RAIB

Rail Accident Investigation Branch

Rail Accident Report

Freight train collision at Leigh-on-Sea 26 April 2008

Department for Transport

Report 24/2009
September 2009

This investigation was carried out in accordance with:

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

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Freight train collision at Leigh-on-Sea, 26 April 2008

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Introduction

Preface

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

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

Key Definitions

3 In this report, locations are referred to by their position, in the form of a distance in miles and chains from zero at London (Fenchurch Street).

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

- acronyms and abbreviations in Appendix A;
- technical terms (shown in *italics* the first time they appear in the report) in Appendix B;
- key standards at the time of the incident in Appendix C;
- fatigue related incidents in Appendix D;
- work site related incidents in Appendix E; and
- research publications on fatigue in Appendix F.

Summary of the report

Key facts about the incident

5 At about 06:27 hrs on Saturday 26 April 2008 locomotive 66719 working engineer's train 6T64, collided with the rear of train 6T63 between Leigh-on-Sea and Chalkwell within a *work site* between Pitsea Junction and Shoeburyness. Two wagons on train 6T64 were severely damaged. Both lines were closed to normal traffic at the time of the collision (Figure 1).

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

Immediate cause, causal and contributory factors, underlying causes

6 The immediate cause of the incident was that the driver did not control the speed of the train so as to be able to stop short of the stationary train on the line ahead.

7 Causal factors were;

- The driver of *engineers' train* 6T64 did not recognise he was within the work site and limit his speed in accordance with the *Engineering Supervisor's* (ES) instructions to travel at walking pace;
- The driver was in a state of fatigue caused by:
  - a) the *base roster* pattern used by First GBRf;
  - b) not obtaining sufficient rest prior to his shift commencing; and
  - c) the main driving task within the work site being in the second half of the shift when fatigue was most likely to occur.

- The driver did not report his state of fatigue to First GBRf control;
- The relief driver and *trackman* travelling in the cab of train 6T64 did not challenge the driver's excessive speed whilst travelling through the work site; and
- The lack of a formal documented procedure to provide a written record of instructions between the Engineering Supervisor, train driver or *competent person* with 'read back' protocols that documented and confirmed the understanding and responsibility of all parties concerned with the particular task and movement of the train.

8 The following factors were contributory:

- The trackman and train driver of 6T64 did not come to a clear understanding regarding their specific roles and responsibilities for the planned movement. Each person believed the other would be the person managing the movement and would be aware of the geographical locations of the train within the work site and direct the movement on the approach to train 6T63;
- The Engineering Supervisor did not know where the other trains were within the work site to enhance his briefing to the driver and trackman; and
- The removal of the *work site marker boards* by the Engineering Supervisor when he arrived at the work site limits, whilst the driver was asleep and before the Engineering Supervisor spoke to the driver, may have contributed to the driver believing that he was within a *possession* rather than a work site.

9 The following were underlying causes:

- The First GBRf base roster at the time of the incident was consistent with the Hidden guidelines and the Railways and Other Guided Transport Systems (Safety) Regulations 2006 but included an inconsistent start time, *prohibitive rest period* and a reverse shift pattern which contributed to the train driver's increased fatigue;
- Delay during the consultation process prior to the publication of the First GBRf Professional Driving Policy, and hence the delay in the subsequent change to the base roster, with the removal of *reverse rotation shift* patterns;
- Engineers' trains travelling within the work site at speeds above walking pace were observed by staff working within the work site, but were not reported to the Engineering Supervisor; incidents of a similar nature were at risk of occurring due to the need to operate trains over a long distance at walking pace; and
- The Balfour Beatty and Network Rail planning process did not highlight the risks associated with the management of the movement of engineers' trains running within one single large work site.

Severity of consequences

10 Severe damage was sustained by two wagons. The *buffers* on the locomotive of train 6T64 were damaged.

11 There were no reported injuries.

Recommendations

12 Recommendations can be found in paragraph 250. They relate to the following areas:

- the need for a documented communication procedure between an Engineering Supervisor, train driver and a 'competent person';
- the planning, challenge and risk assessment processes relating to the length of possessions and work sites;
- identification of the risks when there are multiple engineers' train movements within long possessions and work sites so that this risk is incorporated into the hazard list of the *Person In Charge of the Possession* (PICOP) pack;
- the planning processes used for developing possession plans; and
- defining the Rule Book requirements of the Engineering Supervisor and role and competence of the 'competent person'.

The Incident

Summary of the incident

13 Planned track renewal work between Benfleet and Chalkwell required nine trains to work into a work site on Saturday 26 April 2008 (Figures 1 and 2).

14 At approximately 06:00 hrs the Engineering Supervisor authorised engineers' train 6T64 to enter the work site. It was formed of locomotive 66719, 17 empty FEA[1] type wagons and locomotive 66716 at the rear. The driver of train 6T64 was instructed to move his train forward an unspecified distance and couple to the rear of train 6T63 (Figure 2).

15 On approach to Chalkwell Station, with the driver, relief driver and a trackman in the locomotive's leading cab, train 6T64 struck the rear of train 6T63 at approximately 15 mph (22 km/h). Two wagons of train 6T64 were severely damaged; minor damage was sustained to the locomotive.

The parties involved

16 The Infrastructure is owned and maintained by Network Rail. Network Rail managed the track renewals project and possession plan in conjunction with Balfour Beatty Rail Infrastructure Services (referred to as Balfour Beatty throughout this report).

17 Balfour Beatty was the main contractor for the works and provided the Engineering Supervisor, *Work Site Manager* and *Controller of Site Safety* (COSS).

18 Train 6T64 was operated by GB Rail Freight (First GBRf). English Welsh and Scottish Railway (EWS, now re-named as DB Schenker) operated other trains within the possession.

Location

19 The railway at the location of the incident consists of one up and one *down line* from London Fenchurch Street to Shoeburyness. Leigh-on-Sea and Chalkwell stations are located in the western suburbs of Southend-on-Sea (Figure 1).

20 Engineering work for track renewals was planned for the 26 April to 28 April 2008 and listed in the *Weekly Operating Notice* (WON) 05, items 158 to 173 (Figure 2). The T3 possession limits were from signal UR 279 (27 miles 13 *chains*) to the buffer stops at Shoeburyness (39 miles 40 chains), a distance of 12 miles and 27 chains. The *protecting signal* was UR 276 located at Pitsea Junction (26 miles 70 chains).

21 The work site extended from Benfleet station (29 miles 11 chains) to Westcliff-on-Sea station (34 miles 66 chains), a work site length of 5 miles 55 chains. The track renewal work within the work site was planned for the *up line* beyond Benfleet station (29 miles 59 chains) to the approach to Leigh-on-Sea station (31 miles 28 chains); a distance of 1 mile 78 chains existed between the possession limit and the first work site marker boards. Initial preparation work was on the up line at Carpenters Lane user worked crossing (30 miles 53 chains).

22 The rear of train 6T63 (8) was located at 33 miles 20 chains, a distance of 4 miles 9 chains from the entry point of the site.

[1] FEA is the code record for a bogie flatbed wagon

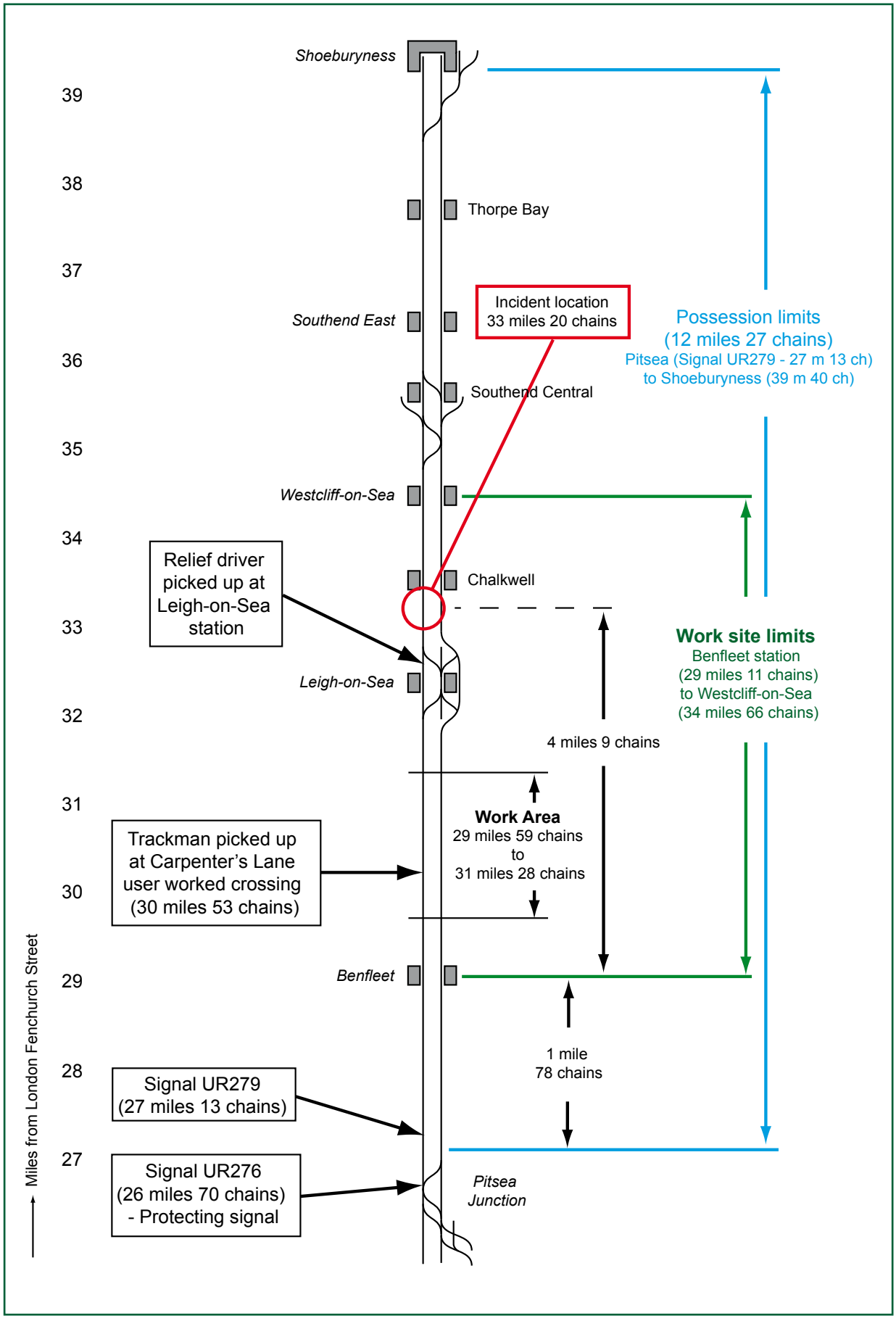


Figure 2: Location of Possession and work site limits

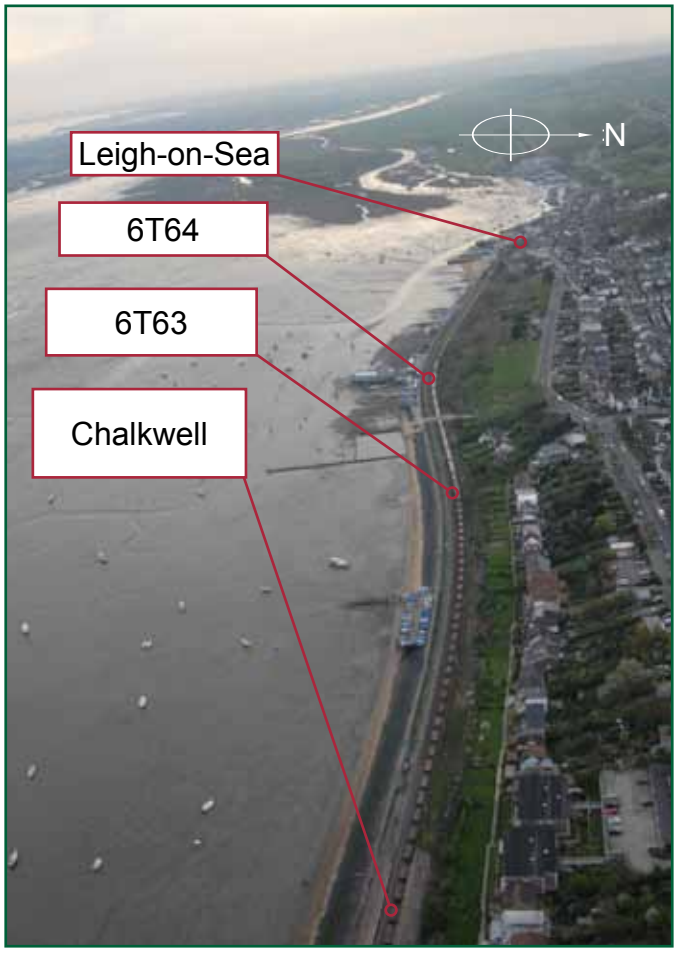


Figure 3: Aerial photo showing locations of station and train positions

23 The incident occurred on a left-hand curve on the approach to Chalkwell station.

External circumstances

24 The morning of 26 April was dry and clear. Sunrise was at 05:36 hrs, directly ahead of train 6T64. Neither the sunlight nor diminished visibility from the direction of the sunlight contributed to the incident.

25 The evening and night was warm, increasing from 12º to 16º Celsius to 24º Celsius during the day of 26 April. The temperature during the evening and early morning is not considered to have contributed to the incident.

Train(s)/rail equipment

26 Nine trains were planned to enter the possession and work site between 02:00 hrs and 06:00 hrs on 26 April. These were trains 6T11 (number 1) to 6T14 and 6T60 to 6T64 (number 9).

27 Train 6T63, the 01:00 hrs Whitemoor to Benfleet consisted of locomotive 66722 hauling 11 FEA wagons loaded with concrete *sleepers*. It was the eighth train to enter into the possession.

28 Train 6T64, the 01:27 hrs Whitemoor to Benfleet was to be used to carry the worn rails from the engineering work. It was the ninth and final train to enter the possession.

