RAIB
Rail Accident Investigation Branch

Rail Accident Report

Derailment of a freight train at Brentingby Junction, near Melton Mowbray 9 February 2006

Department for Transport

Report 01/2007
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This investigation was carried out in accordance with:

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

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Contents

Introduction

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

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

3 Network Rail and English Welsh & Scottish Railway (EWS) freely gave the RAIB access to their staff, data and records in connection with this investigation.

4 Appendices at the rear of this report include glossaries explaining the following:

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

Summary

Key facts about the accident

5 At 05:31 hrs on 9 February 2006, train 6Z41, the 05:17 hrs freight train, operated by EWS, from Mountsorrel, Leicestershire, to Barham, Suffolk, derailed at *trap points* at the end of the *Up Goods Loop* at Brentingby Junction, near Melton Mowbray.

6 The derailment of the class 66 locomotive and the first three wagons occurred after the train passed signal 53 at the end of the Up Goods Loop at danger.

7 No-one was injured as a result of the accident.

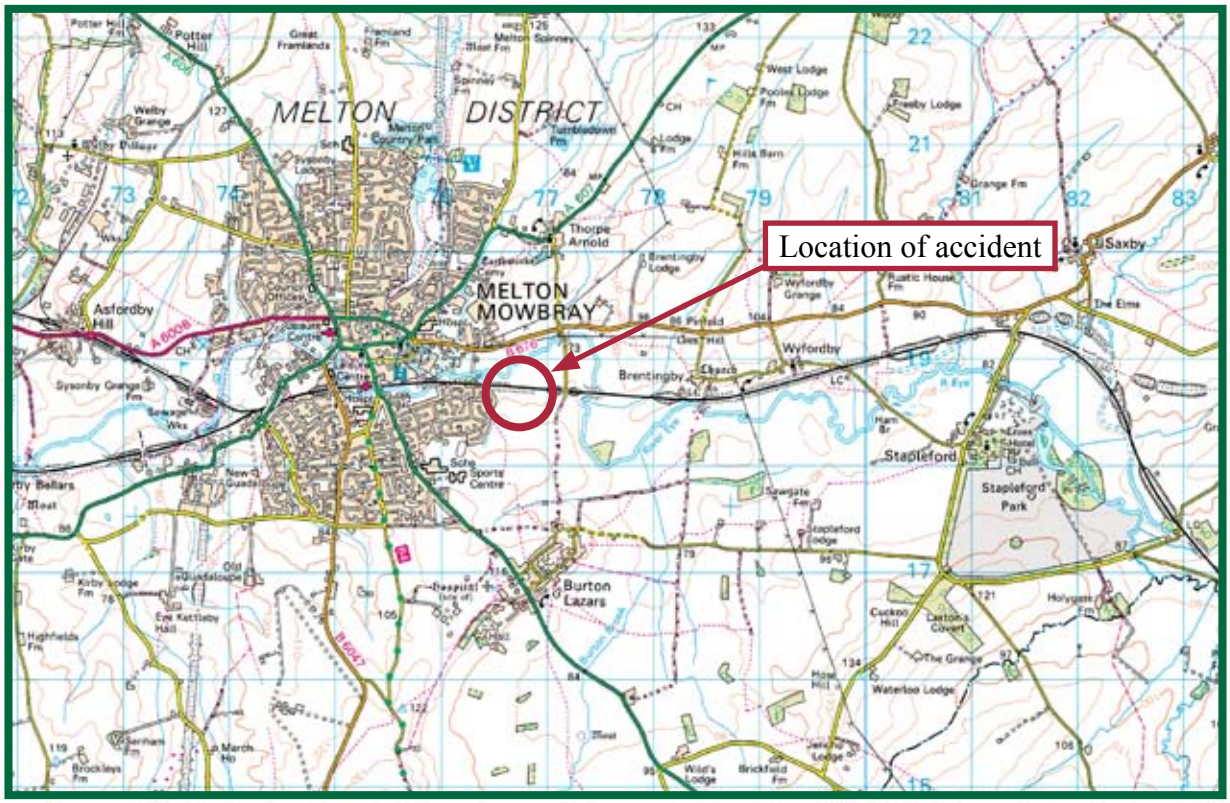

Figure 1:Extract from Ordnance Survey map showing location of accident

Immediate cause, contributory factors, underlying causes

8 The immediate cause was that the driver had a microsleep (explained in paragraph 140) approaching signal 53 at danger and was only woken up again after the train had derailed at the trap points beyond the signal.

9 Causal factors were:

- The driver was suffering from fatigue because he had not slept for about 22 hours. Also, the time of the day the accident happened coincides with the period when levels of alertness are naturally low.
- The use of trap points as an overrun mitigation measure beyond signal 53.

10 Contributory factors were the following:

- The shift roster pattern during the week of the accident (week commencing 5 February 2006) consisted of spare turns where the driver was required to work two early turns where the driver's sleep was likely to have been shortened, followed by a day where he was not required for duty followed by a night turn of duty where it would be difficult to get prior sleep.
- The main driving task was in the second half of the shift when the risk of fatigue was greatest.
- The rostering process did not specifically identify the risk of fatigue associated with a first night turn of duty or the timing of the main driving task within a shift.
- The driver arrived at work early at 23:40 hrs owing to the unavailability of public transport after this time. This eroded the duration of his rest period at a time when it would have been easier to sleep if he had attempted to do so. This effectively increased the duration of the shift increasing the risk of fatigue.
- Drivers could normally (in the absence of a random fitness for duty check) book on at Leicester Beal Street depot without any check as to their fitness for duty given the location is unsupervised.
- The driver did not obtain sufficient prior sleep to maximise alertness during the turn of duty during which the accident occurred.
- Briefing on coping with shiftworking had been given, but this did not give advice on how to cope with a first night turn of duty and had not been refreshed since 2003.

Severity of consequences

11 The derailment occurred at 11.2 mph (18 km/h), causing minor damage to the locomotive and third wagon that derailed and more significant damage to the first and second derailed wagons.

12 The trap points did not prevent the train being directed towards the adjacent *Up Main* line and although not obstructing it, the potential existed for a collision to occur with a passing train if the passage of and distance travelled by the derailed vehicles had been different.

13 There were no injuries caused as a result of the accident.

Key conclusions

14 The driver had a microsleep approaching signal 53 at danger at the end of the Up Goods Loop and was only woken up when the train derailed beyond the trap points 54.8 m ahead of the signal.

15 The RAIB's investigation found that there have been other incidents where driver fatigue was a principal causal factor and other incidents where trains derailing at trap points have resulted in the obstruction of an adjacent line open to traffic.

Recommendations

16 Recommendations can be found at paragraph 221. They relate to the following areas:

- implementing napping as part of a fatigue management system;
- providing the facilities for napping;
- research into sleeping before a first night shift;
- screening train drivers for sleep disorders as part of regular medical surveillance;
- providing improved guidance to drivers about how they can maximise alertness while at work;
- implementing a system that rebriefs the guidance at intervals;
- research into implementing a system of personal responsibility statements and/or sleep contracts;
- implementing improvements to the procedure to check drivers' fitness for duty concerning fatigue;
- improving the trap points beyond signal 53;
- repositioning the *signal post telephone* fitted to signal 53.

The Accident

Accident description

17 The accident was the derailment at Brentingby Junction, near Melton Mowbray, Leicestershire of the locomotive and first three wagons of train 6Z41, 05:17 hrs freight train from the Lafarge Redland Aggregates sidings at Mountsorrel to the freight terminal at Barham Suffolk on 9 February 2006. The route planned to be taken by the train as far as Peterborough is shown in Figure 2.

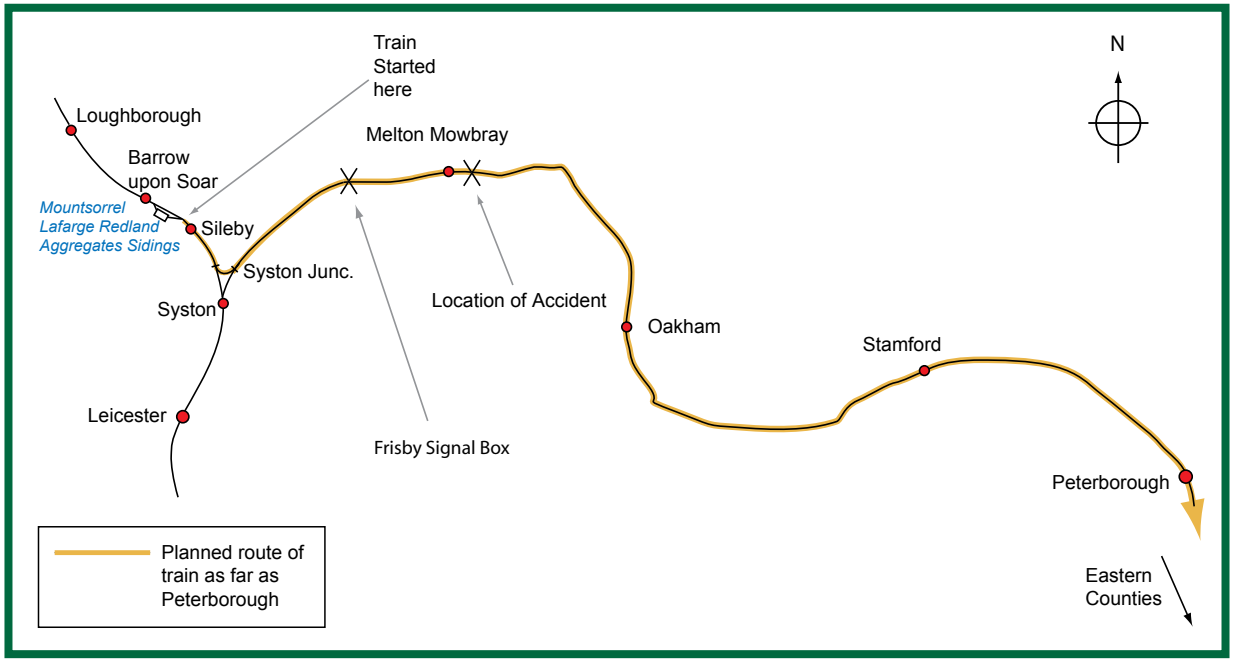

Figure 2: Planned route to be take by train 6Z41

18 The derailment occurred after the train had passed signal 53, at the end of the Up Goods Loop, at danger. The train derailed at trap points located 43 m beyond the signal that are provided to protect the main line by derailing an approaching train in the event of signal 53 being passed at danger.

19 The derailment occurred at a speed of 11.2 mph (18 km/h) after the driver had a microsleep while approaching signal 53 at danger.

20 When the accident occurred, it was dark, and the weather was cold and clear.

21 The accident occurred at 05:31 hrs, and the route was blocked to enable the investigation, recovery and repairs to take place. The Up Main line was subsequently reopened to traffic at 06:19 hrs on 10 February 2006.

The parties involved

22 The train was operated by EWS and the infrastructure is owned and operated by Network Rail.

Location

23 Brentingby Junction is located approximately two miles east of Melton Mowbray on the railway between Syston Junction and Peterborough (see Figure 2). The mileage is 104 miles 19 chains (as measured from London St Pancras).

24 The junction is where the Up Goods Loop rejoins the Up Main line and the *Down* Goods Loop starts from the Down Main Line.

25 The maximum permissible speed on the main lines is 90 mph (145 km/h) for passenger trains consisting of *diesel multiple units* and 75 mph (120 km/h) for other types of train. The maximum permissible speed on the Up Goods Loop is 15 mph (24 km/h).

26 The Up Goods Loop starts at mileage 105 miles 17 chains, just east of Melton Mowbray station and is on a rising 1 in 200 gradient towards signal 53, although the gradient levels off about 300 m before the signal.

27 Trap points designated 52A are located 43 m beyond signal 53. The points where the Up Goods Loop rejoins the Up Main line are designated 52B. These are shown diagrammatically on the extract from the signal box diagram shown in Figure 3.

