M	H	M	H	H	L	H	M	L	H	H
UU	X	X	M	L	M	L	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LOCATION					**Oxford**																			
BAY	L	H	H	H	H	M	H	L	L	L	L	M	M	L	M	L	L	L	M	H	L	M	L	H
DGL	H	H	H	H	H	H	H	H	H	H	H	H	L	L	H	H	L	H	H	H	H	L	H	H
DM	M	L	M	M	H	X	X	L	L	X	X	X	X	X	X	L	X	X	L	L	X	X	X	L
DPL	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	X	X	L	X	L	M	H
TL	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
UGL	H	H	H	H	H	H	H	M	H	M	M	H	L	M	H	M	H	H	L	H	M	L	H	H
UM	L	L	M	L	M	L	X	L	L	L	L	L	X	M	M	X	L	L	L	M	L	L	M	X
UPL	L	L	H	H	H	H	L	L	X	L	L	L	L	L	L	L	L	L	L	X	L	M	L	L

Appendix E - Accident statistics for track workers

Year	Track worker fatalities	Type of accident (excludes road accidents)
2008	2	Struck by platform Fall from height
2007	2	Struck by train (x2)
2006	0	
2005	3	Struck by train (x3)
2004	8	Struck by road-rail vehicle (x2) Struck by runaway trolley following deliberate tampering with braking system (x4) Fell down tunnel shaft (x1) As consequence of collision (x1)
2003	3	Struck by plant (x1) Electric shock (x2)
2002	2	Crushed by load (x1) Electric shock (x1)
2001	4	Struck by train (x4)
2000	2	Struck by train (x2)
1999	2	Struck by train (x2)
1998	5	Struck by train (x3) Off-track (x1) Electric shock (x1)

Appendix F - Infrastructure

Points

Facing point lock tests

F1 Network Rail requires that points are subject to a facing point lock test for both the normal and reverse positions to confirm that they are safe to use in a facing direction. At Kennington Junction the period between the tests was nominally 4 weeks. The tests confirm that:

- the switch rails are locked in position and the detection of them lying in their correct position is obtained when a 1.5 mm thickness gauge is inserted between the stock rail and switch rail; and
- the locking of the switch rails and the detection of them lying in their correct position cannot be obtained when a 3.5 mm thickness gauge is inserted between the stock rail and switch rail.

HW2000 point machine

F2 Most point machines incorporate three separate functions, all of which require checking on a periodic basis:

- moving the switch rails;
- locking the switch rails in their correct position; and
- detecting the switch rails in their correct position.

F3 As movement takes place in the track, and wear occurs on the rails and within the point machine, adjustments occasionally need to be undertaken for the point machine.

F4 The point machine for 207A point (Figures 5 and 6) is bolted on two extended sleepers and is located to side of the running rails and next to the cess. The drive to move the switch rails, and their locking and detection are all combined within the electrically powered machine.

F5 Four mechanical rods connect the point machine to the track; a drive rod, a lock rod and a detector rod for each of the switch rails. The drive rod connects to the front stretcher bar which connects the two switch rails together. Each detector rod is bolted to a switch rail close to its tip. The lock rod is bolted to the second stretcher bar. The design is such that the failure of one function will be detected by the control system; thus when an unsafe condition is detected it will prevent signals from clearing for the passage of a train.

F6 When the facing point lock test is undertaken on a HW2000 point machine a hand winding handle is inserted in the end of the machine to move the switch rails. This action also removes control of the points from the signal box; operating the point machine remotely under power is thus disabled to ensure the safety of maintenance staff.

F7 Once the machine covers have been removed, it usually takes about 6 minutes to complete a facing point lock test on a point, however if adjustment is required the time can be much longer. Adjustment on each of the four rods can be undertaken independently, however, each adjustment will affect the operation of the other functions. A systematic approach is thus necessary to ensure that the alterations are completed in an efficient manner.

Signalling

F8 The line between Oxford and Didcot uses three aspect signals; this combined with the high line speed means that the distance between signals, and the period between passing trains is relatively long. With an intensive train service, typical minimum headways of about 3 minutes are available. This does not provide for lengthy periods of access to undertake maintenance.

F9 At Kennington Junction track circuits are used for train detection. The output from these is combined within electrical equipment, called an interlocking, to check that it is safe to set points and clear signals for the passage of trains. The command for a particular route to be set is provided by controls operated by the signaller.

F10 During the facing point lock test the direction of the point has to be moved a number of times from normal to reverse and back again. When a route has been set over a point any change will be detected by the interlocking. It will automatically try to protect this new unsafe condition by changing the protecting signal back from a green or yellow aspect to red. Preceding signals may also change, e.g. from green to yellow. The consequences of hand winding the point may thus be seen by a train driver many miles away.