29 The authorised speed limit within the work site for engineers' trains and on-track plant was reiterated to the train drivers by the Engineering Supervisor as being walking pace, in accordance with the requirements of Module T7 of Railway Group Standard GE/RT8000, the Rule Book (paragraph 99).

Events preceding the incident

30 With the exception of train drivers bringing trains into the work site, all staff working within the possession were required to book on duty at the Leigh-on-Sea site office and receive a safety briefing from Balfour Beatty staff. The Engineering Supervisor booked on duty at 23:00 hrs and met with the Work Site Manager, who also acted as a COSS, to discuss the required work, method statement, site plan and the train movements within the work site.

31 The track renewals work included ballast cleaning, rail cutting, rail replacement, stressing, resleepering, reballasting and tamping. The first phase was to transfer the wagons, materials and engineering plant into the work site. This entailed the movement of nine trains and one *tamping machine*. The main engineering work was due to start at 06:00 hrs.

32 At 02:03 hrs on 26 April the Signaller gave the required authority to the PICOP for the possession. The work site limits were then set up with marker boards placed within the four foot at 29 miles 11 chains and 34 miles 66 chains on the up and down lines.

33 The Engineering Supervisor met train 6T11, the first train to enter the possession, at the work site limit at 02:10 hrs. The Engineering Supervisor contacted the COSS to advise him of the forthcoming train movements through the work site that would begin on the down line at 02:20 hrs, and that he would contact him when subsequent trains were entering the work site. The initial plan was to *cascade* the first three trains into the work site. The remaining six trains were to enter the work site at 30 minute intervals.

34 The COSS took a team of trackmen out to a work site at 30 miles 53 chains to start work on digging out a hole in the ballast for the ballast cleaning train.

35 During the night it was reported that an intoxicated trespasser had walked onto the track within the possession in the Westcliff-on-Sea area. Engineers' trains 6T12, 6T13 and 6T14 (train numbers 2 to 4) were instructed to proceed at extreme caution. Despite a police search no person was found, but the incident caused the train movements to run behind schedule.

36 Train 6T63 (train number 8) entered the possession and work site and was *stabled* on the approach to Chalkwell station. The locomotive was then detached from the rest of the train, and the brakes applied. This completed the movement of trains 1 to 8 into the work site without incident (Figure 3).

37 The driver at the time of the collision took over train 6T64 at Stratford station as part of a crew change. The driver that he took over from reported that no incidents had occurred during the journey from Whitemoor Yard to Stratford. The driver took charge of 6T64 and travelled to Pitsea, conducting a *running brake test* while on route. The driver did not eat or drink anything while driving the train before the incident.

38 The driver reported that the train cab was warm and the cab window was open; warm air was circulating within the cab. He reported that he was tired but did not feel fatigued before he arrived at signal UR276, the signal protecting the possession at 04:33 hrs. There was no evidence that the visibility of the train cab instrumentation contributed to the incident.

39 The driver telephoned the signaller, who authorised him to pass signal UR276 at danger and proceed on the down line to the possession limit boards where the PICOP would issue further instructions. The driver followed these instructions and stopped at the possession limit board at 04:41 hrs.

40 The PICOP instructed the driver to travel to the work site marker boards located at the designated limits of the work site (Figure 2), where he would get further instructions from the Engineering Supervisor. When the driver stopped at the work site limit at 04:47 hrs the Engineering Supervisor was not there, having been delayed elsewhere by the trespass incident. The driver applied the brakes and fell asleep. He slept for approximately 90 minutes, but was briefly interrupted by a telephone call from the driver of train 6T62 (train number 7) who advised him that his train was now within the work site. The location of train number 7 was not discussed. The train driver then went back to sleep. He did not report his fatigued state to his control office at any time, although this is required by First GBRf's fatigue management procedures.

41 The Engineering Supervisor had contacted a trackman at approximately 05:45 hrs and instructed him to await the arrival of train 6T64 at Carpenters Lane user worked crossing, and then to board the train and accompany the driver until he reached train 6T63 (train number 8). The Engineering Supervisor requested that the trackman telephone him when the train movement was complete. This would enable the Engineering Supervisor to authorise a tamping machine to enter the work site after train 6T64.

42 The Engineering Supervisor did not advise the trackman of the location of train 6T63, nor did he request or authorise the trackman to act as a 'competent person' (paragraphs 100 to 109) to guide or assist the driver in the planned movement and give instructions on the working of the train. The trackman had no knowledge of the specific location or mileage of the trains within the work site and understood that the role he had been given by the Engineering Supervisor was only to relay information back to the Engineering Supervisor.

43 The Engineering Supervisor arrived at the work site marker boards between 05:45 hrs and 06:00 hrs. He removed the markers board from the four foot as this would allow the train to proceed immediately after he had briefed the driver. He climbed into the cab and found the driver fast asleep. The Engineering Supervisor woke the driver, introduced himself and briefed the driver on the planned movement, which would be the last train to enter the work site.

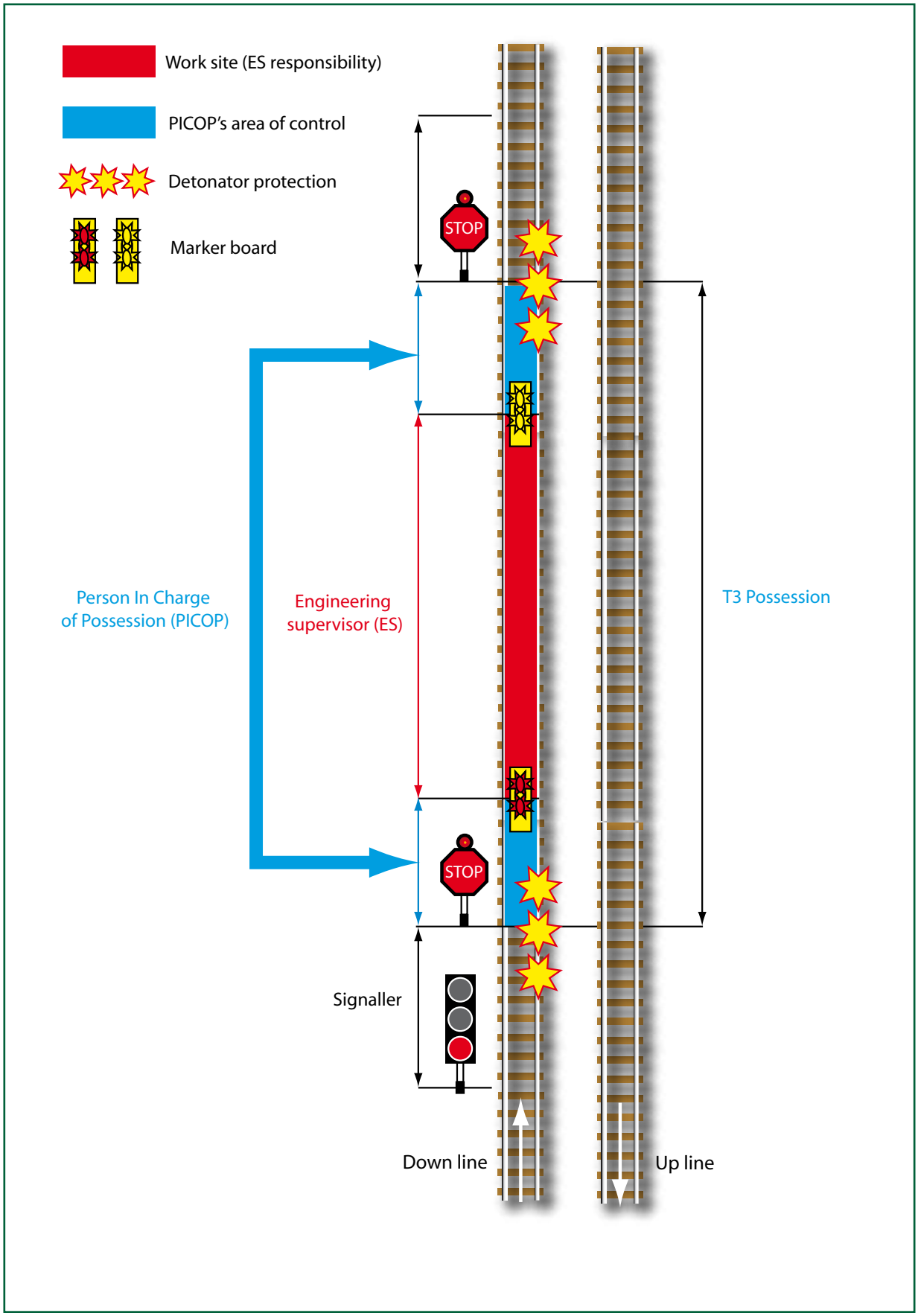


Figure 4: Diagram showing areas of responsibility of the Engineering Supervisor and PICOP

44 The driver was instructed by the Engineering Supervisor to enter the work site and travel to the rear of train 6T63 (Figure 4). Conflicting evidence means that it is uncertain whether a full safety briefing took place advising the driver of the location of train 6T63 and that he should travel at walking pace and stop short of any obstruction. The Engineering Supervisor advised the driver that he would accompany the driver in the train cab to Carpenters Lane user worked crossing (within the work site) where he would leave the cab and the trackman would join the train. The Engineering Supervisor also instructed the driver to make an additional stop at Leigh-on-Sea station platform where he was to pick up a relief driver. The Engineering Supervisor gave no details of the responsibilities of the other staff that would join the train.

45 The Engineering Supervisor had spoken with the COSS and told him that he would contact him when each train had entered the work site to enable him to warn his staff to stand clear of the line when the train approached. Shortly before 06:15 hrs the Engineering Supervisor telephoned the COSS to advise him that 6T64 had entered the work site and would be stopping at the COSS's location. Train 6T64 approached Carpenters Lane and sounded its horn. The COSS and gang acknowledged the train and left the track for a position of safety.

46 The train travelled into the work site at 06:07 hrs; the *On Train Data Recorder* (OTDR) shows that its speed was 8 to 11 mph (12 to 17 km/h). The train stopped at Carpenters Lane user worked crossing and the trackman joined the train at 06:09 hrs. The Engineering Supervisor left the train to walk back and join the tamping machine.

47 The trackman boarded the cab and introduced himself. No other conversation reportedly took place during the journey between the trackman and driver on the planned movement or why the trackman was in the cab to accompany the train driver.

48 The train then passed over the user worked crossing at 06:15 hrs travelling at 11 to 12 mph (17 to 19 km/h).

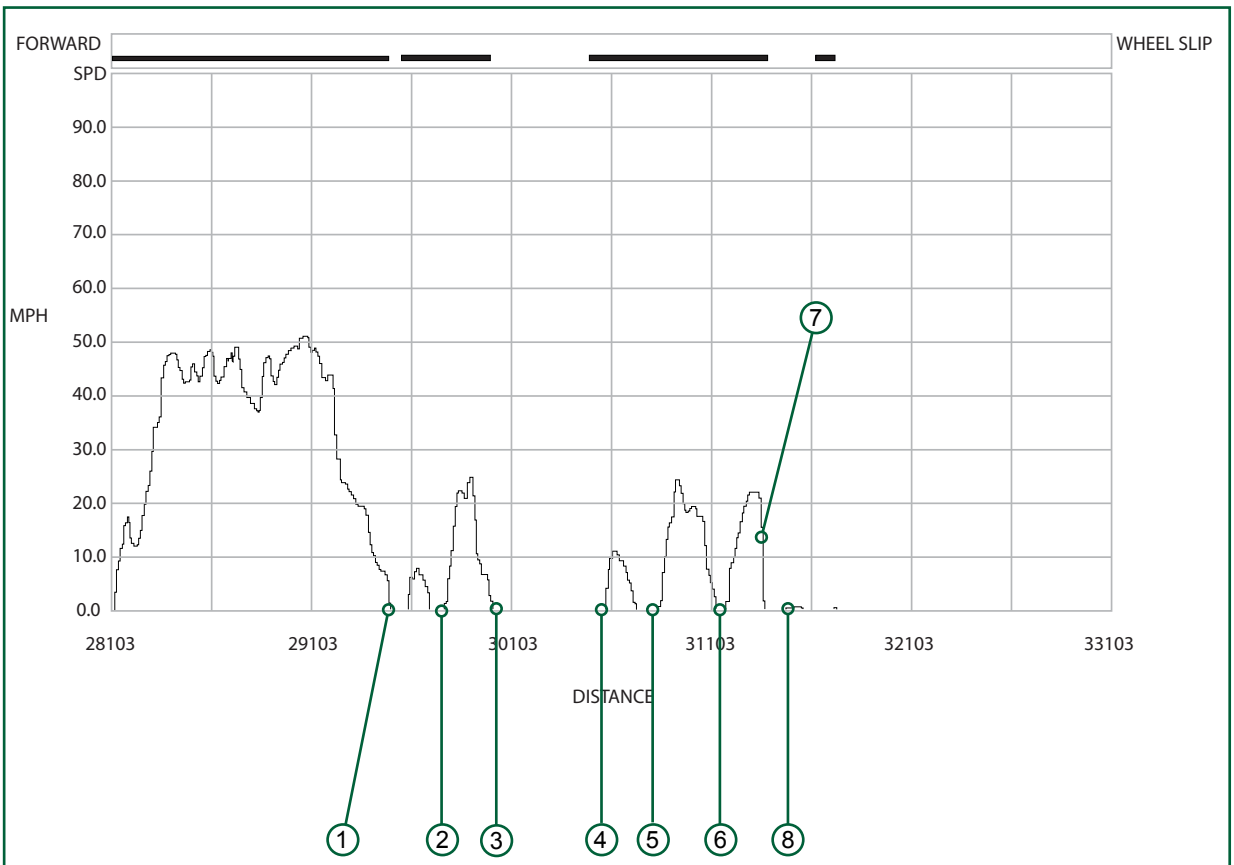
49 The driver drove the train to Leigh-on-Sea station at 20 to 25 mph (32 to 40 km/h), where the train stopped at 06:22 hrs to pick up the relief driver before continuing its journey.