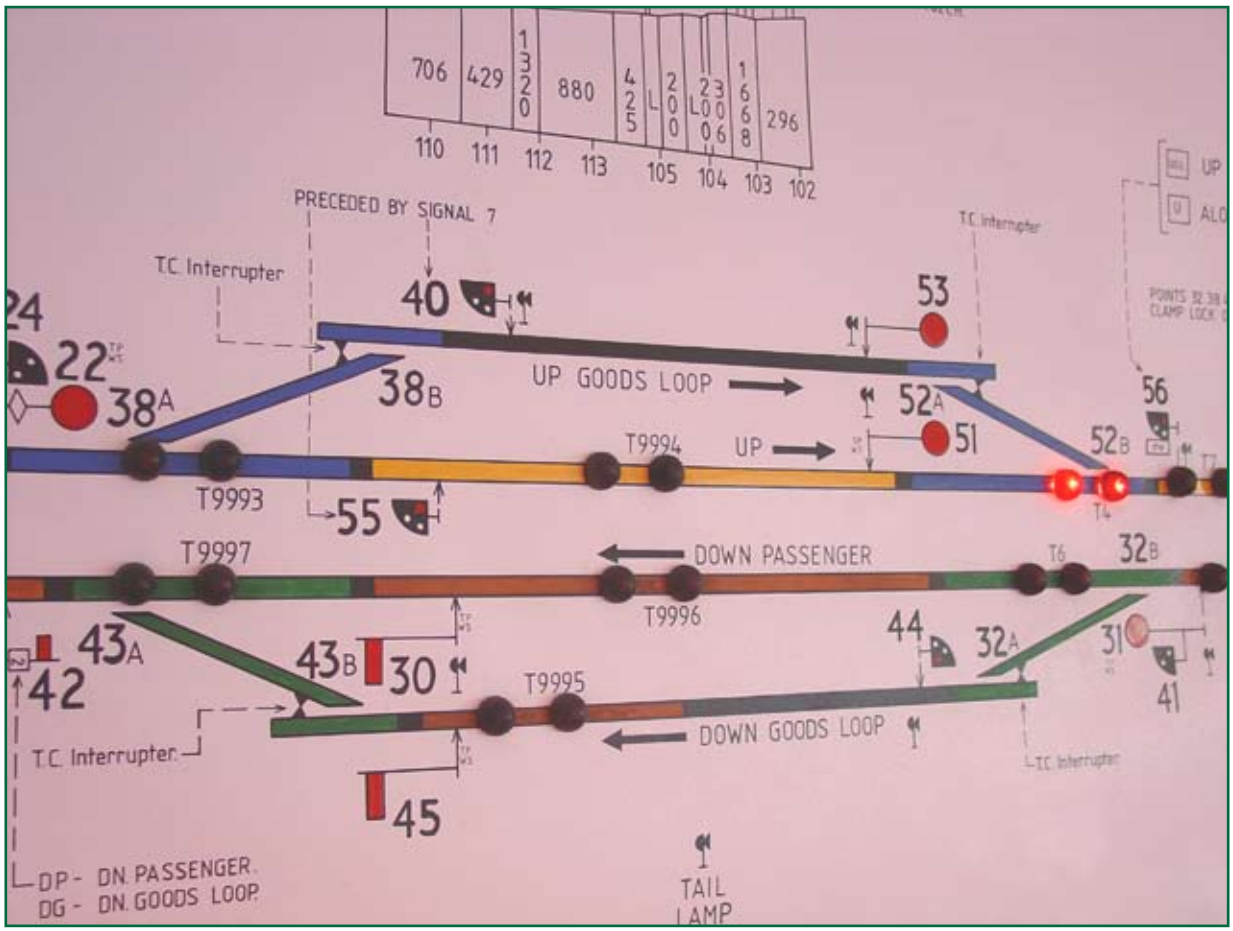

Figure 3: Extract of Melton Mowbray signal box diagram showing the Brentingby goods loops

The signalling

28 The signalling at Brentingby Junction is controlled by Melton Station signal box at Melton Mowbray located at 105 miles 27 chains. Signal 53 is a *two-aspect colour light signal*, and signal 51 (adjacent to signal 53) on the Up Main line is also a two-aspect colour light signal. The signals, which do not carry identification plates, and the trap points beyond signal 53 are shown in Figure 4.

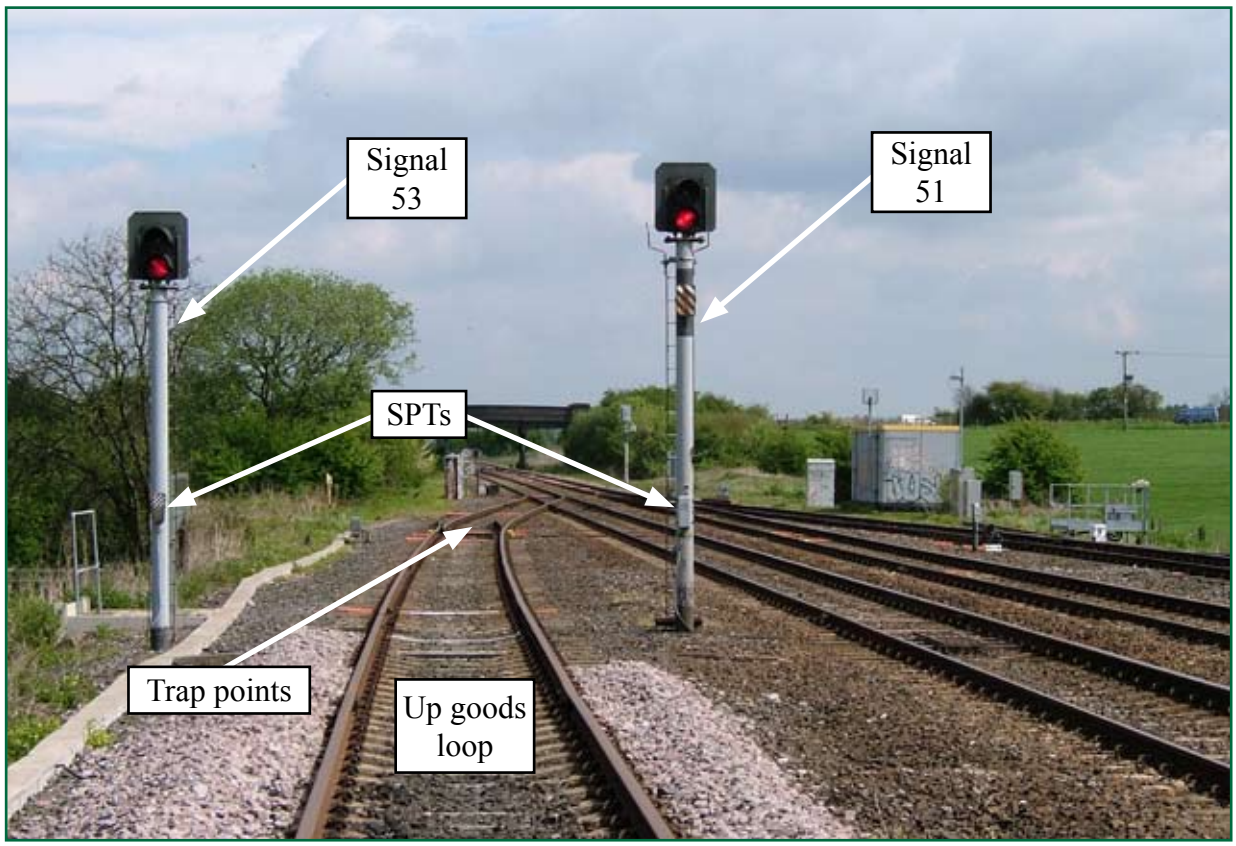

Figure 4: Signals 53 and 51 (by courtesy of Network Rail)

29 The method of signalling is *absolute block* with the block section east of Melton extending to Whissendine and the block section west of Melton extending to Frisby. The layout of the signalling at Melton Mowbray in the Up direction is shown in Figure 5.

30 In general, the lines through Melton Mowbray are *track circuited*, although the Up and Down Goods Loops are only track circuited at their ends where they join the respective Up and Down Main lines.

31 Entry into the Up Goods Loop is given by signal 24 which is a *position light signal* fitted to the side of the post that carries signal 22, a *three-aspect colour light signal* applying to movements along the Up Main line.

32 In the Up direction, and for trains entering the Up Goods Loop, *Automatic Warning System* (AWS) is only fitted to the *distant signal* (signal 19) and to signal 22. *Train Protection and Warning System* (TPWS) is fitted to signals that protect against other train movements such as signal 51. Neither AWS nor TPWS is fitted to signal 53, because the trap points provided are designed to mitigate the consequences of any incident in which signal 53 is passed at danger.

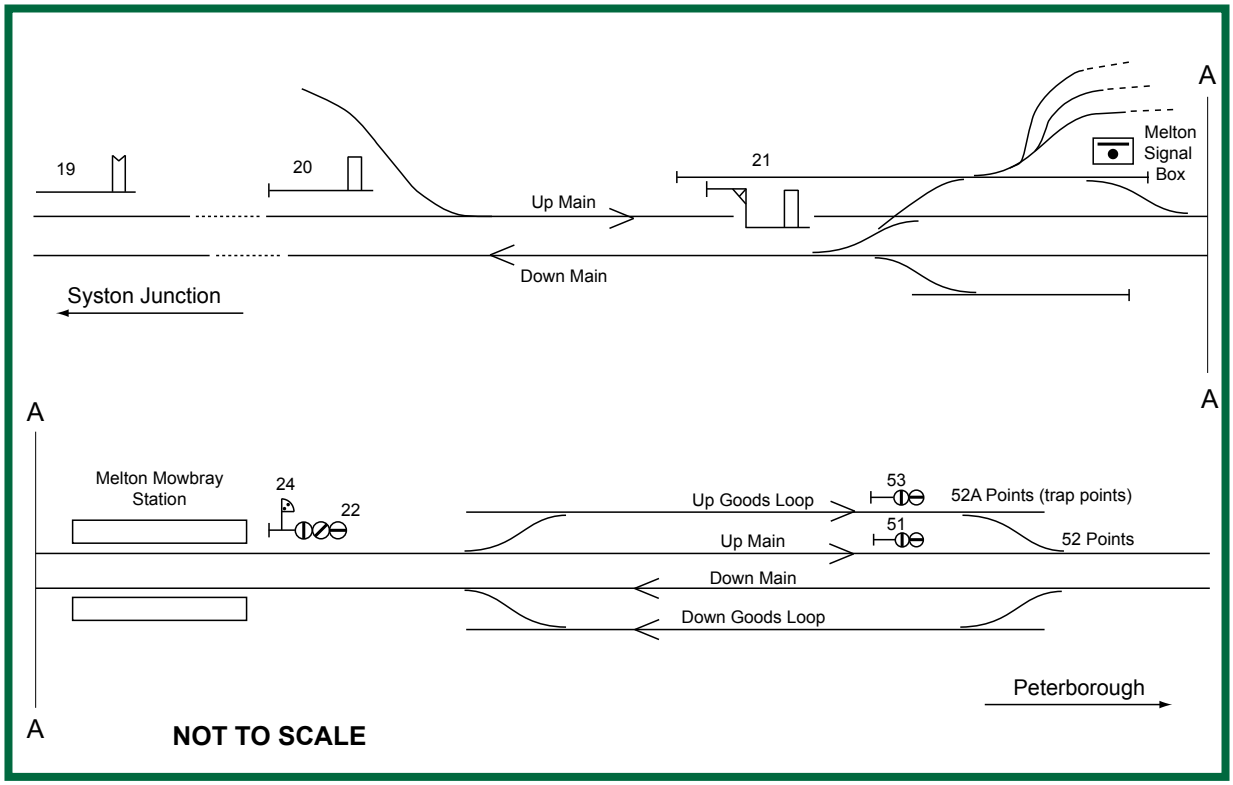

Figure 5: Location of relevant signals and points, Melton Mowbray

33 A *track circuit interrupter* is fitted to the trap points beyond signal 53 so that any train that passes signal 53 at danger and subsequently derails at the trap points will break the track circuit interrupter and cause signals 51 and 22 if they have been cleared to go back to danger.

34 Both signal 51 and signal 53 are fitted with SPTs mounted on their respective posts. These are shown in Figure 4.

The train

35 The train that derailed consisted of 26 four-wheeled hopper wagons carrying stone loaded at the terminal at Mountsorrel. The wagons were hauled by a General Motors class 66 locomotive, number 66017.

36 The total weight of the train including the locomotive was 1435.7 tonnes. The trailing weight of the train was 1309 tonnes.

The driver of train 6Z41

37 The driver of train 6Z41 (subsequently referred to as 'the driver') was 58 years of age when the accident occurred. He first joined the railway industry as a guard on 2 January 1974 and subsequently became a driver on 16 April 1990. He had always been based at the Leicester Beal Street depot.