F11 Where a pair of points form a crossover between two running lines, as exists for 207A and 207B points at Kennington Junction, the interlocking will also recognise that an unsafe condition may apply for the adjacent line if one point is detected in the wrong position. A train could thus be diverted over the crossover to the wrong line with the potential for a collision. The interlocking will protect this condition by placing the protecting signal on the adjacent line to red, with consequential changes of aspect for the signals preceding it. This is known as flank protection.

F12 To protect any train driver from seeing an adverse change of aspect whilst a facing point lock test is underway and to maintain the safety of the railway, the signaller will place all the affected signals protecting the point to danger. The signaller's controls in Oxford signal box are push/pull buttons. As a reminder that the route must not be set or the signal cleared, the signaller will place a reminder device round the button preventing it from being operated.

Figure 12: Typical reminder devices (red tubes around the press button) used on a control panel. A press button without a reminder device is on the right-hand side of the picture

F13 The action of holding the protecting signal at danger also precludes a train travelling over the points when they are set in the wrong direction.

Appendix G - Rules and instructions

Safety management

G1 The management systems for ensuring the correct planning of track maintenance activities are described in Network Rail Company Standard NR/SP/OHS/019 entitled 'Safety of people working on or near the line'. This requires that as much work as is reasonably possible is programmed to take place in Green Zones. This is facilitated by a Green Zone Guide containing information about when it is possible to block one or more lines without disrupting train services and the arrangements for 'booking' blockages of the line.

G2 Network Rail has formalised the arrangements for managers to personally monitor and record safety behaviour on the track in NR/PRC/MTC/SE0118 'Safety Tours' by requiring Territory Maintenance Managers, Infrastructure Maintenance Managers and Maintenance Delivery Unit Managers to carry out a minimum of six planned systematic safety tours each year. They should:

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

Planning for maintenance work

Engineering possessions

G3 The Rule Book allows possessions to be booked for planned work. Possession work, under T3 procedures, always requires more resource than working on the track under red zone procedures within margins; this applies both during the planning stages and during the possession. A T3 possession will always block the line and thus prevent any normal service booked for that period of time from operating. Because of the resource overhead that would be wasted if the planned work could not be carried out, T3 possessions for facing point lock tests are rarely considered at Oxford.

G4 If it is not practicable to establish an engineering possession, the Rule Book provides for the protection of a work site by means of special arrangements described in modules T2 and T12.

T2 Protection of staff undertaking engineering work

G5 Work under a T2 protection (which encompasses five separate procedures) involves blocking the line so that no trains will run through the affected area if the 'safety of trains' will be affected. Such a blockage would allow a green zone to be set up. The term 'safety of trains' is not defined.

G6 Most work under T2 arrangements will be planned and published in advance. T2 protection can be achieved in a number of ways, depending upon the signalling system present on the line, however (apart from T2X protection which is used for emergency situations) they are all more robust than a signaller solely placing signals at danger.

G7 Signal maintenance teams also need to react to failures at short notice. Because of the resource overhead that would be wasted if the planned work could not be carried out, T2 protection for facing point lock tests is rarely considered at Oxford. Furthermore, the availability of green zone working periods between Oxford and Didcot is severely limited, with virtually none available during the day. Planned work under T2 procedures would thus need to be undertaken mostly at night or at weekends. Elsewhere, T2 protection is commonplace; however, in some locations alternative train paths are available, such as between Didcot and London, in others the train service is less intense.

G8 Facing point lock testing could be undertaken under T2 procedures and maintaining signals at danger. The first method uses a track circuit operating device which is placed across the rails once the signaller has set the protecting signal to danger. The second method involves a member of the maintenance team withdrawing fuses so that the protecting signal cannot be set to show a proceed aspect. They both involve a planning overhead and time to set up when the work is to be carried out. Both involve additional time in that a technician will need to travel some distance between the work site and equipment in the vicinity of the signal in order to place the track circuit operating devices or to withdraw the fuses.

G9 T2X protection is one exception under these arrangements; it is however limited to emergency work that does not affect the safety of train. The protection is obtained by the signaller placing protecting signals to danger and using reminder devices to ensure that a train is not signalled over the affected section. T2X protection could not have been used at the start of the work on 207A points as the work was not of an emergency nature; later it could not be used to correct the failure of the facing point lock test because that test affects the safety of trains.