Events during the incident

50 The OTDR, from which all train speeds were recovered, confirmed the train had stopped at Carpenters Lane user worked crossing.

51 At 06:23 hrs the train left Leigh-on-Sea station; the driver increased the train's speed to 20 to 25 mph (32 to 40 km/h). As the train entered the left-hand curve on the approach to Chalkwell station, the driver, relief driver and trackman observed the flashing tail lamp on the rear wagon of train 6T63.

52 The driver applied the brake at 22 mph (35 km/h) at 06:27:15 hrs. Four seconds later he applied the emergency brake; the driver, relief and trackman anticipated the collision and braced themselves. The train travelled a further 31.3 metres before colliding with the rear of train 6T63 at 06:27 hrs whilst travelling at 15.7 mph (24 km/h). The train travelled a further 7.6 metres after the impact.



1: Driver arrives at signal UR276
2: Driver meets PICOP at PLB (Signal UR279)
3: Driver arrives at work site markers and then falls asleep awaiting the Engineering Supervisor
4: Driver is briefed by the Engineering Supervisor and then travels to Carpenters Lane user worked crossing
5: The train then picks up trackman at user worked crossing
6: Driver stops at Leigh-on-Sea to pick up the relief driver
7: Impact with 6T63
8: Train moved and uncoupled

Figure 5: OTDR diagram from train 6T64 showing train speeds and locations within the Leigh-on-Sea possession and work site

Consequences of the incident

Train 6T64

53 The front buffers of locomotive 66719 of train 6T64 were compressed and damaged. The central spines on two FEA wagons, 640658 and 640633, were severely damaged and caused the wagons to become raised off the rails as a result of the impact. The remaining wagons were undamaged.

Train 6T63

54 The loads on all of the wagons on 6T63 were shifted by the collision, causing the retaining straps for the loads to snap and tear.

Events following the incident

55 The driver examined the leading locomotive on train 6T64. He noted the collision had damaged the front buffers. He was not aware of any other damage to the train. The incident was not reported by the driver, relief driver or trackman immediately after the collision.

56 The driver detached the front locomotive of 6T64 and coupled it to train 6T63. The driver then proceeded to walk alongside train 6T63 taking the hand brakes off. As he walked along the train he also noticed the straps used to restrain the loaded sleepers on train 6T63 were hanging down next to each of the wagons. He then began to throw the straps over the wagons so that they could be re-attached.

57 The relief driver and trackman left the cab and began to walk back along the train to inspect for further damage (Figures 6 to 9).

Figure 6: Front Locomotive of 6T64 after collision with the rear wagon of 6T63

Figure 7: Rear cab of front locomotive of 6T64 after collision

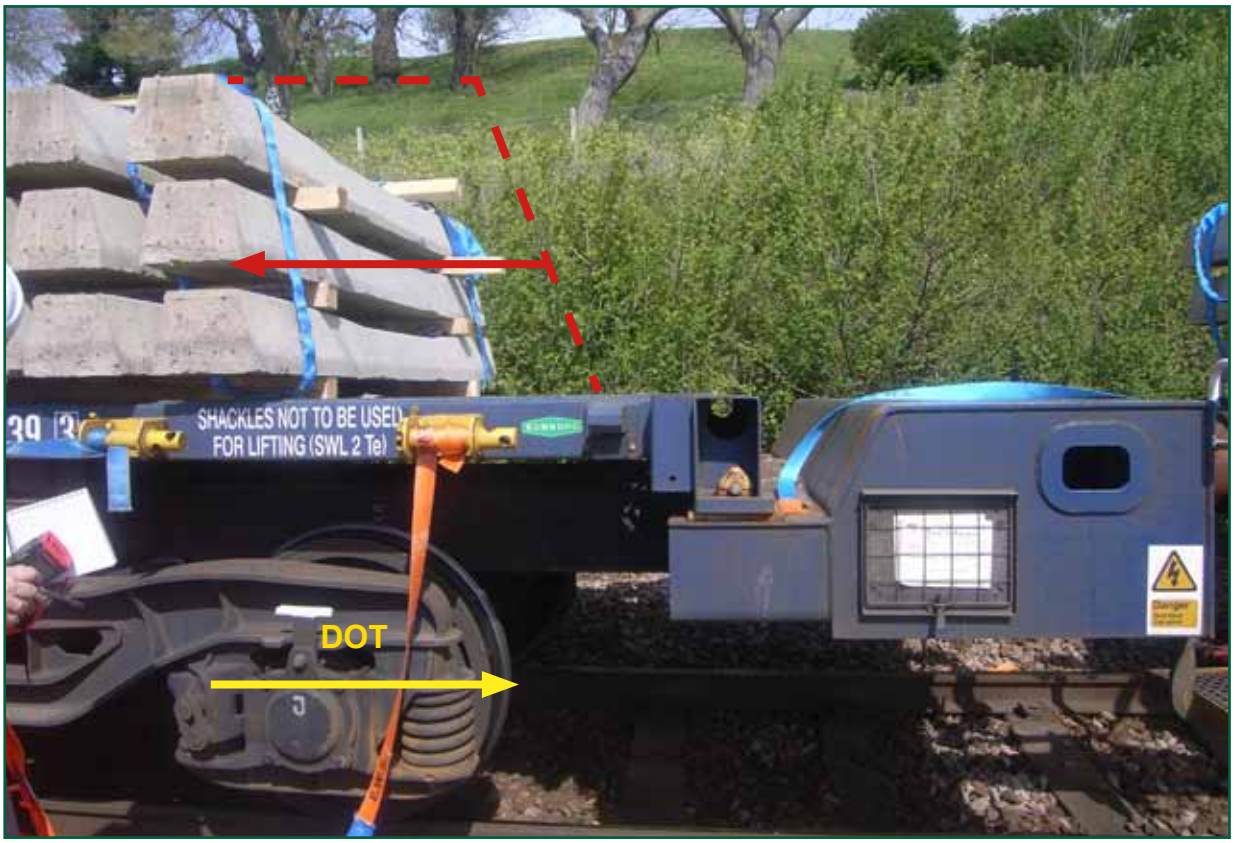


Figure 8: Rear wagon of 6T63 showing the direction of travel (yellow arrow) and the movement of the load (sleepers) from its original position to its final position after the collision (red dotted line)

Figure 9: Photograph and (inset photograph) of train 6T64 and FEA wagon damage sustained as a result of the collision

58 At 06:45 hrs the Engineering Supervisor telephoned the trackman from the tamping machine, requesting an update on the movement of train 6T64. The trackman did not advise the Engineering Supervisor that a collision had taken place.

59 At 06:51 hrs the relief driver telephoned the Engineering Supervisor when he observed the two severely damaged FEA wagons at the rear of train 6T64.

60 At 06:59 hrs the driver realised that the retaining straps on the wagons of train 6T63 had actually torn and snapped as a result of the collision; he contacted the First GBRf control desk and reported the incident. The relief driver and trackman returned to the front cab of train 6T64 and informed the driver of the damage to the two FEA wagons at the rear of train 6T64.

61 At 07:08 hrs the driver contacted and updated his control desk with the new information. Network Rail and the RAIB were separately notified.

The Investigation

Investigation process and sources of evidence

62 Evidence has included:

- The On Train Data Recorder;
- Witness interviews;
- Site photography and measurements;
- Possession planning and the possession management documentation;
- Driving standards, fatigue management procedures and guidance of First GBRf;
- Rostering policy used by First GBRf;
- Actions taken by the rail industry and Office Of Rail Regulation (ORR) in relation to similar incidents;
- Rule Book requirements and the other procedures and instructions issued to possession management staff and train drivers for working within a possession and work site; and
- *Rail Safety and Standards Board* (RSSB), Rail Industry Advisory Committee, Medical Research Council and Health and Safety Executive (HSE) incident and research reports relating to fatigue and fatigue management (Appendices D, E and F).

Key Information

63 Drugs and alcohol tests were undertaken, as is routine following such an incident, on the train driver, relief driver and trackman involved in the incident; all the results were negative.

64 The roster and duties of the Engineering Supervisor, PICOP, relief train driver and trackman were examined. No fatigue related issues were identified relating to any of these people and therefore their working hours did not form any further part of the RAIB investigation.

The train driver of 6T64

Experience and lifestyle

65 The driver of train 6T64 was employed by First GBRf and had over 31 years experience in the railway industry, most of which had been as a driver. The driver was reportedly fit, and in good health. He had not consumed alcohol in the 48 hours before the incident. He had no history of suffering from sleep disorders.

Competence and assessment

66 The driver was last assessed on his knowledge of the Rule Book and driving techniques by First GBRf in December 2007. The assessment took place during a T3 possession. The driver was assessed entering a possession, working within the work site, using radio communication with the Engineering Supervisor and a shunter during coupling and uncoupling movements and leaving the possession. All of these operations were completed correctly. The driver's knowledge and understanding of train movements within possessions, work sites and single line working was correct. He was deemed competent and given feedback on the assessment in February 2008.

67 The driver was on leave from Saturday 19 April to Wednesday 23 April. On his rest days, the driver's reported daily routine was to get up in the morning between 06:00 hrs and 07:00 hrs each day and retire to bed between 22:00 hrs and 22:30 hrs before an early turn shift (Figure 10).

68 On the evenings of the 23 April and 24 April he went to bed between 22:00 hrs and 22:30 hrs to be fit for the early turn duties.

69 On Thursday 24 April he completed a 06:02 hrs to 14:58 hrs shift which finished late at 16:30 hrs. On Friday 25 April he was rostered to be on duty from 07:02 hrs to 13:07 hrs but finished late, booking off at 15:07 hrs. The driver's conditions of employment required him to have a 12 hour rest period before returning to his next shift. The driver's next shift was scheduled to start at 01:10 hrs on Saturday 26 April, but, because of the late finish, his start time was revised to 03:07hrs.

70 After finishing his duty at 15:07 hrs on the Friday he did not feel tired during the afternoon and evening and believed there was no value in going to bed any earlier than 22:00 hrs, because he would not go to sleep. He went to bed at approximately 22:30 hrs and fell asleep shortly afterwards. He was awoken by his alarm and got up at 01:00 hrs on Saturday morning, having had two and a half hours sleep.

Day	Date	Actual start	Actual finish
Sunday	13/04/2008	REST DAY	REST DAY
Monday	14/04/2008	05:45	14:37
Tuesday	15/04/2008	06:31	14:58
Wednesday	16/04/2008	06:02	15:58
Thursday	17/04/2008	06:02	14:58
Friday	18/04/2008	06:02	08:56
Saturday	19/04/2008	06:02	14:58
Sunday	20/04/2008	REST DAY	REST DAY
Monday	21/04/2008	REST DAY	REST DAY
Tuesday	22/04/2008	REST DAY	REST DAY
Wednesday	23/04/2008	REST DAY	REST DAY
Thursday	24/04/2008	06:02	16:30
Friday	25/04/2008	07:02	15:07
(Saturday)	26/04/2008	**03:07**	**13:07**

Figure 10: Diagram showing the train driver's actual working hours prior to the incident (incident shown in black)

71 The driver had been notified at the end of his shift on Friday by First GBRf control that he would book on at a remote booking on point at Stratford, and relieve the driver of 6T64 when the train arrived at the station.

72 At 01:40 hrs, a taxi hired by First GBRf took the driver from his home to Stratford station. The driver signed on duty at 03:07 hrs and waited for 38 minutes on the platform until the arrival of train 6T64, which he took over at approximately 03:45 hrs.

73 The driver read his *train diagrams* and *engineering notices*. He stated he was aware from reading this paperwork of the planned route of 6T64 and the location of the protecting signal for the possession at Benfleet.

The relief driver

74 The relief driver had 18 months experience as a First GBRf freight train driver. The driver's diagram required him to book on duty at 01:33 hrs on 26 April and finish his duty at 13:01 hrs. His diagram had two parts: the first was with train 6T14, and the second was with train 6T64. The relief driver was due to meet train 6T14 at 03:00 hrs; this was delayed and he did not take charge of it until 04:00 hrs at Leigh-on-Sea.

75 He then took 6T14 towards Westcliff-on-Sea where a shunter coupled the trains. The Engineering Supervisor then requested the relief driver make his way back to Leigh-on-Sea station to await the arrival of 6T64. He was to go to the rear locomotive of 6T64 and await further instructions.

76 When train 6T64 arrived at Leigh-on-Sea station the relief driver got into the front cab of train 6T64 to introduce himself to the driver and the trackman; he initially presumed the trackman was a trainee train driver. As the relief driver was a qualified shunter he advised the driver that he would be able to act as a shunter if one was not available on their arrival at their destination.

77 Because of conflicting information it is not possible to be certain, but it is highly probable that during the journey from Leigh-on-Sea the trackman did not confirm to the driver or relief driver that his role was to act as a 'competent person', nor did he communicate at any time with the train driver regarding the location of the trains or distances involved.

78 The relief driver was aware that train 6T64 was travelling within the work site, having been involved in a previous train movement. Although he did not look at the speedometer, he was aware of the speed being well above walking pace.

79 The train driver and relief driver had not previously worked together. There was some conversation about what further tasks each driver was to undertake after they arrived at the rear of train 6T63. No conversation took place between the drivers in relation to the movement taking place or the location of the train ahead.

The trackman

80 The trackman was employed by Balfour Beatty and had 11 years experience working on the railway. He had little previous experience of cab riding and had no knowledge or competence to assist the driver in the movement within the work site. He was reportedly fit and in good health.

81 He signed on at 00:10 hrs on 26 April and was briefed by the COSS on the work within the possession and the proposed movements of the nine trains. He started work at Carpenters Lane user worked crossing, assisting members of the public in using the crossing while the movement of engineers' trains was taking place. He had been present when earlier trains had passed across the crossing at low speed.

82 As instructed by the Engineering Supervisor, he joined train 6T64 at Carpenters Lane user worked crossing at 06.09 hrs. While travelling in the cab of train 6T64 the trackman was aware that the speed of the train was above walking pace, at approximately 15 to 20 mph (24 to 32 km/h), through the work site.