38 EWS operates a competence management system in accordance with Railway Group standard GO/RT3251 which requires a periodic reassessment of a driver's competence over a rolling two year period. The driver was recertified as competent in rules and regulations, class 66 locomotives and the route between Syston Junction and Peterborough on 9 January 2006. The driver had last driven a train over the route from Mountsorrel to Peterborough on 24 January 2006, but no record was kept of the last time he had driven a train along the Up Goods Loop between Melton Mowbray and Brentingby Junction.

39 As part of the competence management system, EWS carried out practical assessments of the driver during the two year period preceding the accident that covered different elements of the train driving task such as preparing a locomotive for service and train handling. The date of the last assessed ride was 19 October 2005 when the driver drove a train from Acton Yard in West London to Mountsorrel. Assessments during the two year period were carried out using a mix of personal observation and examination of On Train Monitoring Recorder (OTMR) downloads.

40 In accordance with GO/RT3251, EWS also operates an Employee Performance Profile procedure used where there are reasonable grounds to suppose a driver has caused or contributed to an incident. The procedure includes the drawing up of an action plan to address any identified competence weaknesses. The driver had been involved in three *safety of the line incidents* during the previous three years and had been assigned to a category that required additional competence assessments to be carried out.

41 The driver was last assessed against the medical fitness standards specified in GO/RT3251 on 19 September 2005 with the result that he was declared fit for normal duties. He had been examined more frequently, about every six months, than the two yearly intervals specified by GO/RT3251 because of medical conditions that were not relevant to the accident.

42 During the week commencing Sunday 5 February 2006, the driver was rostered free of duty on the Sunday and then spare as required from Monday to Friday inclusive. Drivers are required to attend work when spare at a time that is within a period a maximum of four hours sooner or later than a time known as the 'datum time' (see paragraph 103), unless they are informed they are not required.

43 The driver was subsequently advised that he was required to work the driving turns shown in Figure 6 during week commencing Sunday 5 February 2006. The driver's roster for the previous week is also shown in Figure 7.

Date	Time on duty	Time off duty	Total time	Fatigue Index
05-02-2006	Free of duty	Free of duty	0:00	5.0
06-02-2006	05:07 hrs	16:14 hrs	11:07 hrs	26.5
07-02-2006	05:07 hrs	16:14 hrs	11:07 hrs	29.5
08-02-2006	spare	spare	0:00	4.0
09-02-2006 *	01:05 hrs	08:52 hrs	07:47 hrs	22.1

* the day of the accident

Figure 6: Turns of duty for the driver week commencing 5 February 2006 (see paragraphs 154 to 159 for and an explanation of the fatigue index)

Date	Time on duty	Time off duty	Total time	Fatigue Index
29-01-2006	Free of duty	Free of duty	0:00	2.0
30-01-2006	22:35 hrs	02:51 hrs	04:16 hrs	14.5
31-01-2006	22:35 hrs	04:00 hrs	05:25 hrs	21.5
01-02-2006	21:18 hrs	03:35 hrs	06:12 hrs	26.7
02-02-2006	23:59 hrs	09:30 hrs	09:31 hrs	33.0
03-02-2006	21:30 hrs	07:30 hrs	10:00 hrs	39.0
04-02-2006	Free of duty	Free of duty	0:00	9.0

Figure 7: Turns of duty for the driver week commencing 29 January 2006, the week preceding the accident (see paragraphs 154 to 159 for an explanation of the fatigue index)

44 The two turns of duty on Monday 6 February 2006 and Tuesday 7 February 2006 required the driver to travel by the 05:25 hrs passenger train from Leicester to London, travel to Bow Junction in East London and then, following a break of 45 minutes, drive train 6M47 (an empty stone train) back to the terminal at Croft, between Leicester and Nuneaton. Following arrival at Croft, the driver was required to drive the locomotive back to the depot at Leicester Beal Street.

45 The driver had not been required for duty throughout the 8 February 2006 and had spent the time relaxing at home after getting up between 07:30 hrs and 08:00 hrs following a night's sleep.

46 On the previous evening of Tuesday 7 February 2006, the driver drank five or six pints of beer. This would very likely have eroded the quality of the sleep that he had that night. The driver's sleep during the previous two nights was also likely to have been shortened due to the early turns starting at 05:07 hrs on 6 and 7 February 2006. Therefore, the quality and duration of sleep obtained from the three nights prior to the accident is likely to have contributed to the fatigue during the turn of duty in which the accident occurred.

Events preceding the accident

47 The driver for train 6Z41 arrived for work at the EWS depot at Leicester Beal Street at 23:40 hrs on 8 February 2006, although his turn of duty was not actually due to start until 01:05 hrs on 9 February 2006. The driver arrived early because he did not have a car and caught the last bus of the day to get to work. The driver spent the time between 23:40 hrs and the start of his turn of duty watching television in the mess room.

48 The mess facilities at Leicester Beal Street consisted of a room containing tables and dining type chairs, several easy chairs and a television. There was also a separate kitchen, but there was no separate quiet room where drivers could take a nap if necessary.

49 The first part of the driver's shift was to have been shunting work at Leicester Humberstone Road sidings, just north of Leicester station, but this was cancelled. This would have entailed driving a locomotive at 01:30 hrs from Beal Street depot to Humberstone Road sidings, attaching it to a train and then working that train back to Leicester station followed by detaching the locomotive and returning it to Beal Street depot at 02:25 hrs. The driver was then due to take a 20 minutes break prior to travelling by taxi at 03:02 hrs to Mountsorrel.

50 Owing to the cancellation of the work at Humberstone Road sidings, the driver had time to assist another EWS employee by accompanying him by road to Syston, a few miles north of Leicester, to attend to a train failure. The driver's task was to give the other employee directions about how to get to the location of the failed train. Then, following return to Leicester at about 02:45 hrs, the driver worked a train that had come from Northampton forward to its destination at Mountsorrel leaving Leicester at about 03:00 hrs and arriving at Mountsorrel at about 03:20 hrs. This train was hauled by 66017, the locomotive that was subsequently to work train 6Z41.

51 Locomotive 66017 was refuelled at Mountsorrel, and a fitter had to give remedial attention to the OTMR.

52 Train 6Z41 departed from the sidings at Mountsorrel at 04:55 hrs, before its booked departure time of 05:17 hrs. In doing so, it ran ahead of passenger train 1L01, the 04:56 hrs from Nottingham to Norwich which was due to stop at Melton Mowbray at 05:31 hrs. So that the passenger train could overtake train 6Z41, the signaller at Melton Mowbray was instructed by the control office at Leicester to route train 6Z41 into the Up Goods Loop. Train 1L01 could then pass train 6Z41 on the Up Main line.

53 The signaller at Frisby (see Figure 2) *offered* train 6Z41 to the signaller at Melton Mowbray at 05:15 hrs and he *accepted* it. The Melton Mowbray signaller received *train entering section* from Frisby at 05:18 hrs and gave *train out of section* to Frisby at 05:26 hrs when he had seen train 6Z41 pass the signal box complete with *tail lamp*. As the train was to go into the Up Goods Loop, the Melton Mowbray signaller did not offer the train forward to the signaller at Whissendine.

54 In order to signal a train into the Up Goods Loop, the standard procedure to ensure that the speed of an approaching train is reduced is to leave all signals initially at danger (caution in the case of the distant signal (signal 19)), except for the first *home signal* (signal 20). Once a train has passed this signal and is approaching the following home signal (signal 21) at danger, signal 21 is cleared to allow the train to run at low speed towards signal 22. As the train *times out* on the track circuit before signal 22, signal 24 clears allowing the train to enter the Up Goods Loop. The signaller adopted this procedure for train 6Z41.

55 As soon as train 6Z41 had moved clear of the points giving entry to the Up Goods Loop, the Melton signaller cleared his Up Main line signals (22 and 51) for the passenger train 1L01 that was at the time approaching Melton Mowbray station for its booked stop.

56 The driver of train 6Z41 knew that having left Mountsorrel early, his train would very likely be in front of train 1L01 and that he would probably be routed into the Up Goods Loop. He noticed that signal 51 on the Up Main line had been cleared to green and that his own signal 53 at the end of the Up Goods Loop was at red.

57 EWS operates a *professional driving policy* (PDP) as part of a signal passed at danger (SPAD) reduction and mitigation policy. This requires drivers to drive at no more than 10 mph (16 km/h) at a point 180 m from a signal at danger and to stop a locomotive length (20 m) before it.

58 The driver controlled his speed within the permissible speed limit while passing along the Up Goods Loop and prepared to stop at signal 53. Contrary to the PDP, he was intending to draw right up to the signal in order to get as close to the SPT fitted to the signal post as possible. This required an application of power to the number three position at a point 141 m from signal 53 in order to prevent the train stopping short of the signal.

59 The power controller remained in the number three position as the train passed signal 53 and until the derailment occurred.

Events during the accident

60 Sometime after the application of power as described in paragraph 59, the driver fell asleep. The driver thought this to be half the locomotive length (approximately 10 m) to the locomotive length (approximately 20 m), away from signal 53. The OTMR showed that speed continued to rise to 9.5 mph (15 km/h) as the train passed signal 53 at danger, and derailed beyond the trap points (54.8 m ahead of the signal). The derailment of the locomotive woke up the driver.

61 The train came to rest with the front of the derailed locomotive close to but not obstructing the Up Main line. The driver climbed out of the driving cab, put *track circuit clips* on the Up Main line and contacted the Melton Mowbray signaller using the SPT fitted to signal 51. Figure 8 shows the aftermath of the accident.

Figure 8: Derailment of train 6Z41, Brentingby Junction

Consequences of the accident

62 No one was injured as a result of the derailment.

63 The damage caused to locomotive 66017 was superficial and included a damaged buffer, damaged *traction motor covers,* slight bruising to the underside of three traction motors and sheared bolts to a *rail guard*.

64 The damage to the first two wagons that derailed was the most extensive, while the third wagon that derailed was damaged least. Damage to the first two wagons variously consisted of damaged buffers, brakegear, couplings, pipework, hoses and brake end cocks; as well as damage to the *underframes* of each vehicle.

65 Track damage required the replacement of 13 concrete sleepers and the replacement of two 60 foot rails in the Up Goods Loop and one 30 foot rail in the Up Main line.

66 Damage to signalling equipment required the renewal of two single core cables and the renewal of the track circuit interrupter fitted to the Up Goods Loop exit trap points.

Events following the accident

67 While the passenger train 1L01 was still at Melton Mowbray station, the signaller noticed that signal 22 had reverted to red and track circuit T4 covering the Up Goods Loop exit points beyond signal 53 was illuminated and therefore showing occupied on the signal box diagram (see Figure 3).

68 Thinking that a SPAD incident had occurred, or that there might have been a track circuit failure, the signaller attempted to contact the driver of train 6Z41 using the *National Radio Network*. While doing so, the signaller was contacted by the driver of train 6Z41 from the SPT at signal 51. This occurred at 05:33 hrs. The driver reported that he had passed signal 53 at danger and derailed the locomotive and first three wagons at the trap points.

69 On learning from the driver what had occurred, the signaller ensured that all signals under his control were maintained at danger so that no trains could approach the site of the derailment and notified the railway control office of the circumstances.

70 Although the main line was not obstructed, Network Rail decided to close the route until recovery of the site was completed. The main lines were reopened at 06:19 hrs on 10 February 2006. The Up Goods Loop was not restored to use until 16:08 hrs on 11 February 2006 due to the repairs required.

The Investigation

Investigation process

71 The RAIB's investigation included examination of the site, interview of key personnel, examination of relevant documentation and interpretation of the OTMR from the locomotive.

Key evidence

Site evidence

72 Measurements were taken on site of the subsequent path taken by train 6Z41 after it had passed signal 53. The results of these were:

- distance from signal 53 to the *switch toes* of the trap points (52A): 43 m;
- length of *switch blades*: 11.8 m;
- distance travelled by the locomotive beyond the trap point switch blades: 37 m;
- the train therefore travelled 91.8 m beyond signal 53 before it came to rest;
- distance from signal 53 to the switch toes of 52B points: 112 m.