T12 Protection of staff undertaking engineering work

G10 T12 protection is a method of protection that can be used for short engineering activities (a maximum of 30 minutes). It is intended to have the minimum impact on train services by utilising the gaps between scheduled train services. It does not need to be pre-planned but ‘must not endanger the safety of trains’ (section 2.1); as a consequence it cannot be used for a facing point lock test. The protection is obtained in a similar way to that for T2X protection; solely by maintaining signals at danger

G11 The Rule Book does not define ‘not endangering the safety of trains’, however, Network Rail interprets this as meaning that a continuous line of unobstructed rails (or track) must be present. A derailment will thus be precluded. At Oxford some staff believed that T12 protection should not be used for facing point lock tests, as these require the movement of the switch rails. The condition for a continuous line of rails thus cannot exist.

Obtaining T2 or T12 protection

G12 The process of taking a T2 or T12 possession for an engineering activity involves the completion of line blockage form (RT3181). The signaller and COSS both need to complete a copy; this is usually done co-operatively by telephone. On completion and when the line has been blocked the signaller will issue an authority number. This process takes several minutes to complete, often much longer if the signaller has to attend to other duties. At Oxford the process could often take over ten minutes due to the number of signalling activities required by the frequency of train movements. The completion time for the form can thus significantly reduce the time available for the engineering activity.

Rule Book modules T6 and T7

G13 The rules relating to the duties of the COSS and site lookout are contained in modules T6 'Walking as a group and walking on or near the line' and T7 Safe systems of work when walking or working on or near the line' of the Rule Book. The key provisions relevant to the type of work activities that were being undertaken at Kennington Junction on the 23 May are summarised in the following paragraphs.

Duties of all employees (including the lookout)

G14 Module T6, section 3.6 informs staff that they will be briefed by the COSS on the hazards applying at a work site. Section 3.6 also requires that staff sign the 'RT9909 COSS Arrangements and Briefing' form to confirm their understanding of the safe system of work (SSOW) that will apply.

G15 Module T6, section 5.1, informs staff that they will be briefed by the COSS on the method of warning to be given by the lookout. Section 5.2 lays down the following actions to be taken by staff when a warning is given by the lookout:

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

G16 Module T6, section 7, covers the responsibilities of the lookout. Section 7.6 lists the means by which a lookout should warn members in his group of the approach of a train, as shown in the following extract:

b) **Immediate Action**

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

c) **Giving warning by horn, whistle or shouting**

You must give a warning by:

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

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

G17 There is no mention in Module T6, section 7 of what to do if the lookout ceases to be able to see the members of group.

Duties of the COSS

G18 Module T7, section 1.1, covers the responsibility of the COSS to make appropriate arrangements associated with work on the line and the requirement for the COSS to ensure that everybody in the group is aware of the hazards that are present. Section 4.6 covers the specific briefing to be provided before work starts and the completion of the RIMINI form and its signature by all persons in the group.

G19 Module T7, section 3.1 establishes the responsibility of the COSS for setting up a safe system of work. When the system of work has been pre-planned the COSS must check that the planned arrangements are adequate for the task to be undertaken. If the system of work has not been pre-planned the COSS should select the best available from a list. This list is summarised in Table 1.

Priority	**Safe system of work**	
First	Safeguarded green zone	No trains moving along line under work or the adjacent line
Second	Fenced green zone	No trains moving along line under work. A fence is provided to separate the work site from lines still open to traffic.
Third	Separated green zone	No trains moving along line under work. A Site Warden is provided to give a warning if anyone strays outside the permitted work site toward a line still open to traffic.
Fourth	Red Zone with warning given by ATWS	ATWS is an automatic train warning system. Trains can move along the line under work.
Fifth	Red Zone with warning given by TOWS	TOWS is a train operated warning system. Trains can move along the line under work.
Sixth	Red Zone with warning given by LOWS	LOWS is a lookout operated warning system. Trains can move along the line under work.
Seventh	Activities to be undertaken in a red zone with warnings given directly by one or more lookouts	Warning is given by the lookout's horn or whistle. Trains can move along the line under work.

Table 1: Safe systems of work for track working (listed in order of priority)

G20 This hierarchy means that activities in the Red Zone with warnings given by one or more lookouts should only be undertaken when all other methods are not available. No facilities for using red zone working with ATWS or TOWS exist at Kennington Junction.

G21 Module T7, section 9.7b defines how lookouts may be used during darkness or poor visibility. They are not permitted unless additional methods are used to assist in the safety of the work site. These include the use of an automated warning system to warn of a train's approach, or restricting the speed of trains to 20 mph (32 km/h) or below, or working within a possession under specified arrangements.

G22 Module T7, Section 9.3 specifies that the COSS must provide adequate warning of trains in both directions and defines the process to be used for ensuring that sufficient warning is given. This requires that the COSS takes into account the following factors:

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

G23 Module T7, section 9.7, defines the ways in which lookouts should be positioned, their competency and equipment.

G24 Module T7, section 9.8, requires the COSS to brief the group on how warning of an approaching train will be given. In the absence of special warning systems the options outlined are:

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

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

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

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