The Work Site Manager

83 The Work Site Manager undertook the duties as the COSS at Carpenters Lane user worked crossing. He had six years experience as a Work Site Manager and COSS and was employed by Balfour Beatty. The Work Site Manager is a role specific to Balfour Beatty. The role is to ensure that there is a focal point for communication and control when there are multiple work sites within a large possession.

84 At approximately 02:30 hrs the Work Site Manager assumed the role of the COSS and managed the trackmen undertaking preparatory work at Carpenters Lane user worked crossing for the ballast cleaning train and rail cutting at the start of the track renewal work at 06:00 hrs.

85 During the night, he saw trains 1 to 8 pass through the crossing without incident. Sometime after train 6T64 (train 9) had passed, the Engineering Supervisor contacted the Work Site Manager to advise him of the incident. The Work Site Manager told the Engineering Supervisor that before the incident he and other trackmen had observed train 6T64 stop to pick up a trackman and then accelerate as it passed through the user worked crossing; it was, in his opinion, travelling at a speed faster than walking pace but he did not deem it a safety issue and thus he did not report it (paragraph 229).

The Person In Charge Of the Possession (PICOP)

86 The PICOP was employed by TES 2000 and subcontracted by Network Rail East Anglia. He booked on duty at approximately 01:00 hrs.

87 At 08:00 hrs the PICOP met with a relief PICOP and briefed him about the possession and told him that there were no incidents to report. He then contacted the signaller to advise him of the change of PICOP and new contact details. The Signaller asked the PICOP for an update on the incident. The PICOP told the signaller that he had no knowledge of any incident. The signaller then briefed the PICOP on what had happened, and the PICOP then conveyed this information to the relief PICOP. The relief PICOP then went to the site (paragraph 227).

The Engineering Supervisor

88 The Engineering Supervisor had been employed by Balfour Beatty for nine years, six of which had been in the capacity of Engineering Supervisor and a Work Site Manager. He booked on at 23:00 hrs and met with other project management staff to discuss the possession details. He had previous knowledge of the site and had travelled with an earlier train 6T11, but this was some time before train 6T63 was in position.

Engineering Supervisor training

89 The Rule Book states that an Engineering Supervisor is responsible for the management of:

- a work site within a possession;
- setting up the work site marker boards to indicate the limits of that work site; and
- authorising the movement of engineers' trains within an engineering possession as shown in module T11 'Movement of engineering trains under GE/RT/8000/T3 arrangements' of the Rule Book.

Network Rail competence and training of Engineering Supervisors

90 The Network Rail company standard NR/SP/CTM/021 'Competence and Training in Track Safety' is the bespoke specification for the Engineering Supervisor's training. It includes instructions for those who present the training and assess the staff as competent to carry out Engineering Supervisor duties. The training plan shows the modules of the Rule Book which require the Engineering Supervisors involvement (Figure 4).

91 ES Unit 2, element 3 of NR/SP/CTM/021 requires that the Engineering Supervisor must be able to:

- give explicit instructions to drivers as to the precise extent of the movement; and
- accurately establish the position of each train before authorising further train movements.

92 The same unit also requires the Engineering Supervisor to have knowledge and understanding of:

- what effects the train movements within the work site might have on the safe operation of work.

Network Rail Training plan

93 Network Rail's instructions to the training organisation delivering the 'Engineering Supervisor trainers plan' are to explain and discuss the requirements of the Rule Book and the procedure for letting a train into the work site. The presentation must include:

- how far the movement is to be made;
- the speed which is required and that any movement in a work site must be made at extreme caution and at no greater than walking pace, unless the driver is given specific instructions by the Engineering Supervisor on the maximum speed to be applied; and
- the Engineering Supervisor must reach a clear understanding with the driver before authorising any movement.

Rule Book requirements

94 The movement of engineers' trains within a work site is explained within the Rule Book. The Rule Book defines the term possession as:

> A line is under possession when the arrangements shown in module T3 "Possession of a line for engineering work" have been carried out to block the line to the normal passage of trains. The only movements allowed within a possession are on-track plant and engineers' trains as shown in module T11 "Movement of engineering trains under T3 arrangements". Possession limit boards normally indicate the limits of a possession.

95 The Rule Book defines the term 'work site within a possession' as:

> 'A portion of line within a possession where work is taking place is called a work site. An Engineering Supervisor is in charge of each work site.'

96 Rule Book modules T3, T6, T7, T11 and S5 define the arrangements for the movement of engineers' trains and for the protection of staff within possessions and work sites.

Module T3: 'Possession of the line for engineering work'

97 The work at the time of the incident was being carried out under Module T3 'Possession of the line for engineering work', Section 1.3 of the module, headed Length of the possession' states:

> 'The length of the possession must be kept as short as possible'

Module T6: 'Walking as a group on or near the line'

98 Module T6, Section 12.1 'Riding in the cab of an engineers' trains within a possession' states that employees must not ride in the train cab unless authority has been given by the PICOP or Engineering Supervisor. Having obtained the verbal authority employees are only allowed to speak to the driver to give instructions on:

- the location of the work; or
- protection arrangements.

Module T7: 'Setting up a separated green zone'

99 Module T7, Section 8.1 describes the conditions and methods of working if the site is within an Engineering Supervisor's work site. The module states that the work site may still be treated as a *separated green zone* if there are movements of engineers' trains or on-track plant, provided these movements are made at extreme caution and do not exceed walking pace (paragraphs 26 to 29).

Module T11: 'Movement of engineering trains and on-track plant under T3 arrangements'

100 Module T11, Section 1, states that depending on any lower speed that may apply the maximum speed in a possession is 40 mph. Section 7.3. 'Reaching a clear understanding with the driver or machine controller' emphasises that:

> 'When any of you authorise a movement, you must make sure the driver or machine controller clearly understands what to do and how far the movement is to proceed'.[2]

101 Section 4.4, 'Movements entering a work site' states that only the Engineering Supervisor can authorise the movement into the work site and he must ensure the engineering train has stopped at the marker board placed in the four foot and that the marker board is replaced immediately after the movement into the work site (paragraph 194).

102 Section 7.1 'Responsibility for instructing the driver or machine controller', section (c) states that a PICOP or Engineering Supervisor can send a competent person to give instructions to a driver or machine controller. The competent person must be able to give clear and precise instructions and reach a clear understanding with the driver or machine controller on the instructions that are given.

103 Section 9.1 'Authority for the movement of engineering trains' section (b) states that a PICOP or 'competent person' on behalf of the PICOP can authorise a movement that is required to pass the protecting detonators into the possession, move between the protecting detonators at each end of the possession and the nearest work site, pass the marker board at the exit from a work site and move between work sites.

104 Section 9.1 (c) states that the Engineering Supervisor or a 'competent person' on his behalf may authorise the movement past a marker board into a work site. The Engineering Supervisor can permit a person to travel in the cab in order to give instructions about the working of the train within the work site. No other persons are authorised to travel within the cab unless they are authorised by the PICOP or Engineering Supervisor in accordance with Module T6 Section 12.1 (paragraph 98), or by the train driver, and hold a valid cab pass.

105 Sections 9.1(b and c) describe the respective arm bands worn by the PICOP and Engineering Supervisor to show their role and authority to other staff. No identification is required for a 'competent person' acting on behalf of the PICOP or Engineering Supervisor.

106 Module T11 Glossary defines the role of a 'competent person' as a qualified person who is passed as being qualified and has the required knowledge and skills to carry out a particular rule, regulation, instruction or procedure (paragraphs 197 to 204).

[2] Applicable to the Signaller/PICOP/Engineering Supervisor.

107 There is no test, certificate or accreditation for a 'competent person'. The definition of 'competent' relates to the experience and knowledge of a person when assisting a train driver involved in the dropping of ballast or the positioning when laying long welded rail. The laid down duties allow the person with the relevant authority to authorise the movement past the work site marker board and give instructions on the working of the train, but this does not include guiding the driver from one location to another.

108 Section 9.2. 'Reaching a clear understanding with others' states that the person authorising the movement (PICOP, Engineering Supervisor or 'competent person') with the driver, must reach a clear understanding as to what must be done and how far the movement is to proceed.

109 Section 9.4. 'Making a movement at caution' states the driver must:

- make the movement at caution;
- not exceed 40 mph at any point in the journey when entering, making a movement within, or leaving the possession;
- be prepared to stop if required by *handsignal*; and
- make any movement in a work site at extreme caution and at no greater than walking pace unless you are given specific instructions by the Engineering Supervisor on the maximum speed to be applied.

110 Module T3 does not include or make reference to the permitted speed of engineers' trains within a work site, as this is shown within Module T11.

Standards and guidance on fatigue

111 The driver of train 6T64 fell asleep when the train was standing at the work site marker boards. There is a wide range of guidance and legislation relating to working hours and fatigue.

Confidential Incident Reporting & Analysis System (CIRAS)

112 The *Confidential Incident Reporting & Analysis System* (CIRAS) conducted research on precursors to Signal Passed At Danger (SPAD) incidents, based on over 600 reports to CIRAS made between June 2000 and September 2005. Freight train operators submitted a total of 110 reports. The research identified that fatigue was the most commonly identified precursor (28% of the reports).

113 The CIRAS research identified that underlying fatigue amongst freight train drivers might be caused by roster patterns, in particular poor shift design, long shifts and inadequate rest periods. It concluded that compliance with working time directives and the *Hidden limits* (paragraph 135) would not in themselves guarantee that drivers would not suffer from fatigue.

The Health and Safety (HSE) Fatigue & Risk Index

114 The development of the Fatigue Index, which was first published in 1999, arose from the requirement to assess the risks from fatigue associated with rotating shift patterns and, in particular, the requirement to provide a tool that could be used to assess the design of a base roster. A Risk Index to represent the relative risk of the occurrence of an incident on a particular shift was developed in 2006 as part of a review of the Fatigue Index. The two indices were combined to form the *Fatigue and Risk Index* (version 2.2). The original Fatigue Index and combined Fatigue and Risk Index are still used as either a separate risk assessment tool to be used with other management systems or integrated within a train operating company's roster management system.

115 The main differences between the indices relate to the different trends with respect to fatigue and risk, and their effects relating to the time of day. The highest risk occurs in the evening, close to midnight, whereas the peak in fatigue tends to occur some five hours later, in the early morning between 04:00 hrs and 06:00 hrs (paragraph 231d).

116 The Fatigue and Risk Index produces a fatigue and risk score based on a number of parameters which include:

- a cumulative component relating to the way in which individual duty periods or shifts are put together to form a complete schedule;
- a component associated with duty timing (the effect of start time, shift length and time of day throughout the shift);
- the job type; and
- a personal needs break component relating to the content of the shift, in terms of the activity being undertaken and the provision of breaks during the shift.

117 The output from the Risk Index is a figure which shows the relative risk of an accident or incident occurring. A value of 1.0 corresponds to the average risk on a schedule with 12-hour shifts, assuming average values for the job type and breaks.

118 The output from the Fatigue Index relates to the probability of high levels of fatigue and sleepiness. The data output is shown as a value between 0 and 100. A shift pattern for an average job type (with breaks) will produce a value of 20.7. The current Fatigue Index scale shows the indicative threshold score as 30 to 35 in the daytime, 40 to 45 at night. This threshold indicates the point at which there is a high probability that an individual's actions will be affected by fatigue and the employer should consider putting suitable control measures in place (see Appendix E (reference document HSE RSU/08/03)).

119 Factors outside the scope of the Fatigue and Risk Index include shift rotation direction (paragraph 122). Hence, when similar patterns of shift work are input in a forward and reverse direction the resulting Fatigue Index score is the same. Personal attributes such as age, fitness and medical history are also not included. A person could therefore be in a state of fatigue with a score well below that shown as critical by the Fatigue and Risk Index.

120 The Fatigue Index may therefore not always identify the fatigue risk, or direct the user to review the roster against the requirements of regulation 25 of the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) (paragraphs 127 to 133).

121 The Fatigue and Risk Index is intended to be used as a risk assessment tool in conjunction with the train company's own management systems and guidance and research on fatigue published by the Rail Safety and Standards Board, the Health and Safety Executive, and Trade Unions to formulate a roster pattern, (Appendix E).

Shift rotation

122 The Office Of Rail Regulation guidance on fatigue issued with the Fatigue and Risk Indices request that companies design their rosters in line with good practice, in a forward 'advance' rotation and not a reverse 'delaying' rotation[3] as this will affect a person's ability to shift their *circadian rhythm*. The realignment of a normal sleep pattern takes a shorter time in a forward rotation time roster than a backward rotation roster.

123 Prior to the incident First GBRf had reviewed its base roster and identified that lifestyle, inconsistent start times of shifts and direction of shift rotation could present a risk, as the duration of time between shifts could result in an insufficient rest period taking place. The RAIB examined evidence of the proposal to change the roster and the First GBRf Professional Driving Policy published as a train driver's handbook, which showed the consultation process was in progress at the time of the incident.

124 The Rail Safety and Standards Board research conducted on forward and reverse shift rotation is limited to a small percentage of responders and does not conclusively identify any short term risks for either rotation; however prolonged rotation of the reverse 'delaying' shift may increase the risk of fatigue. The personal lifestyle of train drivers and their ability to manage it to enable their fitness for duty is the primary mitigation to counter fatigue. First GBRf had published guidance for train drivers to mitigate fatigue and had reviewed their base roster.

Rail Safety and Standards Board (RSSB)

125 The Rail Safety and Standards Board (RSSB) has produced guidance entitled 'understanding human factors - a guide for the railway industry'. The guidance covers factors such as design, training, culture and job conditions. It includes shift working, and reference is made to Regulation 25 of ROGS'.