73 The critical measurements in paragraph 73 above are shown in Figure 9.

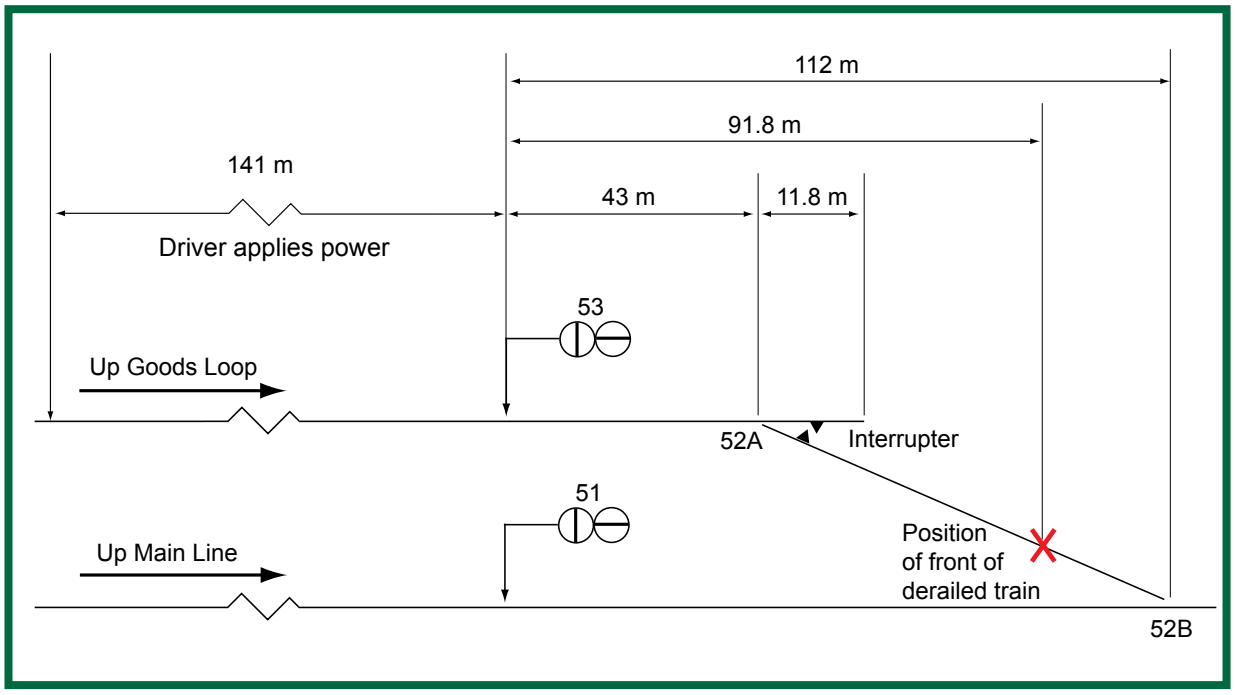

Figure 9: Critical measurements - Brentingby Junction

74 Whilst the derailed locomotive infringed the normal *passing clearance* between two trains, it would not have been struck by a passing train.

75 The alignment of the light beam of signal 53 was checked on site and found to be acceptable.

Locomotive on-train monitoring recorder

76 The OTMR from locomotive 66017 was downloaded by EWS and made available to the RAIB for analysis. This is described in paragraphs 128 to 133 of this report.

Locomotive cab environment

77 Due to the orientation of the locomotive on site, it was unsafe for the RAIB inspectors to enter the locomotive cab (designated the no. 1 cab of the two driving cabs), although it was possible to see the position of the principal controls from outside the locomotive. Following re-railing, the cab was more thoroughly examined by EWS and the findings passed to the RAIB.

78 Of the principal controls, the power controller was in the number one position, but not fully engaged (it is thought that this may have been knocked by the driver as he left the driver's seat after the derailment); the train brake control handle was in the normal centred position (the normal running position, but also the position the handle returns to following a brake application), and the direct (locomotive) air brake was in the normal running (off) position.

79 The cab heater control was in the number one heat position – this being the first, and lowest, of three cab heater positions.

80 The cab was in a clean and tidy condition.

Driver vigilance device

81 Class 66 locomotives are fitted with a driver vigilance device (DVD) that monitors the driver's interaction with the cab controls. Should the driver not operate any of the principle cab controls within a 55 - 65 second period, the system sounds an audible warning which the driver must cancel by releasing a foot treadle and then depressing it. If the driver does not cancel the warning, an automatic emergency brake application is made five to seven seconds later.

82 Following the accident, EWS tested the DVD and found that the system worked satisfactorily.

83 The audible warning produced by the DVD is not recorded on the OTMR unless it leads to an automatic emergency brake application, which did not happen in this case.

Signalling infrastructure

84 There was no record of any previous instance of signal 53 having been passed at danger and no record of the signal ever having been examined by a *signal sighting committee*. It is unlikely therefore that sighting of the signal had ever been raised as a concern by drivers.

85 The alignment of signal 53 and the adjacent signal 51, on the Up Main line, was last checked as part of the regular maintenance programme on 24 November 2005 (RT/SMS/SG00) and recorded as satisfactory. The correct alignment of signals when placed adjacent to one another is important to minimise the possible risk of a driver responding to the wrong signal.

86 The RAIB viewed both signal 51 and signal 53 from the driving cab of a class 66 that followed the same path into the Up Goods Loop as train 6Z41, with the signals being cleared in the same sequence. The purpose was to assess whether the driver of train 6Z41 may have misread signal 51 as applying to his train. The run was done during daylight rather than darkness when the accident occurred, but this was considered to be valid so far as the reading of signals 53 and 51 was concerned. The results are discussed in paragraphs 186 to 189.

87 Signal 53 was risk assessed by Network Rail after the accident, on 14 February 2006, using the signal assessment tool described in their procedure RT/E/P/14201 and was reviewed by the RAIB. Based on the level of usage of the loop, the low speeds involved and the existence of *trapping protection* beyond signal 53, the results gave rise to a very low score of one. This result – well below the benchmark figure of 150 that requires more detailed assessment - required no further consideration by Network Rail of additional measures to mitigate the consequences of a SPAD incident at signal 53.

88 Following the accident (and using a procedure adopted for all SPAD incidents), Network Rail carried out a procedure to risk rank the SPAD at signal 53. This process gave a measure of the level of risk associated with the SPAD and considered factors such as the distance beyond the signal passed at danger to a point where a head on, converging or crossing collision could occur; the probability of an actual collision occurring and the likely severity of the consequences if a collision did occur. The risk ranking provides a score between zero and 28 with those of 20 and above being classified as potentially severe. Network Rail calculated the risk ranking of the SPAD at 53 prior to the derailment as 20.

89 AWS had only been partially fitted to the signals controlled by Melton Station signal box, and as remarked earlier in paragraph 33 AWS had not been fitted to signal 53. This is because signal 53 is on a line that may only be used by freight trains and where movements on to a passenger line (the Up Main Line in this case) are protected by trap points. This is in accordance with Railway Group standard GE/RT8035.

90 TPWS had been fitted to all signals controlled by Melton Station signal box that were required to be fitted by legislation (the Railway Safety Regulations 1999). In respect of train 6Z41's journey, signals 20 and 21, 22/24 had been fitted with TPWS, but signal 53 was not required to be so fitted, because movements beyond it were protected by trap points in the event of a SPAD incident.

91 Signal 53 had no *overlap,* although there was effectively a safe overrun distance of 54.8 m between the signal and the end of the trap points beyond which derailment would occur. Overlaps are generally provided at colour light signals on passenger lines that can be approached at danger to mitigate driver misjudgement of the brake on the final approach to a signal at danger. Overlaps are normally 180 m long, although shorter ones are permitted on lower speed lines and based on a process of risk assessment (described in Railway Group standard GK/RT0064).

<u>The driver</u>

92 Following the accident, the driver was tested for drugs and alcohol under standard procedures (Railway Group standard GE/RT8070). The results were negative.

93 The driver was also examined by EWS's occupational health service. This identified no medical issues making it more likely the driver would fall asleep. However, given the driver's build and his age, an assessment of whether the driver was likely to suffer from a sleep disorder was carried out. This provided no evidence that the driver did suffer from a sleep disorder, but EWS decided to investigate this further by referring the driver to a sleep clinic. However, this did not take place, because the driver resigned his employment before his appointment date.

94 There was no evidence from the records available that the driver had used his company issued mobile telephone while driving along the Up Goods Loop towards signal 53. He did not possess a personal mobile telephone.

Rostering procedures

95 The rostering of drivers is to the 'Best Practice Guide' that EWS has agreed with the drivers' trade union ASLEF and starts with the *diagrams* that are required to be covered. The diagrams are put into a *link system* using a computer system (Crewplan) which generates rosters that are in accordance with the 'Best Practice Guide'. This requires that rosters incorporate shifts that are forward rotating (mornings/afternoons/nights) and constructed to incorporate a set number of *rest days* and annual leave days per year.

96 Since 1 April 2006, rosters have been constructed based on 133 rest days and 33 annual leave days per year. Prior to this date, the number of rest days was based on the average turn length of the turns of duty in the particular link concerned. For the driver of train 6Z41, this amounted to 141 or 142 rest days per year.

97 The rostering process also has to take into account the limits on working time set by the British Railways Board in response to the report on the investigation of the accident at Clapham Junction on 12 December 1988 that was inquired into by Sir Anthony Hidden QC (often referred to as the 'Hidden Limits'), and also the Working Time Regulations 1998.

98 The Hidden Limits are:

- No more than 12 hours to be worked per turn of duty.
- No more than 72 hours to be worked per calendar week (Sunday to Saturday).
- A minimum rest period of 12 hours between booking off from a turn of duty to booking on for the next turn. This may be reduced to 8 hours at the weekly shift changeover, in the case of staff working a shift pattern which rotates or alternates on a weekly basis.
- No more than 13 turns of duty to be worked in any 14 day period.

99 The Working Time Regulations 1998 subsequently amended with effect from 1 August 2003 to include workers in the transport sector incorporate the following basic requirements:

- A limit of an average of 48 hours a week which a worker can be required to work (though workers can choose to work more if they want to).
- A limit of an average of 8 hours work in 24 which nightworkers can be required to work.
- A right for night workers to receive free health assessments.
- A right to at least 11 hours rest a day.
- A right to at least a day off each week.
- A right to an in-work rest break of 20 minutes duration if the working day is longer than six hours, subject to any workforce agreement.
- A right to at least four weeks paid leave per year.

100 The right to breaks is modified if the worker works in rail transport and he spends time working on board trains. In these circumstances, if a break cannot be taken, the worker is entitled to a period of rest the same length as the duration of the break that has been missed.

101 The proposed rosters are also run through the Fatigue Index (FI) (discussed further in paragraphs 154 to 159) and then agreed with the trade unions. This is known as the base roster.

102 The base roster times can be varied on a weekly basis to take account of changing traffic demands. The weekly roster incorporating any changes to the base roster times is posted at depots for the week ahead on the Friday of the week before. The FI is not applied to these changes.

103 There are s*pare turns* included in the base roster to cover annual leave, sickness and any additional work that may occur. Drivers can be rostered to start work while spare a maximum of four hours either side of the start time on the base roster known as the datum time. Drivers are generally advised of their requirement to work a spare turn on the weekly roster which is published on the Friday of the preceding week. In addition, drivers can also be given notice to attend work at 12 to 16 hours notice (a time window to avoid drivers being notified when they are likely to be asleep) in accordance with the datum time. This can be notified either by posted daily roster or by text message to their EWS-issued mobile phone.

104 For the roster covering the week commencing 5 February 2006 (see Figure 6), the datum time mentioned in paragraph 103 above was reset for Thursday 9 February 2006, because the driver was not required to work the spare turn on Wednesday 8 February 2006.

105 For the week commencing 5 February 2006, the daily rosters confirming the working turns for the driver of train 6Z41 were posted at Leicester Beal Street depot on Friday 3 February 2006 for Monday and Tuesday 6 and 7 February 2006, on Monday 6 February 2006 for Wednesday 8 February 2006 and Tuesday 7 February 2006 for Thursday 9 February 2006. The driver therefore knew on Tuesday 7 February 2006, that he was not required for a working turn the following day and that his next turn of duty was at 01:05 hrs on Thursday 9 February 2006.

Booking on procedures

106 As mentioned in paragraph 47, the driver arrived at work at 23:40 hrs, although his turn of duty was not due to start until 01:05 hrs. Leicester Beal Street depot is an unsupervised depot with drivers being required to book on duty remotely by telephone to the supervisor at the depot at Immingham. The driver subsequently booked on duty just before his turn of duty was due to start.

107 The risks arising from remote booking on from unsupervised depots have been assessed by EWS and include procedures to check fitness for duty. Each employee was required to be subject to six fitness for duty checks per year of which two were to be out of normal office hours and planned on a random basis. EWS staff carrying out fitness for duty checks have been given guidance on how to judge a person's fitness for duty.

108 The fitness for duty checks consisted of:

- checking that the person met an acceptable standard, conduct and appearance;
- checking that the person complied with the EWS policy on drink and drugs;
- checking with that the person that they have had at least 12 hours rest since their previous turn of duty.

109 The first of the checks in paragraph 108 consisted of an assessment of appearance (eg how the person was dressed, whether unshaven, unkempt hair etc.), demeanour (compared with normal behaviour), physical (whether unsteady, smelling of alcohol, glazed eyes etc.) and preparedness (whether there was a correct understanding of the tasks to be performed and whether in possession of the correct equipment).

110 The EWS policy on drink and drugs includes a screening programme prior to employment and on an unannounced basis for staff who do safety critical work. The screening programme also operates following all incidents involving safety critical work where there are reasonable grounds to suspect the effects of alcohol or drugs might have been a contributory factor. The policy also includes the disciplinary actions required where offences are committed under the policy.

111 The last fitness for duty check carried out on the driver was at 09:00 hrs on 3 February 2006. The last out of normal office hours check had been at 05:10 hrs on 16 August 2005. There were no issues arising from these checks.

112 Since the accident at Brentingby Junction on 9 February 2006, EWS has enhanced its fitness for duty checks to coincide with the introduction of new booking on procedures for all drivers by mobile phone text message.

Refusal to work policy

113 EWS operates a 'refusal to work on grounds of safety' policy defined in its safety manual that allows any of its employees who feel that in undertaking a task it would clearly expose them or others to a significant risk of injury to decline to carry out that task. An employee could use the policy if they booked on duty and then subsequently felt too tired to continue to work safely.

114 If an employee puts the policy into effect, the situation is attempted to be resolved by firstly the employee's person in charge. Should this not be successful, the matter is referred to the on call manager and then the employee's health and safety representative. If this is still unsuccessful in resolving the matter, advice and guidance must be sought from the head of safety assurance and risk management organisation.

115 The refusal to work policy is put into effect by employees in EWS three or four times per month (there are approximately 5000 employees in EWS).

Previous occurrences of a similar character – fatigue as a causal factor

116 The railway industry records details of incidents occurring on the main line railway network in the *Safety Management Information System* (SMIS). The SMIS database can be searched to identify SPAD incidents caused by particular causal factors such as fatigue. A search on the database for the period 1 January 2001 to and including the date of the accident at Brentingby Junction on 9 February 2006 revealed 68 SPAD incidents where fatigue was cited as one of the causal factors.

117 The Confidential Incident Reporting & Analysis System (CIRAS) has been set up as a charitable trust and is a way for railway staff to report safety concerns on a confidential basis in situations where they would feel inhibited from doing so through normal company channels.

118 CIRAS conducted research on precursors to SPADs based on over 600 reports to CIRAS made between June 2000 and September 2005. For the freight train operators (110 reports), the research identified that fatigue was the most commonly identified precursor (28 per cent of the reports), although fatigue was also identified as a precursor of SPAD incidents involving passenger train operators.

119 The CIRAS research identified that underlying fatigue amongst freight train drivers was a concern about rostering and in particular poor shift design, long shifts and inadequate rest periods. It concluded that compliance with working time directives and the Hidden Limits would not in itself guarantee that drivers would not suffer from fatigue.

120 Only the day before the accident at Brentingby, on 8 February 2006, signal W275 at East Somerset Junction, near Frome, was passed at Danger by nearly 400 m by EWS train 7A09 when the driver of that train had a microsleep as he approached the signal at 06:49 hrs. The RAIB reviewed the download from the OTMR and obtained a copy of the Network Rail investigation report. The report stated that signal W275 is located at the bottom of a falling gradient of 1 in 65 (1.54 per cent), and the driver of train 7A09 was woken by the warning from the AWS for the signal by which time speed had reached 35 mph (56 km/h). The report further stated that the driver of train 7A09 immediately applied the brake but was going too fast to stop before the signal and that he also had three microsleeps as he approached the previous signal at single yellow (W273) and was also woken by the AWS at that signal.

121 The Network Rail investigation report further stated that on the day of the incident at East Somerset Junction, the driver of train 7A09 had booked on for a turn of duty starting at 01:00 hrs and was scheduled to be a standby driver until 05:00 hrs, following which he was to work train 7A09. His previous turn of duty the day before had started at 00:55 hrs and finished at 11:20 hrs. On returning home, the driver had watched television, done domestic chores and attended to his young family. The driver did not go to bed until 22:30 hrs. The report concluded that the driver of train 7A09 was heavily fatigued resulting in a number of microsleeps on the approach to signals W273 and W275 caused by the driver having insufficient sleep before his turn of duty. A warm cab environment was also identified as a factor that could increase sleepiness.

122 The Network Rail report made recommendations on EWS that included giving the driver of train 7A09 a lifestyle briefing and to consider producing an article in the company's 'Traction Digest' magazine to remind drivers of the need to get sufficient rest before starting work and to remind them of the existence of the refusal to work policy if they considered themselves to be unfit.

123 The RAIB also obtained a copy of the formal inquiry report issued by the Rail Safety and Standards Board (RSSB) into the collision between two freight trains operated by Freightliner Ltd at about 03:12 hrs on 16 October 2003 at Norton Bridge. The collision occurred after a Freightliner Ltd train stopped at a signal at danger (NB16) and the driver of a following Freightliner Ltd train failed to react to cautionary signals and to stop at the signal protecting the train in front (NB149) at danger and ran into the back of the train ahead.

124 The RSSB investigation of the Norton Bridge accident was unable to definitely identify the underlying causes but considered that fatigue that had accumulated due to long working hours (including overtime) in the days leading to the accident and insufficient rest periods between shifts may have been a factor. High values of the Fatigue Index supported this view. The accident also happened at a time of day when alertness levels are naturally low.

125 Of the 68 incidents in paragraph 116, fatigue is only one of a range of other possible causal factors and may not have been the immediate cause of the incident concerned. Seventeen incidents were identified where fatigue was the primary cause of the SPAD incident, and the RAIB obtained and reviewed copies of the Network Rail formal investigation reports for these incidents (including the incident covered in paragraphs 120 to 122). In these 17 incidents, the level of fatigue was such that either the drivers concerned actually did microsleep or there was a high probability that they did. Only one of the 17 incidents led to a derailment and none to collision. The 17 incidents are listed in Appendix C. Not all of the reports relate to operators of freight trains or with the incidents occurring during the night.

Previous occurrences of a similar character – derailments on trap points

126 Although the derailed vehicles at Brentingby Junction would not have been struck by a train passing on the adjacent line, the potential existed for a collision to occur. The derailed vehicles stopped almost obstructing the Up Main line; had they done so and had the passenger train 1L01 been closer to the accident site at the time the accident happened, a collision could very easily have occurred.

127 The RAIB reviewed the following Network Rail investigation reports where trains had derailed on trap points and had then either obstructed adjacent running lines or come very close to doing so:

- A derailment occurred at trap points protecting Mansfield Junction, Nottingham, on 9 October 2000, when a train on the Down Goods line passed signal TT294 at danger. The train derailed on the trap points and continued for about 140 m ending up obstructing the adjacent Down Fast line. Signal TT294 was not fitted with AWS, and there were no recommendations carried forward in respect of trap points.
- There have been two derailments at Clapham Junction (14 June 2001 and again on 28 April 2004) where trains leaving Clapham Yard have passed signal W1032 at Danger, derailed on the trap points and ended up obstructing the adjacent Down Windsor Slow line. No recommendations were made concerning the use of trap points. Signal W1032 has since been fitted with TPWS.
- A derailment at trap points occurred at Bedwyn on 13 October 2001 when a train started from the *turnback siding* and passed signal R475 at danger. The train ended up obstructing the adjacent Up Main line. The derailed train broke off the track circuit interrupter, and this caused signal R839 that had been cleared for train 1A27 from Penzance to Paddington approaching on the Up Main line to revert to danger. The driver of train 1A27 saw the change in signal aspect in time, applied the emergency brake and stopped about 1400 m from the derailed train. Recommendations included the possible modification to the trap points to ensure derailed vehicles would not continue towards the Up Main line and risk assessment of all similar locations with one of the factors to be taken account being trapping protection which was not a full turnout.
- A derailment on trap points at Rugeley Power station on 27 February 2004, after signal S42A was passed at danger, did not obstruct the adjacent Up Main line, but the passing clearance was infringed. There were no recommendations made in respect of trapping protection.

- A derailment at trap points at London Victoria Grosvenor Sidings on 7 June 2004, after signal VS552 was passed at danger, obstructed the adjacent Down Chatham Fast line. The report recommended that comparable sites with trapping protection should be checked to ascertain that the trap points were able to stop a derailing train before obstructing a running line.

Analysis

Identification of the immediate cause

128 Examination of the OTMR showed that train 6Z41 departed from Mountsorrel at 04:55 hrs and the course of the journey to Melton Mowbray was uneventful.

129 Approaching Melton Mowbray, the driver cancelled the AWS for the distant signal (signal 19) that was at caution and reduced speed to 15 mph (24 km/h). The driver made a short application of power into the number one and two positions and cancelled the AWS for signal 22. The train then entered the Up Goods Loop at 05:27 hrs, and the driver made further short power applications up to position three as the train progressed along the loop on the rising gradient. Speed was maintained at 15 mph (24 km/h) or less.

130 When train 6Z41 was 141 m from signal 53 and running at only 5 mph (8 km/h), the driver again applied power into position three one minute and two seconds before the derailment occurred. Speed started to increase to about 9.5 mph (15 km/h) as the train passed signal 53, and continued increasing until the derailment occurred 54.8 m beyond signal 53 at a speed of 11.2 mph (18 km/h).

131 The driver admitted that he fell asleep on the final approach to signal 53 at danger only waking up when the locomotive ran off the end of the trap points. His recollection was that he fell asleep half a locomotive length to possibly a full locomotive length from the signal (10 – 20 m).

132 Given the delay before the DVD sounds an audible warning (found to be an acceptable 60 seconds when tested - see paragraph 81), and the time from applying power to position three to the derailment occurring (one minute two seconds), the DVD had no effect.

133 The OTMR output was reviewed for evidence of driver fatigue or microsleeps earlier in the journey. The time taken to cancel the AWS for the distant signal 19 approaching Melton Mowbray was 1.5 seconds. Normally, a driver would be ready to cancel the AWS immediately the warning sounded having seen that the signal it related to was at caution or danger.

134 The driver of the train that the RAIB accompanied to view signals 51 and 53 mentioned that the distant signal 19 was sometimes hard to see. This could explain why the driver of train 6Z41 was late cancelling the AWS for it. The OTMR download of another train that went through the Up Goods Loop obtained by the RAIB also showed that the driver had been late cancelling the AWS for signal 19. This suggested a sighting problem with signal 19 rather than evidence that the driver of train 6Z41 had a microsleep earlier in the journey. The possible sighting issue was reported to Network Rail and EWS.

135 Given the evidence provided by the OTMR and the driver's own admission that he fell asleep, it is clear that the immediate cause of the accident was the driver having a microsleep at some point after he had applied the power controller into the number three position a short distance away from the signal.

Identification of causal and contributory factors

Fatigue and sleep

136 There is a difference between fatigue and sleepiness but both interact. Fatigue can be defined as the impairment of mental activity associated with the pattern of work and rest, whereas sleepiness is the propensity of an individual to fall asleep. Alertness is related to both of these and can be defined as a state of wakefulness when a person is best able to process information and be responsive to the external environment.

137 The level of alertness is firstly determined by the amount of prior sleep that has been obtained and the time since last awakening; and secondly by the body's internal clock known as the circadian rhythm. The circadian rhythm programmes maximum sleepiness at night and maximum wakefulness during the day. Sustaining alertness during the night can therefore be difficult, because the circadian rhythm causes alertness to be lowest between 02:00 hrs and 06:00 hrs and highest in the late afternoon about 12 hours later.

138 The circadian rhythm has a strong influence over the duration and timing of sleep; for example, individuals trying to sleep during the day may experience greater difficulties getting to sleep and then maintaining sleep than those sleeping at night.