126 Guidance measures on how to counter fatigue of train drivers have been published by both the RSSB, trade unions and other research bodies. These measures include guidance on lifestyle, food and sleep patterns. Evidence shows that the taking of a nap by train drivers in a safe environment can assist in preventing the build up of fatigue. However the guidance does not cover:

- procedures to identify when and where a nap period could assist a train driver;
- when and where a nap should not be taken (work site or possession limits) when the time and ability to recover sleep may not be available before the train movement commences; and

[3] The term reverse or delaying rotation shift pattern has also been considered in conjunction with other areas of research and the term referred to as *poor blocking*.

- advice or processes for the Engineering Supervisor or PICOP on how to identify fatigue and characteristics of *sleep inertia* if they find a driver who is taking a nap or asleep.

Railways and Other Guided Transport System (Safety) Regulations 2006 (ROGS)

127 The ROGS Regulations came into force in 2006. The regulations placed requirements on the controllers and operators on the mainline railways. The regulations require railway operators to maintain a Safety Management System and hold a safety certificate or authorisation indicating the safety management system has been accepted by the Office of Rail Regulation.

128 Guidance in support of Regulation 25 incorporates a table to highlight various issues with shift patterns. Shift variability is highlighted as a concern and the greatest risk of fatigue is shown to occur when there is a rapid switch from a late finish or night shift to an early shift.

129 Guidance is given on how to mitigate or eliminate the requirement for shift variability and the benefits of exchanging fatigue inducing duties (e.g. late to early turn swopped for an additional early turn). The document states that allowing employees to select or swap shifts to tailor work to their social and domestic needs can help reduce fatigue and can improve satisfaction with the shift work system.

130 Regulation 25 also states that:

'Every controller of safety critical work shall have in place arrangements to ensure, so far as is reasonably practicable, that a safety critical worker under his management, supervision or control does not carry out safety critical work in circumstances where he is so fatigued or when he would be liable to become so fatigued that his health or safety or the health or safety of other persons on a transport system could be significantly affected'.

131 The effect of this regulation is that if fatigue levels are assessed as high, it is incumbent upon the employer to introduce suitable control measures. These are likely to include training and fatigue / lifestyle awareness programmes combined with a shift pattern that conforms to the good practice guidelines so far as is reasonably practicable. The guidelines relevant to the incident are:

- planning a minimum of 12 hours between shifts;
- using forward rotation (morning / afternoon / night); and
- taking travelling time into account.

132 The Office of Rail Regulation provides guidance to regulation 25 and sets out a series of stages that a controller of safety critical work should follow in managing the risks from fatigue. Following the guidance document is not compulsory; however, by following the guidance controllers of safety critical workers will normally satisfy the requirements of Health and Safety at Work legislation. The guidance document lists nine stages that should be followed including:

- identifying those safety critical workers affected;
- designing work patterns;
- providing information to safety critical workers; and
- monitoring and reviewing the arrangements for managing fatigue risk.

133 Section 2.27 indicates that one feature to be considered is shift rotation. This is shown as a particular risk when the shift start times and finish times change on a frequent basis. The guidance document states that a clockwise (forward rotating) shift pattern is usually preferable to a counter-clockwise (reverse rotating) shift pattern and that fatigue management measures should be reviewed where the direction of shift rotation varies between shifts.

134 New regulations on working times for employees within the rail industry were introduced in the Working Time Regulations 1998 and amended in August 2003, to extend working time measures in full to all workers in the railway industry.

Evolution of working time legislation

135 In 1988, the Clapham Junction accident occurred, when three commuter trains collided. The inquiry into the accident was chaired by Anthony Hidden, QC. The report was published in September 1989. The immediate cause of the accident was identified as a signal wiring fault. The working time practices of the staff involved were also identified as a factor. The inquiry recommended changes and limits to the hours employees were allowed to work. The criteria and limits were commonly referred to as the Hidden limits.

136 The Hidden limits relevant to the incident state:

> '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'.

137 The Hidden limits were included in an appendix to Railway Group Standard GH/T4004 'Changes in Working Hours-Safety Critical Work'. This standard was withdrawn in 2007 as the requirements were included in the ROGS Regulations which came into force in 2006.

First GBRf management of fatigue

Development of a base roster for train drivers

138 First GBRf rosters for staff time are assessed against the Fatigue and Risk Index and applicable legislation under Regulation 25 of ROGS, the Working Time Regulations 1998 and supporting guidance issued in these documents. Rosters are introduced following consultation with staff and the trade unions.

139 The start times within a base roster can be varied on a weekly basis to take account of changing demands in rail traffic. The planned times of duty are disseminated to the train drivers for the week ahead.

140 The base roster may include spare turns to cover annual leave, sickness, training courses and any additional work that may occur. Spare turns have a datum time which is a maximum of four hours either side of the start time on the base roster. Train drivers are generally advised the week before of any requirement to work a spare turn on the roster.

141 Due to other work commitments at the time of the incident, there were no First GBRf drivers available on spare turn shifts and the remaining drivers were already on normal night duty. The company had no contingency measures to prevent a reverse shift pattern taking place on the roster on the morning of Saturday 26 April.

Professional Driving Policy and base roster

142 The First GBRf Professional Driving Policy was published as a handbook and first issued to all train drivers in May 2007. The document gave guidance to drivers on lifestyle and how to manage fatigue.

143 In 2007 First GBRf reviewed their base roster for train drivers in line with the guidance outlined within Regulation 25 of ROGS and the HSE Fatigue and Risk Index. This resulted in the development of a draft fatigue management document. The document included codes of practice and a new clause within the fatigue management section relating to First GBRf eliminating the inconsistent start time and anti-clockwise (reverse rotation)[4] shift within their base roster (Figure 10).

144 The draft document was sent to the train driver's trade union, the Associated Society of Locomotive Engineers and Firemen (ASLEF), for comment on the contents. In September 2007 First GBRf requested agreement and comments from ASLEF on implementing the changes. ASLEF agreed to all of the items proposed during the consultation stage but did not formally confirm their written acceptance of the codes of practice and the handbook documents to First GBRf.

145 The code of practice and changes to the base roster had therefore neither been published nor implemented at the time of the incident. They were published the following week.

Fatigue monitoring

146 First GBRf has systems in place to ensure that the hours its drivers work are monitored. The company reviews its driving procedure and drivers hours on a six monthly basis. The review in 2008 identified the reverse shift pattern which initiated the proposal in the changes to the base roster. All paperwork relating to the procedure and the driver involved in the incident was found to be correct.

147 Train drivers regularly book on by telephone to the First GBRf control office, either from home or from a designated relieving point, none of which have on-site supervision. The risk arising from remote booking on from unsupervised locations has been assessed by First GBRf and the company has implemented procedures to check drivers are fit for duty. These checks form a part of First GBRf's train crew monitoring arrangements and include formal performance monitoring as well as unannounced monitoring. First GBRf policy mandates that two unannounced face to face checks as drivers book on duty are completed, and two OTDR downloads are undertaken, in a two year period. Documents examined by the RAIB show these tasks had been completed.

148 First GBRf also have staff who conduct unobtrusive monitoring at specific locations when First GBRf are engaged in some form of operational activity. These arrangements are mandated within First GBRf's company standard OSM106 'Management of Train Manager's Competence and Performance'.

[4] The term reverse rotation shift pattern has also been considered in conjunction with other areas of research and the term referred to as poor blocking.

Refusal to work policy

149 First GBRf operates a 'refusal to work on grounds of safety' policy. This allows any of its employees who feel that fatigue is affecting them to call an on call manager, prior to booking on duty, or if they subsequently start to feel too tired to continue to work safely. The First GBRf control and on call managers monitor train plans and are available if an employee's hours exceed the permitted limits during a shift and if there is a need to implement contingency measures (paragraph 38). There was no evidence of this procedure being used in the five years prior to the incident. The driver of train 6T64 did not recognise that his own fatigued state had affected his judgement and therefore he did not contact the First GBRf control room.

First GBRf driving policy

150 First GBRf stipulate that employees such as train 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 to ensure that compliance with the company procedures is sustained throughout their shift.

151 The First GBRf professional driving policy gives guidance to drivers on company standards. The document outlines the areas where risk and errors occur when driving within engineering possessions. Examples of errors include:

- poor safety critical communications - not reaching a clear understanding with either the signaller, PICOP or Engineering Supervisor and / or relaying messages through a third party;
- inadequate route knowledge or lack of local knowledge; and
- becoming frustrated when a train is delayed and trying to make up time.

152 The policy gives guidance to train drivers on how to manage the risk to ensure they are fully aware of the 'person' who is responsible for controlling movements in the various sections of line within an engineering possession or work site. Guidance is also given to ensure they do not enter a line under possession until a site safety briefing has been provided by the PICOP or Engineering Supervisor.

153 The policy outlines that train drivers must always ensure that the following areas have been clearly briefed and understood:

- the position of work site marker boards;
- any movement of engineers' trains;
- when driving in a possession outside the confines of a work site the speed of the train not exceed 25 mph (this is lower than the Rule Book requirement of 40 mph); and
- when driving within a work site (as denoted by marker boards) the speed of the train must not exceed 5 mph as walking pace is not defined within the Rule Book.

Possession Planning

Network Rail planning

154 The planning processes used by Network Rail and its contractors are similar. They are timed by a countdown to the possession, denoted by a "*T*" prefix (e.g. *T*-52 is 52 weeks prior to the start of the work).

155 The Network Rail company standard NR/SP/MTC/0086 Work and possession planning for the railway infrastructure (change control) outlines the business and change control processes for possession planning on the railway infrastructure.

156 Network Rail company standard NR/PRC/MT/0056 Work and possession planning for the railway infrastructure (meeting management pack) describes a series of meetings that are required to bring together the planning of the work and access onto the railway infrastructure. It requires Network Rail and the contractor meet on a frequent basis as the project management responsibility changes from Network Rail to the contractor. Depending on the size of the project the Network Rail planning process can commence over a year in advance of the project at T-90 weeks.

Balfour Beatty planning

157 The Balfour Beatty planning process runs in parallel to Network Rail's process and uses key stages. The Balfour Beatty stages are known as a 'stage gate' review where responsibilities for the project may change. The review is a control point prior to the scheme moving into the next stage of the project. It aims to assess and highlight the project risks, issues and assumptions, which if not addressed, could threaten the successful delivery of the project. At the end of the stage gate meeting the procedure requires that agreement is reached by all parties as to whether the project can move to the next stage.

158 The first Balfour Beatty stage gate meeting was scheduled for T-52 week and occurred after the specification was received from Network Rail and after Balfour Beatty staff had completed their first site visit.

Previous occurrences of a similar character

Previous incidents involving fatigue and sleep pattern

159 The Confidential Incident Reporting & Analysis System (CIRAS) is a process managed by the RSSB which allows railway staff to report safety concerns on a confidential basis in situations where they would feel inhibited from doing so through normal company channels. CIRAS has 68 incidents (2001 to 2006) reported where fatigue was either the causal factor or one of a range of possible causal factors relating to an incident.

160 Of the 68 incidents, 17 were identified where fatigue was the primary cause of a train exceeding the limits of its movement authority (known as a signal passed at danger).

161 In these 17 fatigue related incidents, the level of fatigue was such that either the drivers concerned actually experienced *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 fatigue incidents and other related work site incidents are listed in Appendix D and E. Not all of the reports relate to operators of freight trains or with the incidents occurring during the night.

162 A number of RAIB investigations (report number in brackets) have involved driver fatigue. These are:

● Brentingby	2006	(01/2007)[5]	Fatigue contributory factor
● Basford Hall	2006	(06/2007)	Fatigue causal and contributory factor
● Maltby	2006	(24/2007)	Fatigue contributory factor
● Purley	2006	(27/2007)	Fatigue causal factor
● Badminton	2006	(30/2007)	Fatigue causal factor

163 Causal and contributory factors relating to these, and other incidents relevant to the Leigh-on-Sea incident, are discussed in Appendix E.

Previous incidents involving the length of possession / work site and use of a 'competent person'

164 The RAIB investigation identified other incidents which are reported in further detail in Appendix E. The similarities in causal or contributory factors to the Leigh on Sea incident are:

- the length of the work site / possession influencing the drivers ability to maintain a speed which enables the train driver to stop short of the obstruction;
- the use and definition of a 'competent person'; and
- the PICOP and Engineering Supervisor's awareness of the length of the possession / work site and the movement of engineers' trains within the limits of the possession.

165 The industry and RAIB investigations (RAIB report number in brackets where relevant) are:

- Glynde 1997 (industry investigation) - use of a *train guide* and train speed;
- Aldridge 1997 (industry investigation) - possession length;
- Fosse Road 2005 (industry investigation) - possession length, train speed and use of a competent person;
- Weybridge 2006 (included within Fosse Road industry investigation) - possession length and train speed;
- Badminton 2006 (RAIB report 30/2007) - work site length and train speed; and
- Four Ashes 2008 (Not investigated by the RAIB) - Engineering Supervisor not aware of positions of vehicles in the work site.

[5] Reports available at www.raib.gov.uk

Analysis

Identification of the immediate cause[6]

166 The immediate cause of the incident was that the driver did not control the speed of the train so as to be able to stop short of the stationary train on the line ahead.

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

The driver

167 Witness evidence suggests that the driver's lifestyle and the forward rotation of his roster prior to the incident shift had not contributed to his fatigued state. The driver was experienced and had no social or domestic issues which may have affected his health and fitness for duty. He had completed various shift patterns within his career without incident.

168 On the evening of the shift he had had a short period of rest and sleep prior to his shift. This may have been affected by the warmth of the evening and night, and concern because of:

- anticipating the short period of sleep he would obtain between the two shifts; and
- ensuring that he awoke in time for the scheduled taxi to transport him to work.

169 The taxi conveyed him from his home address to his booking on point at Stratford station. There he waited on the platform for 38 minutes, for the arrival of train 6T64.

170 The following information is based upon witness evidence:

- the driver was aware he was tired at this time but did not feel it was sufficiently serious to contact his control office;
- the temperature of the train cab was warm and the driver felt that his state of fatigue increased as the journey continued even with the cab window open;
- the driver could not recall the Engineering Supervisor stating the exact location of the user worked crossing where the track team were working, nor where train 6T63 was positioned; and
- the lack of understanding and presumptions made in relation to the role of the trackman within the train cab.