139 Napping is brief and shallow sleep that can be effective in restoring alertness, although the duration of naps must be controlled to minimise the degree of grogginess (sleep inertia) experienced afterwards. Naps should be brief (eg 15 to 20 minutes) to be effective and to minimise the effects of sleep inertia. Naps of a longer duration require a longer period of recovery before commencing (or recommencing) duty. Napping is particularly effective when circadian alertness levels are at their lowest in the pre-dawn hours, although napping should not be seen as a substitute for a properly designed and managed shift schedule.

140 With the onset of fatigue, the reduction in alertness that occurs can lead to errors where critical events may be missed. Physiological effects will also occur such as microsleeps which are short periods of involuntary sleep lasting from a few seconds up to about a minute. During the microsleep, the eye loses focus and fixation, and individuals may be unaware they have fallen asleep for such a brief period.

141 Possible causes of fatigue are the pattern of shift rosters; workload; individual characteristics, and social circumstances. A person who has not had enough sleep will feel sleepy if their workload is boring and undemanding. An individual's diet, age, personality and fitness can all have a bearing on fatigue, and if their social circumstances are such that they cannot get sufficient sleep at home, then the onset of fatigue will be exacerbated.

142 There are two distinct states of sleep: non-rapid eye movement (NREM) and rapid eye movement (REM). NREM sleep has four stages during which sleep becomes progressively deeper and brain activity slows. These stages are associated with the recovery of alertness. REM sleep on the other hand is associated with the consolidation of memory.

143 Other factors affecting sleep include:

- age – the amount of deep sleep reduces and there are more awakenings;
- alcohol – suppresses REM sleep and can interact with sleep loss to cause sleepiness;
- medication – side effects can impact on sleep;
- sleep disorders – can disturb sleep and impair alertness;
- prior sleep – sleepiness increases with the time since last sleep.

144 Sleepiness will be exacerbated if a driver suffers from a sleep disorder such as Obstructive Sleep Apnoea (OSA). This is a fairly common disorder in which breathing repeatedly stops during sleep due to the relaxation of the muscles in the throat causing collapse and blockage of the person's airway. The result is that the person is unable to breathe and has to awaken so that the airway can be reopened. When this happens frequently throughout the person's sleep, the disruption to normal sleep patterns is likely to cause excessive sleepiness during the person's normal waking period.

145 The characteristics of OSA are snoring and fatigue when awake, and the condition can also occur in overweight people when excess neck tissue narrows the airway. Sufferers of OSA often dismiss the symptoms as an annoyance rather than a medical condition needing to be treated and remain unaware that they have a serious disorder. Any train drivers suffering from OSA are at much greater risk of falling asleep when driving than non-sufferers.

146 OSA can be treated by doctors and sleep specialists. The most common method is Continuous Positive Airway Pressure in which the sufferer wears a mask during sleep and an attached device forces air through the nose.

147 Although there was no evidence that the driver suffered from any sleep disorder (and his resignation from the employment of EWS prevented a detailed investigation into this), he was of a build and an age that increased the likelihood of him doing so. Research by the Sleep Centre Ltd on behalf of the RSSB (see www.rssb.co.uk) has concluded that the proportion of train drivers suffering from OSA could be as high as 7.3 per cent as opposed to 4 per cent of the general adult male population.

148 The driver had not slept since the previous night and had been awake for about 22 hours when the accident happened. The time of day the accident happened (05:31 hrs) was about the time when the circadian rhythm programmes maximum sleepiness. The quality of the driver's sleep on the night before the accident was probably compromised by the consumption of a significant quantity of alcohol (paragraphs 46 and 143), and his sleep during the two nights previously was probably shortened by the early start times on 6 and 7 February 2006. The driver would therefore have been in a state of fatigue leading to very low levels of alertness leading to a state of fatigue and eventual microsleep.

149 A causal factor of the accident was therefore fatigue leading to the microsleep that was the immediate cause of the accident.

Rostering and minimising the risk of fatigue

150 The rostering process took into account the Hidden Limits and the Working Time Regulations 1998 as detailed in paragraphs 98 and 99.

151 The Hidden Limits are, at the time of publishing this report, included in an appendix to Railway Group standard GH/RT4004 as a benchmark for complying with the standard and complying with an Approved Code of Practice produced by the Health and Safety Executive (HSE) to accompany the Railways (Safety Critical Work) Regulations 1994 (RSCWR).

152 The RSCWR have subsequently been revoked, and requirements relating to fatigue have been included in the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS). Regulation 25 covers fatigue, and the guidance to the regulation advocates a nine stage process for managing the risks arising from fatigue in safety critical workers. This includes setting standards and designing working patterns and taking action when safety critical workers are fatigued.

153 Both the start time of a shift and its duration will have an affect on alertness. The risk of fatigue is at its highest in the early hours, and as the duration of the shift increases, the likelihood of an accident increases.

154 The Fatigue Index (FI) was developed by the Centre for Human Sciences at the Defence Evaluation and Research Agency (now known as QinetiQ) in a research project commissioned by the HSE. This was to provide a means to assess the short-term, daily fatigue and cumulative fatigue risks associated with shift work.

155 The FI is based on the five main factors known to have an impact on fatigue: time of day, shift duration, rest periods, breaks within a shift, and cumulative fatigue. For each component a scoring system operates.

156 The FI takes account of day, night and early shifts and can be used to compare different shift patterns. It can also be used to identify peaks of fatigue within a shift pattern so that suitable control measures can be put in place. For day or evening shifts, an FI value exceeding 30 is likely to indicate that fatigue was too high, whereas the comparable figure for night shifts is an FI value of 35 or more.

157 However, the FI has some shortcomings in that it deals with averages only and takes no account of individual factors such as age, and fitness etc. Significantly, it also takes no account of an individual's lifestyle outside work, including the amount of sleep obtained preceding a shift. The FI does enable effective comparisons to be made between different shift roster patterns.

158 If fatigue levels are assessed as being high, it is incumbent upon employers to introduce suitable control measures. These are likely to include shift work education and a shift system that conforms to good practice guidelines so far as is reasonably practicable, for example:

- restricting the number of nightshifts to no more than four if possible;
- allowing no additional overtime if 12-hour shifts are worked;
- planning a minimum of 12 hours between shifts;
- using forward rotation (morning/afternoon/night);
- taking travelling time into account.

159 EWS uses the FI as a means to assess the risk of fatigue from the base rosters and to assess the actual hours worked following incidents. During the week of the accident on 9 February 2006, the FI calculated by EWS for the roster that the driver worked did not exceed 30 for any of the turns of duty (see Figure 6). Figure 7 for the previous week shows an FI of 39 for the turn of duty on the Friday night 3 February 2006. This value is sufficiently high as to be a cause for concern.

160 The FI has been further developed under work commissioned by the HSE and undertaken by QinetiQ in collaboration with Simon Folkard Associates (research report 446, available from www.hse.gov.uk). This considered issues such as cumulative fatigue, time of day, shift length, the effect of breaks and the recovery from a sequence of shifts. A review was also undertaken of the trends in risk associated with shift work. This resulted in the Fatigue and Risk Index (FRI) containing two separate indices; one relating to fatigue and the other relating to risk. The main difference between the two indices relates to the time of day: the peak in risk occurs close to midnight whereas the peak in fatigue occurs about five hours later. Values of the FRI sufficiently high to cause concern are still under evaluation.

161 The FRI does not explicitly take into account or specifically identify the heightened risk associated with a first night shift following a period during which the person will have been sleeping at night. Like the FI, it deals with averages, but it does take into account that a proportion of employees (identified as the result of field studies and relevant literature) will have taken a nap before starting a night turn of duty.

162 Paragraph 49 explains that the main driving task (driving train 6Z41) was in the second half of the shift when the risk of fatigue was at its highest. Programmed work at the beginning of the shift had been cancelled. The roster pattern could have given rise to a reduced risk of fatigue if the driver had not started his turn of duty until required for train 6Z41, allowing sleep beforehand (with alternative arrangements being made within the roster structure to cover any shunting work at Leicester Humberstone Road). Alternatively, there would appear to have been time within the current roster pattern for the driver to have taken a nap if the facility for this had been provided and it was encouraged.

163 Paragraph 47 describes that the driver had arrived for his turn of duty during which the accident occurred (starting at 01:05 hrs) at 23:40 hrs. This eroded his rest time and used up time that could otherwise have been used for sleeping.

164 Although fitness for duty checks were carried out, these were conducted randomly and may not have coincided with the start of a shift. It was normally the case therefore at Leicester Beal Street depot that drivers could book on duty with no check being made as to whether they were fit. However, under the refusal to work policy (see paragraphs 113 to 115) any driver arriving for duty who felt that they were not fit, for example through having had insufficient sleep, could declare themselves unfit for duty.

165 From the foregoing, the following contributory factors to the driver's fatigue are identified:

- The shift roster pattern during the week of the accident (week commencing 5 February 2006) consisted of spare turns where the driver was required to work two day turns where the driver's sleep was likely to have been shortened, followed by a day where he was not required for duty followed by a night turn of duty where it would be difficult to get prior sleep.
- The main driving task was in the second half of the shift when the risk of fatigue was greatest.
- The rostering process did not specifically identify the risk of fatigue associated with a first night turn of duty or the timing of the main driving task within a shift.
- The driver arrived at work early at 23:40 hrs owing to the unavailability of public transport after this time. This eroded the duration of his rest period at a time when it would have been easier to sleep if he had attempted to do so. This effectively increased the duration of the shift increasing the risk of fatigue.
- Drivers could normally (in the absence of a random fitness for duty check) book on at Leicester Beal Street depot without any check as to their fitness for duty given the location is unsupervised.

166 EWS briefed their drivers in 2003 about 'coping with shiftwork', and the driver of train 6Z41 remembered receiving this. The briefing was to give drivers advice about how to improve sleep and alertness and included advice on diet and exercise, how to organise life outside work and how to ensure sufficient sleep. The briefing did not specifically cover how drivers should ensure sufficient rest before a first night shift following a period working during the day or free from duty.

167 One possible technique when moving from day shift to night shift is to deliberately sleep for a shorter period than normal the previous night and then follow this with a period of sleep during the afternoon. The effect of this technique has not been validated and would need some research to be carried out to establish whether or not it is a viable means of reducing fatigue during the following night shift.

168 The driver had got up on 8 February 2006 between 07:30 hrs and 08:00 hrs following a full night's sleep, the quality of which was likely to have been eroded by the alcohol the driver had consumed during the previous evening. He had not then had any sleep before starting his turn of duty commencing at 01:05 hrs the following day, although he stated that he had attempted a brief nap in the early afternoon. It is difficult however to sleep during a period of the day when a person is used to being awake – the driver had been used to sleeping at night since his night turns of duty the previous week finished at 07:30 hrs on Saturday 4 February 2006.

169 Two further contributory factors contributed to the onset of fatigue suffered by the driver of train 6Z41:

- the driver did not obtain sufficient sleep to maximise alertness during the turn of duty during which the accident occurred; and
- briefing on coping with shiftworking had been given, but this did not give advice on how to cope with a first night turn of duty and had not been refreshed since 2003.

<u>EWS professional driving policy (PDP)</u>

170 The EWS PDP requires drivers to approach signals at danger in a way that minimises the possibility of an overrun occurring. This includes stopping 20 m before reaching the signal.

171 The driver of train 6Z41 admitted that he intended to disregard this rule and stop right at the signal so that if he needed to telephone the signaller, he would not have to walk from the driving cab to the SPT mounted on the signal post (at locations such as Melton Mowbray, when a train stops at a signal at danger, the driver must contact the signaller using the SPT if provided, if the signal does not clear within a set time).

172 The driver's recollection of events is that he fell asleep half an engine length or at the most an engine length away from the signal. If this was the case, the train should already have been stopped in accordance with the PDP, so disregarding the PDP is a possible causal factor of the accident.

173 Had the SPT been located at the stopping point required by the PDP, the driver would have intended to stop at the correct position. The fact the SPT was mounted on the post of signal 53 is also a possible causal factor.

174 No evidence is available to corroborate the exact place where the driver fell asleep. The driver must have been awake when he applied power into the number three position 141 m from signal 53 (paragraph 130). From then on he could have had microsleeps at any time – it has already been reported (paragraph 140) that a person can microsleep without realising it.