171 On arrival at the work site the driver waited at the marker boards for the Engineering Supervisor to arrive and fell asleep in the cab.

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

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

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

172 Although this period of sleep might have been beneficial, the driver's sudden awakening by the Engingeering Supervisor from a period of sleep may have put the driver in a confused and less alert state known as 'sleep inertia', so that he did not store or comprehend the information the Engineering Supervisor was briefing to him (Appendix E). The driver did not contact the First GBRf control and report his state of fatigue at any stage. Not reporting the fatigue is a causal factor to the incident.

173 The driver did not know where train 6T63 was, and how far train 6T64 would be travelling within the work site. This lack of knowledge is a causal factor in the incident.

174 The work site marker boards had been removed from the four foot by the Engineering Supervisor. The Engineering Supervisor is required by the Rule Book to remove the work site marker board if the train has stopped at the marker board prior to entering the work site. The marker board must be replaced in the four foot after the train has entered into the work site. This was not done until the Engineering Supervisor walked back to the work site limit. The removal of the work site marker board before the briefing took place and authority was given prevented there being any conscious alert, or 'trigger', for the driver that he was passing a barrier. The removal of the barrier after the briefing might have alerted the driver that he was entering a work site and that the train was limited to 5 mph (8 km/h).

175 Witness evidence shows that the removal of the marker boards before the briefing may have led to the driver believing the train was about to enter a possession and not a work site, and that therefore he did not limit his speed according to the requirements of the Rule Book and First GBRf policy. Confusion over whether the train was in a work site or not was a contributory factor in the incident.

176 Witness evidence suggests the driver's lack of alertness continued after he had collected the trackman and relief driver at two separate locations. This may be because he was following instructions that could have equally applied to working within a possession. His awareness of the location of the other trains within the work site was not prompted until the approach to Chalkwell station, when he and the other members of staff saw the flashing tail lamp on the rear wagon of train 6T63.

177 The relief driver was aware of the permitted speed limit from his involvement in a previous train movement. The trackman had seen previous train movements while he was standing at the user worked crossing within the work site. Because of the different roles and experience of the people in the cab, there was minimal conversation about the actual movement taking place and a reluctance to tell the driver of the speed violation within the work site.

178 The driver did not limit his speed in accordance with Rule Book Module T11, the Engineering Supervisor's instruction or the First GBRf rule (5 mph), and this was a causal factor in the incident.

179 Evidence shows the train driver responded quickly to the relief driver and trackman's alert when they both saw the flashing tail lamp on the rear wagon of 6T63. The driver applied the brake and *emergency brake plunger* within four seconds of seeing the tail lamp.

Fatigue

180 Fatigue can be defined as the impairment of mental activity associated with the pattern of work and rest. Sleepiness is the propensity of the individual to fall asleep. It is possible to be fatigued without being sleepy; conversely a person can fall asleep quickly without being mentally fatigued if they are subjected to a monotonous routine with no mental or visual stimuli. Alertness is related to both fatigue and sleepiness 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.

181 How alert a person is during the waking period is dependent on two basic mechanisms. If either of these mechanisms is disturbed, fatigue and alertness may both be affected. The two mechanisms are:

- the amount of sleep obtained and the time since last awakening; and
- the body's internal clock, known as the circadian rhythm. This is the routine of the individual and the 24-hour cycle of their biochemical, physiological or behavioral make up.

Napping

182 Based upon prior knowledge of a forthcoming period of expected tiredness or before the start of a shift, the conscious decision of a train driver to take a nap can be beneficial. However, research completed on the effects of fatigue show that when a nap or a period of sleep is taken as a result of a build up of fatigue the effect is different and this can be detrimental to the individual (Appendix F). A sudden awakening of an individual can result in a state of sleep inertia, the characteristics of this state being quietness, ill temperedness, a state of confusion, impaired performance and the inability to fully comprehend information. Witness evidence shows characteristics of this type being displayed by the train driver after he was briefed by the Engineering Supervisor and during the journey with the trackman and relief driver within the work site. This can be of particular risk between 04:00 hrs and 06:00 hrs, exactly the period (the second half of the driver's shift) when the events leading to the incident occurred and may have contributed to the limited exchange of information between the parties within the train cab. The main driving task being undertaken when the effects of sleep inertia were at their greatest is considered to be a possible causal factor.

183 The driver's fatigue and state of sleep inertia continued after the incident, when he observed the retaining straps on the wagons of train 6T63 to be insecure. The driver believed that another member of staff had mistakenly left the straps insecure and if he was later requested by the Engineering Supervisor to take charge of 6T63 he would have to reconnect the straps. The driver's level of fatigue and confusion at this point was such that he did not realise that the straps that were hanging down had been severed by the movement of the sleepers on the wagons during the collision (paragraph 56).

Sleep

184 Several factors can affect the ability of a person to sleep or nap. Generally these will be the age, weight and the anxiety level or mental state of the individual. External factors, including the home environment, noise and hours of daylight, may prevent sleep taking place before the time of the persons normal nocturnal sleep pattern. The pattern of sleep of the individual will affect the time span of sleep in normal circumstances and the quality of sleep between different shift patterns.

185 The driver's normal sleep pattern when he was on rest day or on leave showed he was a preferred early riser, rather than being a person who would sleep for longer periods between night shifts. On the afternoon of 25 April the driver was unable to go to sleep because of the daylight hours; it is likely that his circadian rhythm prevented him from feeling tired.

186 Research undertaken by the RSSB[9] identified that the different effects of sleep and napping during the night shift could compound the effects of fatigue, rather than preventing it. Prior to the incident the train driver did not attempt to go to bed early enough to get more than 2 to 2½ hours of sleep. The driver not attempting to obtain sufficient sleep prior to his shift is a causal factor.[10]

Documentation for the movement of trains within possessions

187 The written authority given by the Network Rail signaller to the PICOP and Engineering Supervisor is recorded in Network Rail's documented procedures (RT3198 and RT 3199) as mandated in the Rule Book. These documents aim to ensure safety critical instructions maintain the safety of the railway line and staff.

188 There is no equivalent requirement for such written record or log to be made by the Engineering Supervisor for the movement of trains within work sites. A written record of instructions between the Engineering Supervisor and train driver with 'read back' might have ensured that both parties understood the movement. Had this process been adopted, it would have also focused the train driver's mind, and may have assisted him in recovering from his confusion on waking. Failure to respond properly may also have indicated to the Engineering Supervisor that the driver did not understand the instructions. The lack of a documented procedure for recording communications between the Engineering Supervisor and train driver is considered to be a possible causal factor.

[9] RSSB: Human factors study of fatigue and shift work-rostering culture/evaluation of current tools and techniques used for estimating risks associated with shift patterns.

[10] RSSB: Working patterns of train drivers - implications for fatigue and safety.

Engineering Supervisor training

Training standard (NR/SP/CTM/021 Issue 1)

189 Network Rail company standard NR/SP/CTM/021 'Competence and training in track safety', specifies what the training of an Engineering Supervisor must include. It is used to develop a training plan (Engineering Supervisor Full Trainer's Plan Issue 11) and course material for the trainers to explain and discuss the procedure for letting a train or on-track machinery into a work site (paragraph 109).

190 The training plan and course material distributed by Network Rail reflects the requirements of the Rule Book but does not fully conform to the specification NR/SP/CTM/021, issue1, which requires that the Engineering Supervisor must have knowledge on the 'precise' locations of the trains to enable the Engineering Supervisor to give 'explicit' instructions. The training presentation and course material do not emphasise to the Engineering Supervisor the requirement to give precise and explicit instructions to train drivers. With Network Rail using large work sites within possessions and having multiple items of work within the work sites, the emphasis on the precise locations of the trains is critical for work site safety.

191 A speed of walking pace poses a relatively low safety risk on a small work site within a possession. On a larger work site a speed above walking pace can be authorised by the Engineering Supervisor, if there is no one walking on or near the line, as permitted by the Rule Book. However, engineering trains travelling over long distances within a larger work site may generate a risk as a result of:

- the train driver allowing the speed of the train to increase, because it is difficult to maintain walking pace speed over a long distance;
- confusion over the exact location of work train or other engineers' trains; and
- lack of knowledge of the exact position of a train at any time during its *transit*.

192 Precise and explicit instructions, and a clear understanding of them, are necessary to mitigate the risks. The Engineering Supervisor's instructions to the driver should include the distances to be travelled combined with explicit references to stations, signal posts or local landmarks to assist his briefing.

193 The omission of the words 'precise' and 'explicit' within the training which is delivered to the prospective Engineering Supervisor staff and their omission within the Rule Book modules is not a factor in the Leigh-on-Sea incident as the train driver's probably fatigued state meant that he was not comprehending the instructions he was being given.

Actions of the Engineering Supervisor

194 Witness evidence shows that the Engineering Supervisor did not have precise knowledge of the locations of train 6T63, and although both the driver and the Engineering Supervisor confirm that the briefing took place, the details of the locations of the trains was not identified to the driver or trackman. The driver's state of fatigue may not have been fully understood by the Engineering Supervisor or train driver. The Engineering Supervisor believed the information he was briefing to the train driver was being understood, although the driver was not verbally responding, or acknowledging his instructions; thus the understanding of the information in line with safety critical communication protocols was not completed.

195 The removal of the work site marker boards before the Engineering Supervisor woke the driver and briefed him is considered to have affected the driver's perception of his environment and is therefore a contributory factor (paragraphs 41, 173 to 175).

196 Evidence shows the Engineering Supervisor had travelled the short distance from the work site marker boards to Carpenters Lane user worked crossing with the train driver after the briefing. During the short distance the train's speed was recorded at 10 to 12 mph (16 to 19 km/h). It is not certain if the Engineering Supervisor was aware of the train's speed being above walking pace, or whether he warned the train driver to follow his previous instructions on the speed limit imposed by him.

Human factors

Understanding the role of the trackman

197 Rule Book Module T11 and Module T6 allow the PICOP or Engineering Supervisor to authorise a person to travel in the train cab. To be appointed and authorised as a competent person, the individual must have been deemed by the PICOP or Engineering Supervisor to have the personal attributes or competence that would enable the individual to give clear and precise instructions on their behalf and reach a clear understanding with the train driver or machine operator on the instructions that have been given.

198 Module T6 allows any authorised employee to ride in the cab to give instructions to the driver on the location of the work or protection arrangements. Module T11 defines the role of a 'competent person' as a person who is passed as being a qualified person and has the required knowledge and skills to carry out a particular rule, regulation, instruction or procedure.

199 The definition of the 'competent person' as shown in Rule Book Module T11 is to allow a 'competent person' to travel with a driver to relay clear and precise instructions to the driver and reach a clear understanding with the driver or machine controller on the instructions that are given which are applicable to the specific 'working' of that train (examples given by the RSSB are dropping ballast or unloading rails). The section does not authorise the 'competent person' to undertake the responsibilities defined in Rule Book Module T11 section 7.3 which are the responsibility of the signaller, PICOP or Engineering Supervisor (paragraph 106).

200 There is no requirement for the 'competent person' to wear an armband, nor is there a definition of the required competence mentioned in Rule Book Module T11 section 7.2; the range of competency can vary depending on what the specific activities of the train are. The trackman was not part of the safety critical communication between the Engineering Supervisor and the train driver of 6T64; however, they did not come to a clear understanding on what his role was within the cab. This was due to a combination of factors relating to fatigue, experience, knowledge and the status of each individual, culminating in relief driver and driver believing the trackman was guiding the train within the work site and the trackman believing the train driver was in charge of the movement and that he was aware of his actions.

201 The definition of the Engineering Supervisors competent person is defined separately in relation to the personal attributes and the role and experience of the individual appointed by the Engineering Supervisor or the PICOP. Evidence shows the driver believed the trackman had been authorised by the Engineering Supervisor to travel within the cab to guide him to the location of the work and the train in front (paragraph 98). There is no formal documentation to record this authority. The driver was aware of the role of a 'competent person' and believed the trackman was performing this role, although no conversation took place to reach a clear understanding on this assumption. The driver was aware that no other persons are permitted to travel within the cab unless they are authorised or hold a valid cab pass.

202 The driver understood the Engineering Supervisor could permit a 'competent person' to travel in the cab, in order to give instructions about the working of the train within the work site, but did not understand that this authorisation did not allow the 'competent person' to instruct and guide the train from one location to another within the work site.

203 When the relief driver entered the train cab he also believed the trackman was acting to assist the driver in the location of the trains. This role in the past been referred to as 'train guide'.

204 The definition used within the Rule Book to describe the 'competent person's' competence and the 'working' of the train was misinterpreted by the driver and relief driver as being the authority for movement of a train between two locations, and not as the definition is intended to be interpreted, with the 'competent person' assisting the train driver during the train's movement whilst undertaking specific tasks. This interpretation is not defined within the Rule Book in relation to the roles that a competent person cannot perform (e.g. train guide). The trackman was carrying out a specific instruction on behalf of the Engineering Supervisor; however, as the trackman and driver had not come to a clear understanding both drivers assumed the trackman was performing a role of a 'train guide'. The driver and trackman not coming to a clear understanding of their roles is a contributory factor to the incident.

Train speed within work sites

205 The eighth train, 6T63, was stabled with its rear at 33 miles 20 chains, a distance of 4 miles 9 chains from the entry point of the work site.

206 The speed limit within a work site is specifically defined (walking pace) within the sections of the Rule Book used by the driver (Module T11), and the driver of 6T64 was instructed by the Engineering Supervisor to travel at walking pace, a speed of 4 to 5 mph (6 to 8 km/h). For the train 6T64 to travel from the work site marker boards to the location of the train 6T63 would have taken between 48 minutes and 71 minutes depending on the speed. The Engineering Supervisor instructed the train driver on the speed restriction within the work site in accordance with Module T7 of the Rule Book. The length of work site is not considered to have been causal or contributory to the incident because the driver's fatigued state meant the speed imposed by the Engineering Supervisor was not obeyed.

Challenging the speed of the train

207 The relief driver did not challenge the driver on the train's speed or warn him to slow down. The relief driver was inexperienced as a freight train driver and considered himself to be a 'junior' driver who was still learning the job. He did not feel he was qualified to challenge the more experienced driver. There is conflicting witness information on whether the trackman verbally advised the relief driver on what his role was within the cab, or if the presence of the trackman mistakenly gave the relief driver the belief that the trackman was acting as a 'competent person' or train guide for the train driver.

208 The Rule Book requirement relating to walking pace speed, unless a higher speed is authorised by the Engineering Supervisor was fully understood by the driver after the incident. The relief driver had route knowledge of the line under possession but had not signed for the route; First GBRf policy does not require the driver to have route knowledge within a work site. He had been briefed on the requirements by the Engineering Supervisor, and had safely taken 6T14, a previous train into the work site. The relief driver's previous trip made him aware of his location but he had no knowledge of the location of the trains after he had left train 6T14, and in particular did not know where train 6T63 was standing.

209 The confusion over the trackman's role and apprehension in challenging the driver contributed to the relief driver not challenging the speed within the work site. If the relief driver or trackman had questioned the train's speed during the movement it may have prompted the train driver to reduce the speed of the train in anticipation of the train ahead. There was no evidence that peer pressure on the train driver contributed to incident. The lack of challenge to the train's speed by the relief driver and trackman is considered to be a causal factor (paragraphs 44 to 52).

Distraction by sunlight

210 As the train was runnning east towards the rising sun, the driver's vision could have been partially impaired by direct sunlight. However, witness evidence shows that this was not a factor in the incident and had no affect on the driver's control of the train.

Identification of underlying causes[11]

First GBRf Policy

Professional Driving Policy

211 First GBRf produced a draft fatigue management document within their Professional Driving Policy as a result of a review, and a new clause was included to eliminate the rostering of a reverse rotation shift (paragraph 142).

212 The publication of the document was delayed from September 2007 until April 2008 (paragraphs 144 to 145) because the trade union had not confirmed their written acceptance. The First GBRf policy had not been implemented at the time of the incident and consequently the base roster incorporated the reverse shift with the associated risk of fatigue. The late adoption of the Professional Driving Policy is therefore considered to be an underlying cause of the incident.

First GBRf base roster

213 The inclusion of the reverse rotation shift pattern in the First GBRf base roster at the time of the incident is an underlying cause which subsequently produced the fatigued state of the driver (which is itself considered to be a causal factor). The driver's inability to change his environment and obtain sufficient rest before the beginning of the shift exacerbated this fatigue and is a possible causal factor.

214 At the time of the incident there were no contingency resources available to First GBRf as there were no train drivers available on spare turn shifts; other train drivers on the roster were already on night turn duties on the morning of Saturday 26 April. Data supplied by First GBRf show that there have been no fatigue related refusal to work incidents reported since 2004. As the driver did not report his fatigue to the First GBRf control, the lack of contingency measures was not a contributory factor to the incident.

The Possession

Balfour Beatty

215 The possession plan was drafted to allow the nine trains plus a tamper to enter the possession.

216 Section B5 of the possession pack describes the movement of the tamping machine and engineers' trains within the work site, and that the COSS must brief staff accordingly. During the planning process the movement of trains within the large / long work site had not been identified as posing a risk and consequently had not been incorporated within section B5 or the hazard list of the PICOP pack and therefore it was not part of subsequent safety briefings.

Network Rail

217 The geographical length of possessions and work sites is decided by the Network Rail Territory Planning Department which takes into account the need to combine the various items of work at the various locations.

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

218 The early stages of the Network Rail planning process are focused on the financial factors of the project and the risks of the project failing to complete on time. The Territory Planning Department looks at the length of the possession in terms of time restraints, financial costs, access points and the logistics of trains entering and leaving the possession to ensure that normal passenger services are only subject to minimum disruption. The process does not reflect or require planning staff to consider the operational requirements of the Rule Book or the safety of the staff in relation to the length of the possession and the work site. This is because of the numerous other factors and logistics that can affect the length of a possession at week T-90 stage. Network Rail regularly plans for standard possession limits that it knows are acceptable to the passenger train operators. The possession length rarely changes during the lifetime of the planning process. Safety issues are addressed in the later stages of the project and incorporated into the method statement and PICOP briefing documentation.

219 The expectation of Network Rail's planning department is that the train movement activity within the work site marker boards will be managed by the main contractors and Engineering Supervisor. The process dictates the size of the possession at an early stage; witness evidence confirmed that the planning staff considered that they could not strictly comply with the Rule Book requirements to keep possessions as short as possible, nor could the arrangements realistically be challenged and altered at a later stage by the PICOP or Engineering Supervisor. Evidence suggests that it has been rare for the possession and work site length to be challenged at any meeting by Network Rail or its contractors.

220 The omission of the Network Rail planning process to consider the specific risk of engineers' trains travelling within the long possession or work site, and its omission from the PICOP hazard list is considered to be an underlying cause.

The work site

221 When the concept of a work site was introduced into the Rule Book in 1985, it was intended that each job within a possession should be a single work site, protected by its own marker boards, and that the area between work sites should be controlled by the Engineering Supervisor. Subsequently the size of work sites has gradually increased, and it is now commonplace for it to be the length of the possession, and for one Engineering Supervisor to manage multiple sites of work within one work site.

222 Multiple sites of work could be spaced over many miles and their complexity means that it is unlikely that the Engineering Supervisor will have detailed knowledge of the location of each COSS or the position of the trains within the site (paragraph 194).

223 Rule Book Module T3 Clause 1.3 requires the contractor and the Network Rail area operations representative to keep the length of the possession as short as possible, as the normal signalling on the line will be suspended. It is thus important to keep the possession as short as possible to mitigate the risk associated with engineering trains travelling long distances without the protection of the signalling system.

224 At the time of the incident there was no similar requirement relating to the length of work sites.

Leigh-on-Sea

225 The extent of the possession and work site was published in the Weekly Operating Notice. The method statement for the renewal project had been set up in a similiar format to documents that had been used on many occasions before the incident. A decision to change the work site limits could have been made at the PICOP or Engineering Supervisor briefing meeting, but precedents, complications and delays inherent in the use of multiple work sites, as well as the requirement for extra staff, provided a strong incentive to only set up a single work site.

226 On this and previous projects, the PICOP and Engineering Supervisor had never been involved in discussions on changing the length of the possession or work site. They had never requested a reduction in the length of a possession or work site from the limits of work that were already agreed.

227 When visiting the site of the incident, the Engineering Supervisor was surprised at the long distance that train 6T64 had travelled before reaching the location of the collision, and confirmed that his lack of knowledge of where train 6T63 was located had affected his ability to manage the work site. The Engineering Supervisor considered that it may have helped all site management staff if they had known the precise location of train 6T63 and its wagons (miles and chains), as the train was positioned just beyond the bend before Chalkwell station where the sighting distances were short. The Engineering Supervisor's lack of knowledge in relation to the location of train 6T63 is considered to be a contributory factor.

Access and booking on point

228 All staff arriving on site were instructed by Balfour Beatty to book on at the site offices at Leigh-on-Sea station. The train plan within the office was used as a visual aid to brief staff on the chronological order of train movements and the weekend possession. The diagram was endorsed 'not to scale' as it did not reflect the mileage, or the final positions of the trains in relation to the stations. The position of train 6T63 was shown as Leigh-on-Sea station when its actual physical location was beyond the curve on the approach to Chalkwell station. No guidance was given to staff on the location of the train and the visual briefing may have led some staff to wrongly assume the location of train 6T63 shown on the diagram was correct when it had actually been stabled further east towards Chalkwell station. However, in view of the train driver's fatigued state, and consequent inability to fully react to the instructions given to him, the train plan used for the briefing was neither causal nor contributory to the incident (Figure 11).

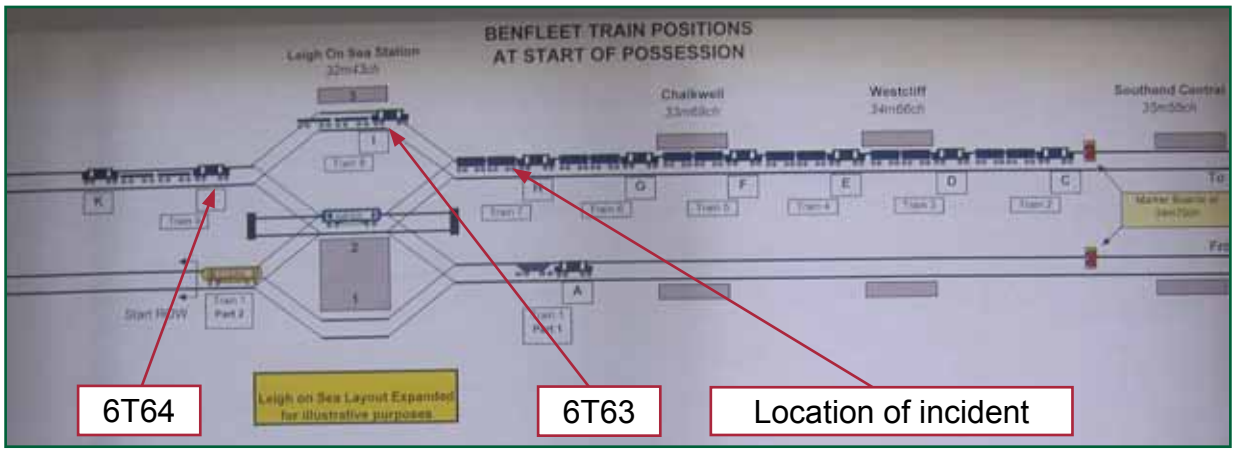

Figure 11: Photograph of the possession plan used for site briefings at the booking on point at Leigh-on-Sea

Safety culture

229 Witness evidence shows that track staff working on the Leigh-on-Sea work site observed trains travelling above walking pace within the work site but did not report the fact. The requirement of drivers to travel within long work sites at walking pace can cause frustration, and, combined with the general pressure to complete the work, may create a habit of driving faster than walking pace. Staff not reporting such issues is considered to be an underlying cause of the incident.

Conclusions

Immediate cause

230 The immediate cause of the incident was that the driver of the train did not control the speed of the train so as to be able to stop short of the stationary train on the line ahead (paragraph 166, Recommendation 1).

Causal factors

231 Causal factors were:

a. the driver of 6T64 did not recognise he was within the work site and limit his speed to walking pace in accordance with the Engineering Supervisor's instructions and First GBRf policy (paragraph 178, Recommendation 1);

b. The driver did not have any knowledge of the location of the train 6T63 and the distances train 6T64 would be travelling within the work site (paragraph 173, no recommendation because First GBRf have re-briefed the driver);

c. the driver was in a state of fatigue which had been caused by the reverse shift on the First GBRf base roster pattern (paragraphs 167 to 179, 213 and 246, no recommendation as First GBRf have implemented a new base roster and eliminated the reverse shift);

d. the main driving task within the work site was in the latter half of the shift when the time and risk of fatigue was greatest (paragraphs 115, 182 and 243, no recommendation as this is viewed as a possible causal factor and the driver has been briefed on management of fatigue and lifestyle);

e. the driver did not report his fatigue to First GBRf control during his duty (paragraphs 149, 171 and 247, no recommendation as the First GBRf 'refusal to work on grounds of safety' policy is in place to deal with such incidents and the driver did not recognise his fatigue);

f. the relief driver and trackman were aware they were within the work site but did not challenge the drivers excessive speed while travelling through the work site (paragraph 249, no recommendation as the relief driver and trackman have both been briefed on these issues); and

g. the lack of formal documented procedure to provide a written record of instructions between the Engineering Supervisor, train driver or 'competent person' with 'read back' protocols that documented and confirmed the details, understanding and responsibility of the two parties (e.g. the driver and Engineering Supervisor) (paragraphs 187 to 188, 194 and 244, Recommendations 1 and 7).

232 A possible causal factor was that the driver did not change his environment and obtain sufficient rest prior to his shift commencing (paragraph 186, no recommendation as this is seen as possibly causal and the driver has been briefed on management of fatigue and lifestyle (see paragraph 247)).

Contributory factors

233 Contributory factors were:

a. the trackman and the driver of train 6T64 did not come to a clear understanding regarding their specific roles and responsibilities for the planned movement. Each person believed the other would be the person managing the movement and would be aware of the locations of the train within the work site and thus direct the movement on the approach to train 6T63 (paragraphs 204 and 249, Recommendation 7);

b. the Engineering Supervisor did not have precise knowledge of the positions of the trains within the site nor the distance to be travelled to enhance his briefing to the driver and trackman (paragraphs 194 and 227, Recommendations 1, 3, 4, 5 and 6).

c. the removal of the work site marker boards before the Engineering Supervisor spoke to the driver may have contributed to the driver believing that he was within a possession rather than a work site (paragraph 175, no recommendation as the Engineering Supervisor has been re-briefed on the requirements relating to the removal of marker boards and safety critical communication).

Underlying causes

234 The underlying causes were:

a. the First GBRf base roster at the time of the incident included a reverse shift pattern that was likely to have produced fatigue (paragraphs 211 to 213 and 246, no recommendation as the First GBRf roster has now been amended and reverse shift eliminated);

b. the delay in publishing the First GBRf Professional Driving Policy and revised base roster which removed the reverse rotation shift pattern (paragraphs 211 and 246, no recommendation as the First GBRf roster has now been amended and reverse shift eliminated);

c. the Network Rail and Balfour Beatty planning processes did not identify specific site safety issues relating to the Rule Book (possession / work site length) as a factor for consideration and therefore engineering trains travelling long distances within a work site were not identified as posing a risk (paragraphs 217 to 220 and 248, Recommendations 2, 3 and 4).