175 If the driver fell asleep when he thought he did, he should already have been braking to stop at the signal, whereas no brake application was made. It would seem most likely therefore that the driver either had a much longer microsleep than he thought he did, or he had a series of microsleeps. Furthermore, the time taken to cancel the AWS at the distant signal approaching Melton Mowbray could also have been an indication that the driver's alertness level was reducing (although see paragraph 134 for an alternative explanation).

176 On the balance of probabilities therefore, although the intention to stop at the signal rather than before it, which was counter to the PDP, and the location of the SPT are both possible causal factors, they are unlikely to be so.

Overrun protection – signal 53

177 The overrun protection provided at signal 53 in the event of the signal being passed at danger consisted of the trap points, designated 52A, located 43 m beyond the signal.

178 Under British Railways' policy, supported by the Railway Inspectorate, freight-only routes were not required to be fitted with AWS; consequently signal 53 was not fitted with AWS when it was installed. However, if the line were to be signalled to today's standard (GE/RT8035), AWS would be required to be fitted to signal 53.

179 Signal 53 was also not fitted with TPWS, because this was not required by the Railway Safety Regulations 1999 that set down the criteria for fitment. Signal 53 did not need to be fitted, because of the protection provided by the trap points.

180 The trap points beyond signal 53 were provided at a time when it was standard practice to provide a connection between a goods line and a passenger line with trap points. This is to protect the passenger line from any train movement that had overrun the protecting signal at danger on the goods line.

181 Guidance on the use of trap points is given in HM Railway Inspectorate's (HMRI's) Railway Safety Principles and Guidance (RSPG) Part 2, Section A. This states: 'where sidings or freight only lines, and any overrun from such lines might foul a passenger line, trap points should be provided to derail vehicles. Trap points should be located and means provided to guide and arrest derailed vehicles away from the passenger lines, structures and any other hazards'.

182 The current Railway Group standard (GK/RT0064) only permits trap points to be provided as an overrun risk reduction measure at the convergence of two running lines if other risk reduction measures are not sufficient to control the risk, and the secondary risks (arising from deliberately derailing a train) of using trap points have been assessed as acceptably low. If trap points are provided, they should guide derailed vehicles away from other lines, structures and any other hazards. However, this standard only applies to new installations and does not have to be retrospectively applied to installations such as at Brentingby that had been put in before the standard was issued.

183 Other risk reduction measures that would be possible at signal 53 instead of trap points would be the fitment of AWS and TPWS, in conjunction with sufficient safe overrun distance to stop a train following a TPWS intervention before the clearance point with the adjacent Up Main line was reached.

184 The design of trap points is covered by Network Rail's Track Design Handbook (RT/CE/S/049). This requires that trap points that protect passenger lines shall have the appropriate switch rail extended to form a throw-off to ensure that any derailing vehicles will be deflected away from the passenger line being protected. This was not the case in the accident at Brentingby Junction where the derailed locomotive almost ended up obstructing the Up Main line. RT/CE/S/049 does not require retrospective action to trap points installed to earlier standards.

185 To the extent of derailing an overrunning train, the trap points performed the function required of them. They did not however guide the derailed vehicles away from the adjacent passenger line, and there were other overrun mitigation measures such as TPWS in conjunction with a sufficient safe overrun distance that could have been more effective. Signal 53 was not however required to be fitted with TPWS under the national TPWS fitment programme required by the Railway Safety Regulations 1999 because of the existence of trap points after it.

Signal sighting issues – signal 53

186 The RAIB investigated whether the driver of train 6Z41 misread signal 51 as applying to his train, which he would have seen after it had been cleared for train 1L01 that was to overtake train 6Z41.

187 The RAIB travelled in the driving cab of the same type of locomotive hauling a very similar train between Mountsorrel and Peterborough. Arrangements had been made for the signals to be cleared in the same sequence as occurred on the day of the accident and for the train to be routed along the Up Goods Loop.

188 Signal 51 was cleared as soon as train 6Z41 cleared the Up Goods Loop entry points and was already at green when it first came into the driver's view. The clearance of the signal would not therefore have acted as a mental trigger to convince the driver he had a clear line ahead. Furthermore, the approach to signals 51 and 53 is along a gentle right hand curve making signal 53 more prominent in a driver's field of view on the approach.

189 Finally, the driver was fully aware that he was driving towards a signal at danger and was focused on that task so far as his fatigued state allowed. There is no evidence therefore to support the possible causal chain that the driver misread signal 51 at clear instead of signal 53 at danger.

Conclusions

Immediate cause

190 The immediate cause was that the driver had a microsleep just after he had applied power into the number three position 141 m from signal 53, and he was only woken up again after the locomotive derailed.

191 It was not possible to determine exactly where in the final 141 m before signal 53 that the driver had a microsleep. It is also possible that the driver had more than one microsleep during this period.

Causal and contributory factors

192 The principal causal factor was fatigue leading to the microsleep that was the immediate cause of the accident.

193 In addition, the following factors were considered to be contributory:

- The shift roster pattern during the week of the accident (week commencing 5 February 2006) consisted of spare turns where the driver was required to work two early turns where the driver's sleep was likely to have been shortened, followed by a day where he was not required for duty followed by a night turn of duty where it would be difficult to get prior sleep.
- The main driving task was in the second half of the shift when the risk of fatigue was greatest.
- The rostering process did not specifically identify the risk of fatigue associated with a first night turn of duty or the timing of the main driving task within a shift.
- The driver arrived at work early at 23:40 hrs owing to the unavailability of public transport after this time. This eroded the duration of his rest period at a time when it would have been easier to sleep if he had attempted to do so. This effectively increased the duration of the shift increasing the risk of fatigue.
- Drivers could normally (in the absence of a random fitness for duty check) book on at Leicester Beal Street depot without any check as to their fitness for duty given the location is unsupervised.
- The driver did not obtain sufficient prior sleep to maximise alertness during the turn of duty during which the accident occurred.
- Briefing on coping with shiftworking had been given, but this did not give advice on how to cope with a first night turn of duty and had not been refreshed since 2003.

194 The fatigue had arisen from the time that the driver had been awake (22 hours) and the time of day (05:31 hrs) when levels of alertness are low. The quality of his previous sleep would also have been degraded by the fact that the driver consumed five or six pints of beer two days beforehand.

195 Napping is known to be an effective measure against fatigue and had the driver taken a nap during his turn of duty, his level of alertness may have been restored sufficiently to prevent the accident occurring. It should therefore be a part of EWS's fatigue management system that napping is one of the possible measures to reduce the risk of fatigue. It would also be necessary to inform drivers about napping as a fatigue counter-measure (Recommendation 1).

196 Where a shift is assessed as having a high risk of fatigue (such as a first nightshift) and napping is identified as the measure required to reduce that risk, appropriate facilities should be provided at depots and time should be built into to the turn of duty to enable a nap to be taken and for recovery afterwards (Recommendation 2).

197 The technique of deliberately shortening a night's sleep and following this with sleep in the afternoon when changing from dayshift to nightshift is mentioned in paragraph 167. Further work is required to establish whether this is a viable method of reducing the risk of fatigue during the subsequent night shift (Recommendation 3).

198 Although there was no evidence that the driver suffered from a sleep disorder, research has identified a proportion of drivers who suffer from OSA. If untreated, these drivers could be the cause of further fatigue-related incidents. At present, drivers are not routinely screened for sleep disorders during routine medicals, or following incidents/accidents where fatigue has been identified as a possible causal or contributory factor. Doing so would enable such drivers to be identified and treated (Recommendation 4).

199 Employers have a responsibility to ensure employees are given sufficient guidance on how to conduct their lifestyles outside work, that is periodically refreshed, and for ensuring – so far as they can – that the guidance is put into effect. The guidance needs to be specific and targeted towards the lifestyle issues faced by drivers and include what can be done to minimise fatigue during a first night shift. Where possible, the guidance should include a range of methods how drivers should prepare for a first night shift so that individuals are able to choose a way that works for them.

200 Guidance on lifestyles may most effectively be drawn up by involving the drivers themselves. Advice from human factors experts and experience from railways in Australia is that it is also beneficial if drivers' families are present when the guidance is briefed out so that they are in the best position to support drivers in following a lifestyle that minimises fatigue when at work (Recommendations 5 and 6).

201 Employees such as drivers who carry out work that is 'safety critical' also have a personal responsibility to conduct their lifestyles outside work so as to be able to report for work with the required level of alertness that will be sustained throughout their shift. A parallel can be drawn with requirements to report for work not under the influence of alcohol or other drugs. The use of personal responsibility statements and/or sleep contracts periodically signed by drivers could emphasise and reinforce their responsibilities. These should be investigated further by the railway industry to see what problems may exist for their implementation and what benefits they may bring (Recommendation 7).

202 The procedures in place for booking on duty at the time of the accident have been described in paragraphs 106 to 112 of this report. Although there was a procedure in place for checking fitness for duty, these checks were carried out on a random basis, were fairly limited in scope and might not have coincided with the time a driver books on duty.

203 Paragraph 112 mentions that the procedures have been revised with the introduction of booking on by mobile 'phone text messaging. This is accompanied by a system of checking 15 per cent of staff booking on face to face for fitness for duty. These fitness for duty checks, which are biased towards staff with higher potential fatigue levels, involve assessment against five criteria and could be made more effective if a set of standard, simple questions were to be asked of drivers at the time of booking on duty. These could identify cases of very long spells without sleep and alert managers to cases of particularly high levels of fatigue (Recommendation 8).

204 The use of trap points as an overrun mitigation measure was also a causal factor. Although trap points are standard fitment where a goods line joins a passenger line, there are other overrun mitigation measures available that are effective and avoid the necessity of derailing an overrunning train.

205 TPWS fitted to signal 53 would have been a more effective alternative overrun mitigation measure when combined with sufficient safe overrun distance to stop a train before reaching the passenger line following a TPWS intervention (necessitating signal 53 being moved back along the Up Goods Loop towards Melton).

206 Network Rail's own investigation made a recommendation to fit TPWS (paragraph 213) but this was subsequently rejected following an internal review within Network Rail. The RAIB also considers that on the basis of the circumstances of this one SPAD, a specific recommendation to fit TPWS with the existing signalling is probably not justified.

207 As an alternative to TPWS fitment and to provide more effective alternative mitigation, in the event of a SPAD, the trap points should be modified so that any derailing train is diverted away from adjacent lines that are open to traffic (Recommendation 9).

208 HMRI's RSPG (paragraph 181) gives no discretion against the use of trap points where sidings or freight lines join passenger lines and any overrun might foul a passenger line. This may no longer be the preferred option for mitigating the risk of an overrun past at signal at danger. However, no recommendation has been made to amend RSPG, as the document is no longer being maintained following the introduction of ROGS.

Observations

209 The driver did not comply with the EWS PDP to stop 20 m before the signal, and this might have been a causal factor depending on where in the final approach to signal 53 the microsleep occurred. If the SPT had been located at the stopping point required by the PDP, the driver would not have disregarded the PDP policy as he was wishing to save himself a walk to the SPT. The location of the SPT is also a possible causal factor (Recommendation 10).

Other factors affecting the consequences

210 The trap points did not prevent the train being directed towards the adjacent Up Main line and although not obstructing it, the potential existed for a collision to occur with a passing train if the passage of and distance travelled by the derailed vehicles had been different.

212 The current requirements for the design of trap points include that the appropriate switch rail be extended to form a throw-off to ensure that any derailing vehicles are deflected away from any passenger line. However, these requirements are not retrospective and the trap points at Brentingby did not have the extended switch rail.

Actions already taken or in progress

212 Before the accident (and following the accident at Bedwyn on 13 October 2001 – see paragraph 127), Network Rail conducted a separate national review to establish which trap points could impact on adjacent running lines if a derailment were to occur at them. This review identified the trap points at Brentingby as falling into this category. Network Rail also developed a procedure for preliminary risk assessments of trap points to identify those needing more detailed assessment. This procedure for preliminary risk assessment was not finalised until after the derailment at Brentingby occurred.

213 Network Rail carried out a formal investigation into the accident, assisted by EWS, and made recommendations including the following:

- a medical assessment of the driver and development of appropriate remedial action;
- re-writing and delivery of the lifestyle brief (coping with shiftwork);
- the management controls where the erosion of rest periods may occur (through eg drivers arriving for work well before their turn of duty is due to start);
- the removal of the trap points beyond signal 53 and fitment of TPWS;
- the adequacy of trap points at other similar locations.

214 During October, November and December 2004, HMRI undertook an inspection of the hours of work and potential for fatigue for a sample of EWS train drivers and groundstaff. In the context of the accident at Brentingby Junction on 9 February 2006, the inspection concluded that:

- EWS should consider the need for providing further advice for the Trainsmaster (the supervisor) on the steps to be taken if someone appeared for work that was liable to be fatigued.
- EWS should look at the roster design and in particular the shift turns identified and justify whether sufficient risk controls are in place. Consideration should be given to making changes to the roster where fatigue risks are raised.
- Consideration should be given to providing training to Trainsmasters, Resource Controllers and others involved in diagram/roster design or planning for special trains to aid understanding of fatigue management.
- EWS should consider repeating the fatigue briefing or issuing drivers/groundstaff with a leaflet. Providing the drivers with good practice advice on taking a nap should also be considered.
- It is confirmed that EWS are operating as set out in their safety case but using limits/standards for controlling working time that leave open the potential for unacceptable fatigue risks.

215 Following the inspection, EWS has been working with HMRI to address the above findings.

216 The RSSB has sponsored research with the aim of understanding the risks of the current shift patterns in train drivers and developing strategies for risk reduction and control. This included the delivery of useable and practicable guidance for designing drivers' shift patterns.

217 The research has been completed, and the outputs are being used to develop a good practice guide for fatigue management systems which will help the industry comply with ROGS (paragraph 152).

218 The report on the research lists fatigue countermeasures for drivers that are considered to be good practice. These are described in the good practice guide for drivers 'Coping with Shift Work and Fatigue' produced by the RSSB. This guide includes how best to manage sleep, how to ensure adequate alertness at work (including napping during breaks) and health monitoring.

219 The train drivers' trade union ASLEF has also produced guidance on shift work, lifestyle and health. This includes information on sleep, shift patterns and working time.

Recommendations

220 The recommendations below also apply to other operators undertaking similar roles to those directly referenced by this report. Those other operators should assess the need to apply the lessons of this investigation to their own activities.

221 The following safety recommendations are made.[1]

Recommendations to address causal and contributory factors

1 EWS should include napping within its fatigue management system and implement it as a fatigue counter-measure if the assessed risk of fatigue indicates that it is necessary (paragraph 195).

2 If the assessed risk of fatigue requires napping as a fatigue counter-measure, EWS should provide facilities so that naps may be taken at locations where drivers take breaks and build sufficient time into rosters for taking naps and recovery afterwards (paragraph 196).

3 The RSSB should initiate research to investigate whether a technique to deliberately shorten a night's sleep when changing from day shift to night shift and following this by sleep in the afternoon could be a viable means of reducing the risk of fatigue during the subsequent nightshift (paragraph 197).

4 The RSSB should investigate and if reasonably practicable instigate a change to Railway Group Standard GO/RT3251 so that screening for sleep disorders is required as part of the system of regular medical surveillance applied to train drivers and following incidents/accidents where fatigue has been identified as a possible causal or contributory factor (paragraph 198).

5 EWS should produce simple, targeted guidance for train drivers that provides clear advice on how they should conduct their lifestyles outside work so that levels of alertness are adequate when at work. The guidance should include the specific issue of how drivers should prepare for a first night shift (paragraph 200).

6 EWS should implement a system to rebrief at intervals the guidance issued as a result of Recommendation 5 above and include the families of drivers in the briefing if possible (paragraph 200).

7 The RSSB should initiate research to investigate the practicalities of implementing personal responsibility statements and/or sleep contracts, and to investigate the benefits these could provide in reducing the risk of fatigue of persons working in the railway industry (paragraph 201).

continued...

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

8 EWS should implement a system where standard, simple questions are asked of drivers when being checked face to face for fitness for duty in order to identify cases of very long spells without sleep and alert managers to cases of particularly high levels of fatigue (paragraphs 202 to 203).

9 Network Rail should extend the right hand switch rail of trap points 52A to direct a derailed train clear of the adjacent line (paragraphs 204 to 207).

Recommendation arising from observations

10 Network Rail should reposition the SPT fitted to signal 53 so that it is located before the signal close to where drivers are required to stop if the signal is at danger at the position required by their companies' PDP (paragraph 209).

Appendices

Glossary of abbreviations and acronyms — Appendix A

ASLEF	Associated Society of Locomotive Engineers and Firemen
AWS	Automatic Warning System
CIRAS	Confidential Incident Reporting & Analysis System
DVD	Driver Vigilance Device
EWS	English, Welsh & Scottish Railway
FI	Fatigue Index
FRI	Fatigue and Risk Index
HMRI	HM Railway Inspectorate
HSE	Health and Safety Executive
NREM	Non-Rapid Eye Movement
OSA	Obstructive Sleep Apnoea
OTMR	On Train Monitoring Recorder
PDP	Professional Driving Policy
REM	Rapid Eye Movement
ROGS	Railways and Other Guided Transport Systems (Safety) Regulations 2006
RSCWR	Railways (Safety Critical Work) Regulations 1994
RSPG	Railway Safety Principles and Guidance
RSSB	Rail Safety and Standards Board
SMIS	Safety Management Information System
SPAD	Signal Passed at Danger
SPT	Signal Post Telephone
TPWS	Train Protection and Warning System

Glossary of terms — Appendix B

Absolute block	Signalling system which only allows one train to be in the same section of line (called the block section) at the same time.
Accepted	Permission given by a signaller ahead for a signaller to be able to clear his signals so a train can proceed into the next block section.
Automatic Warning System	A system that sounds a warning to drivers of a signal aspect ahead that is at danger or caution; or, if the signal is clear, the system sounds a bell.
Diagrams	The sequence of train working to be carried out eg by a driver during his shift of duty.
Diesel multiple units	A self-contained diesel powered train where the engines and drive systems are usually located beneath the vehicles themselves. Two or more such sets of vehicles can be coupled together and driven by one driver from the leading cab.
Distant signal	Cautionary signal at which a train does not have to stop and which therefore does not have a red aspect. When at caution, it is a warning that the next signal could be at danger.
Down	the line taking trains away from London (generally).
Home signal	The first stop signal on the approach to a signal box where the signalling is absolute block.
Link system	The grouping of drivers' diagrams into a list which each driver works in turn.
National Radio Network	The standard railway industry radio communications system that is fitted to the driving cabs of trains that are generally not otherwise fitted with the alternative cab secure radio system used by driver only operated passenger trains.
Offered	The process by which a signaller asks permission from the signaller ahead to signal a train forward into the next block section.
Overlap	The distance beyond a stop signal which must be clear before a train can normally be allowed to approach the signal.
Passing clearance	The clearance that should ensure the safety of trains and used to determine the structure gauge which is the boundary to enable the railway to be operated in safety.
Position light signal	A signal which requires drivers to drive with the expectation that there could be another train in the section ahead. It displays two white lights at 45 degrees when showing proceed.
Professional driving policy	Defines a method of driving that minimises the likelihood of a SPAD incident occurring.
Rail guard	A device fitted in front of the leading wheels of trains to remove small obstructions from the track and prevent them getting under the wheels which could lead to derailment.

Rest days	Days within a roster when a person is not required to work.
Safety of the line incident	An incident caused as a result of a deviation from the normal rules and regulations governing the operation of the railway.
Safety Management Information System	A national IT system used by railway group members to record all safety related events that occur on Network Rail controlled infrastructure.
Signal post telephone	A telephone located on or near a signal that gives direct and secure connection to the signaller controlling that signal.
Signal sighting their committee	A committee convened to assess how well signals can be seen and meaning interpreted.
Spare turns	Turns within a shift duty roster in which a person can be required to work a diagram to cover eg holidays, sickness etc.
Switch blades	The moving portion of rail on each side of a set of points.
Switch toes	The ends of the switch blades.
Tail lamp	Lamp carried on the rear of every train (it may be built into the vehicle) to indicate that the train has arrived complete and no vehicles have become detached.
Three aspect colour light signal	A signal that can only show three normal states.
Times out	The operation of signalling equipment after a pre-determined time following the occupation of a track circuit by a train.
Track circuit clips	Carried in the driving cabs of trains and used in emergencies to put signals back to danger where track circuits are fitted.
Track circuit interrupter	A rail mounted device which maintains a track circuit in its occupied state after the passage of a vehicle that may have derailed.
Track circuited	A section of line fitted with track circuits which are an electrical device using rails in an electric circuit to detect the absence of trains on that section of line.
Traction motor covers	Removable covers fitted to the traction motors of locomotives to facilitate maintenance.
Train entering section	A code sent to the signaller ahead that a train is entering the block section controlled by that signaller.
Train out of section	A code sent to the signaller before that a train has cleared the block section controlled by that signaller.
Train Protection and Warning System	A system that automatically detects whether a train approaching a stop signal ahead at danger is travelling too fast to do so and automatically applies the brakes.
Trap points	Facing points at an exit from a siding or converging line to derail an unauthorised movement.
Trapping protection	Overrun protection by the use of trap points.

Turnback siding	A section of line that can be used to allow trains to reverse direction without blocking adjacent running lines.
Two-aspect colour light signal	A signal that can only show two normal states.
Underframe	The structure of a railway vehicle that supports the body of that vehicle.
Up Goods Loop	A section of line with normal direction of travel towards London that is signalled to the standards applicable to freight trains and which allows a faster train to overtake a slower one in the same direction.
Up Main	The main line track with a normal direction of travel towards London.

Examples of previous SPAD incidents where fatigue caused drivers either to microsleep or there was a high probability of microsleep

Appendix C

Date	Driver's booked start time (hrs)	Incident Time (hrs)	Train company	Signal	Location	Distance passed (m)	Comment
8 February 2006	01:00	06:49	EWS	W275	East Somerset Junction near Frome	400 approx	Driver had insufficient sleep before starting work.
18 September 2005	21:35	08:35	First Engineering	ML200	Kirkdale South Junction	10	Driver had not slept for 23 hours. Incident occurred during the first night shift.
5 October 2004	21:19	04:02	EWS	SJ31	Langley Green	170	Driver was fatigued due to shift roster pattern.
20 September 2004	03:50	10:10 approx	Central Trains	Stop Board	Stop Board at Stourbridge Junction	26 approx[1]	Driver was fatigued due to insufficient sleep following a family bereavement. Incident occurred during first night shift.
19 September 2004	20:00	01:28	EWS	L249	Lewisham Vale Junction	21	The driver's sleeping pattern had been disturbed by work taking place at his home.
12 August 2004	14:00	19:22	Trans Pennine Express	KM51	Kirkham	24	The driver's previous sleep had been disturbed.
5 July 2004	23:59	02:30	EWS	NS426	Stechford	129	Driver was fatigued due to insufficient sleep.

19 April 2004	22:00	23:42	EWS	SN11	Thingley Junction, Chippenham	11	Driver had insufficient sleep before starting work.
15 March 2004	15:10	17:25	Merseyrail	ML558	Conway Park	5	The driver had insufficient sleep before starting work.
3 February 2004	04:49	10:47	Thames Trains	SN36	Subway Junction	18	The driver had not slept well before starting work.
17 December 2003	20:00	03:24	EWS	D266	Hexthorpe Junction, Doncaster	110	Driver had insufficient sleep and had declined to take a rest break.
7 November 2003	04:28	06:15 approx[1]	Freightliner Ltd	L292	Maryland	4	The driver fell asleep but the reason why was not ascertained. Incident occurred during first night shift.
28 April 2003	00:33	08:31	EWS	Mostyn No.37	Mostyn	46	The driver had insufficient sleep before starting work following time off (it was therefore his first nightshift). He was also forced to work through a booked break.

7 January 2003	18:25	21:24	EWS	MB5	Marsh Brook	215	Driver was fatigued due to long travel to work times and sleep disruption due to building work at home. Excessive cab heat was also a factor.
3 September 2002	08:15 (actual time was 08:46)	12:39	Central Trains	TJ19 and TJ16	Worcester Tunnel Junction	1550 approx	Driver was fatigued due to his sleeping pattern.
17 August 2002	16:55	00:27	EWS	D218	St Catherine Junction, Doncaster	16	Driver had not had sufficient sleep before starting work.
22 January 2002	01:28	06:38	EWS	D443	Derby station	274	Driver had not had sufficient sleep, not taken an allocated rest break and the driving cab temperature was excessively high.

Note[1] train subsequently derailed on trap points.

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