Additional observations

Train speed within the possession

235 The Engineering Supervisor had travelled into the work site in train 6T14 and supervised trains 2 and 3 (6T12 and 6T13) travelling in convoy ahead of it. He had instructed all the drivers to travel at walking pace speed and observe and to stop short of any obstructions; he recognised the need for additional safety considerations because of the presence of the intoxicated trespasser (paragraph 35). During the journey the Engineering Supervisor became aware that the drivers of trains 2 and 3 were expressing their frustration at the length of the work site and the speed of travel. The Engineering Supervisor re-emphasised the need for the low speed over the radio because of the trespass incident and in accordance with his previous instructions.

236 Train drivers can be under pressure to reach the site of work relatively quickly to allow punctual completion of the work and reinstatement of normal operation. The length of time spent travelling at low speed can also be extremely tedious and may promote travelling at higher than the authorised speed.

237 The length of the possession or work site is not considered to be a causal or contributory factor as the drivers fatigue was such that he was unable to understand the instructions from the Engineering Supervisor; however, during the night of the possession, train speeds above those mandated by the Rule Book were likely to occur because of the need to operate trains over a long distance at walking pace and the culture of the staff working within the work site of not reporting such speeds above those mandated (paragraphs 221 to 229 and 248, Recommendations 3 and 4).

Access and booking on point

238 The train plan within the office was used as a visual aid to brief staff on the chronological order of train movements and the weekend possession. The diagram was not to scale and did not reflect the final positions of the trains in relation to distances in miles and chains, or to the stations. The visual briefing may have led some staff to wrongly assume the location of 6T63 was shown as correct, when it had actually been moved to a different location (paragraph 228 and Figure 11).

Site management and evidence preservation

239 The staff were briefed from the method statement and PICOP pack in relation to the reporting of incidents. However their knowledge in relation to the preservation of evidence could have been more effective (paragraphs 55, 58 and 249, no recommendation as Network Rail, Balfour Beatty and First GBRf have all been briefed on the legal requirement to preserve evidence after an incident).

Engineering Supervisor training

240 With the development of larger work sites within possessions, the emphasis on the precise locations of the trains is critical for the safety of people in the work site. The use of the words 'explicit' and 'precise' within the specification reinforces the training message to the Engineering Supervisors. The disparity between the training specification, training material and Rule Book are not considered to be causal or contributory but consideration should be given to ensuring uniformity between the documents, and that they accurately reflect the Rule Book (paragraphs 189 to 194, Recommendations 5 and 6).

Balfour Beatty

241 Balfour Beatty planning staff were aware of the requirement to keep possessions as short as possible in line with the Rule Book. Interview evidence confirms that they held a similar view to that of Network Rail staff, in that they would not challenge complex possessions, work site length, and logistics of the train operations, nor would they critically assess them against the requirements of the Rule Book.

242 The Balfour Beatty Safety Quality and Environment department brief their staff on any Rule Book amendments. At the time of the incident Balfour Beatty was unaware of the RAIB recommendation to keep work sites as short as possible, as there was no process in place within the company for safety lessons from other RAIB reports to be discussed or shared with key staff (paragraphs 157 to 159 and 248).

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

First GBRf

243 First GBRf has taken the following action in relation to the incident:

a. First GBRf issued a new Operating Notice in July clarifying the speeds permitted in engineering possessions and work sites.

Network Rail

244 Network Rail has completed and is undertaking the following action:

a. Network Rail is currently reviewing the process of possession management to reduce the numbers of managerial layers, and to simplify the current *protection* methods used for possessions and work sites.

Rail Safety and Standards Board

245 The Rail Safety and Standards Board is undertaking the following actions:

a. The change to the rules to require that the 'length of a work site to be kept as short as possible' was published in the Rule Book (December 2008); and

b. Studies to better understand the effects of fatigue are being undertaken for the rail industry by QinetiQ.

Actions reported which address factors which otherwise would have resulted in a RAIB recommendation

First GBRf

246 First GBRf reports that its base roster and associated drivers' diagrams were changed in May 2008. The base roster no longer allows train drivers to book on duty between 00:01 hrs and 04:00 hrs. A standard night turn has been introduced and in some circumstances depending on the length of the route, the train is crewed by two drivers. First GBRf no longer rosters drivers to undertake safety critical duties after 08:00 hrs if their booking on time was before 23:59 hrs (paragraph 234 (a)).

247 First GBRf reports it has amended the Professional Driving Handbook in order to give greater emphasis to the speeds within engineering possessions and work sites. Their drivers now have to demonstrate both competence in driving and knowledge of the handbook (paragraph 230).

Balfour Beatty

248 Balfour Beatty reports it has implemented a process to ensure that relevant members of staff are re-briefed to report unsafe systems, and has introduced an internal agenda item within the monthly safety meetings to ensure staff are made aware of RAIB recommendations that may directly affect their role (paragraph 242).

249 Balfour Beatty reports it has re-briefed incident response staff and its sub contractors on the role of the RAIB (paragraph 239).

Recommendations

250 The following safety recommendations are made[12]:

Recommendations to address causal and contributory factors

1 Network Rail should introduce a procedure that will provide a written record of instructions between the Engineering Supervisor, train driver and 'competent person' with verbal read back to confirm an understanding of the planned movement (paragraphs 230 and 231).

2 Network Rail should incorporate a challenge stage within the planning process so that possession and work site length are minimised and that planned train movements are operationally risk assessed (paragraph 234 (c)).

3 Network Rail should modify procedures so that, if a specific risk is identified from the risk assessment (Recommendation 2), such as train movements over long distances within a work site, the risk is documented in the hazard list within the PICOP pack (paragraph 234 (c)).

4 Balfour Beatty should introduce a process so that staff involved with train movements within the work site have accurate knowledge of train positions (paragraph 233 (b)).

5 Network Rail should modify the Engineering Supervisors Training Manual to accurately reflect the specification within its company standard relating to the requirement on the Engineering Supervisor to give precise and explicit instructions to drivers or a 'competent person' (paragraph 240).

6 Rail Safety and Standards Board should make a proposal, in accordance with the Railway Group Standards code, to introduce a requirement to modify the modules within the Rule Book relating to the requirement on the Engineering Supervisor so as to require him to give precise and explicit instructions to the driver or 'competent person' as shown in the Network Rail company standard NR/SP/CTM/021 (paragraph 240).

continued

[12] Those identified in the recommendations, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.
Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail Regulation to enable it to carry out its duties under regulation 12(2) to:

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

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

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

7 Network Rail in conjunction with Rail Safety and Standards Board should make a proposal, in accordance with the Railway Group Standards code, to define the competence and limitations of the role of a 'competent person' authorised by the Engineering Supervisor, so that this role can only pass on the instruction to the driver given by the Engineering Supervisor on the movement of trains within a work site but cannot guide or manage such movements (paragraph 233 (a)).

Appendices

Appendix A - Glossary of abbreviations and acronyms

ASLEF	Associated Society of Locomotive Engineers and Firemen
CIRAS	Confidential Incident Reporting & Analysis System
COSS	Controller of Site Safety
EWS	English Welsh and Scottish Railway (now DB Schenker)
FEA	Flat bed air braked wagon
HSE	Health and Safety Executive
OTDR	On Train Data Recorder
ORR	Office of Rail Regulation
PICOP	Person In Charge Of Possession
RAIB	Rail Accident Investigation Branch
ROGS	Railways and Other Guided Transport Systems (Safety) Regulations 2006
RSSB	Rail Safety and Standards Board
SPAD	Signal Passed At Danger
WON	Weekly Operating Notice

Appendix B - Glossary of terms

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

Ballast Regulator	An on-track machine used to remove or despatch ballast on the permanent way.
Base roster	A roster which has been assessed against the rail industry standards and guidance and approved by the company and trade union.
Buffer	An impact absorbing device fitted to trains to prevent them from colliding heavily during braking.
Cascade	The movement of trains in succession.
Chain	A measurement of distance. There are 80 chains in one mile (22 yards or 20.12 metres).
CIRAS	Confidential reporting system administered by RSSB for staff to raise safely concerns anonymously.
Circadian rhythm	The 24-hour cycle in the biochemical, physiological or behavioural processes of human being.
Competent person	An Engineering Supervisor can appoint a competent person in accordance with GE/RT/8000/T11 Movement of engineer's trains T3 arrangements. The PICOP or Engineering Supervisor must choose and individual person who: ● is competent to give clear and precise instructions; and ● be able to reach a clear understanding with the person as to what instructions must be given to the driver or machine controller. The 'competent person' will be permitted to travel with the driver in the cab of an engineers' train to give the driver instructions about the working of the train within the work site. The person must be qualified in the rule, instruction and procedure.
Controller of Site Safety (COSS)	A safety critical qualification demonstrating the holder's competence to arrange a safe system of work, i.e. protecting staff working on the line from approaching trains.*
Down line	A track on which the normal passage of trains is in the down direction*, i.e. away from London, or towards the highest mileage (eastbound at Leigh-on-Sea).
Emergency brake plunger	A plunger within the train cab which applies a full brake application to the train.
Engineering notice	A document published each week or issued as required giving details of possessions and speed restrictions.

Engineering Supervisor	The person nominated to manage the safe execution of works within an engineering work site. This includes arranging the marker boards, authorising movements of trains in and out of the work site and managing access to the site by Controllers of Site Safety (COSS).*
Engineers' train	A train used for engineering works.
Fatigue and Risk Index	A software spread sheet developed by the Health and Safety Executive to identify cumulative fatigue and risk associated with fatigue.
Freight Operating Company	A company that holds a rail safety case for and operates freight trains as its core business.*
Green Zone	A safe place of work on or near the line. Such an area can be created by: ● Safeguarding, that is stopping all train movements by taking some form of possession ● Fencing the area off with blue netting or black and yellow tape ● Separating the area from the running line by 2m (6' 6") and appointing a site warden to ensure all staff stay within the safe area The opposite is a Red Zone.*
Handsignaller	A 'competent person' authorised to control the passage of trains by means of coloured flags and railway fog signals (colloquially called detonators) in the absence of normal signalling.
Hidden Limits	Working hours directive derived from the recommendations into the Clapham train accident.
Microsleep	A microsleep is an episode of sleep lasting for a fraction of a second or up to a few seconds. It often occurs as a result of sleep deprivation.
On Train Data Recorder (OTDR)	A device that continually records selected parameters associated with the journey, including speed, throttle, brake control, horn and activations of the warning systems.
Person in charge of possession (PICOP)	The 'competent person' nominated to manage the following: ● Safe and correct establishment of the protection for the possession, and removal of protection at the end of the possession ● Managing access to the possession area by engineering supervisors (ES) ● Managing the establishment of engineering work sites within the Possession ● Liaising with the signaller regarding the passage of the train into and out of the possession ● Controlling the movement of trains within the possession, excluding work sites.*

Poor blocking	A term used to describe inconsistent start times shown on a base roster. The resultant effect is a base roster which may produce a rest period which may prohibit a proper sleep pattern being obtained due to the individual's circadian cycle and insufficient time between shifts.
Possession	A period of time during which one or more tracks are blocked to normal service trains to permit work to be safely carried out on or near the line.
Prohibitive rest period	(see 'poor blocking')
Protecting signal	A signal used to protect a possession.
Protection / Possession limits	The marking of the limits of a portion of railway line that has been blocked or duties carried out by individuals responsible for the management of the limits of the blockage of the line. The possession will be marked with possession limit boards and the placement of detonators.
Railtrack (PLC)	Railtrack was a group of companies that owned the track, signalling, tunnels, bridges, level crossings and stations of the railway system from its formation in April 1994 until 2002.
Rail Safety & Standards Board	The pan-industry body responsible for producing and maintaining the suite of Railway Group Standards.
Reverse rotation shift	A shift that goes backwards (e.g. early turn to night turn).
Route Knowledge	Before any driver can drive a train along a particular route, they must first learn the locations of junctions, stations, signals, permissible speeds, etc. This is Route Knowledge.
Running brake test	Brake test preformed by the driver whilst the train is in motion.
Separated green zone	(See 'green zone')
Sleepers	A beam made of wood, pre- or post-tensioned reinforced concrete or steel placed at regular intervals at right angles to and under the rails. Their purpose is to support the rails and to ensure that the correct gauge is maintained between the rails.*
Sleep inertia	A physiological state usually occurring immediately following an abrupt awakening, characterised by a decline in dexterity and coordination with the subjective feeling of grogginess.
Stable	The temporary storage or parking of a locomotive or on-track machine.
Tamping machine	An On-Track Machine (OTM) that can (generally) lift and slew the track and simultaneously compact the ballast under the sleepers.*
Trackman	A member of staff concerned with the maintenance of the track.
Train diagrams	A schedule of train times and locations.

Train guide	A person who was authorised to act on behalf of the PICOP or Engineering Supervisor. The role was abolished in 1998 as a result of the recommendations from the Glynde incident.
Transit	Movement of on-track machines between locations
Trap points	An assembly of one or a pair of switch half sets of switches intended to derail a train making an unauthorised movement.*
T3 GE/RT/8000/ Module T3	Rule Book module explaining the requirements for the possession of the line for engineering work.
T-	Number of weeks / days before the start of the job
T+(plus)n	Number of weeks after the job
Up line	A track on which the normal direction of trains is in the Up direction, i.e. towards London, or the lowest mileage.
User Worked Crossing	A level crossing where the barriers or gates are opened and closed by the user. There is generally no indication to warn the user of the approaching train.*
Weekly Operating Notice (WON)	A Network Rail document published on a route basis, providing information about engineering work, speed restrictions, alterations to the network and other relevant information to train drivers.
Work site marker board	A board with lights used to denote the entry and exit point of a work site within a possession.
Work site	The subdivision of an engineering possession that is delimited by marker boards and managed by an Engineering Supervisor.
Work Site Manager	A role specific to Balfour Beatty. A person who has the responsibility to manage multiple Engineering Supervisors and multiple work sites within a possession.

Appendix C - Key Standards current at the time

Railway Group GE/RT8000/T7	Standard safe systems of work when walking or working on or near the line
Railway Group standard GE/RT8000/T3	Possession of the line for engineering work
Railway Group standard GE/RT8000/T6	Walking as a group and working on or near the line.
Railway Group standard GE/RT8000/T11	Movement of engineering trains and on-track plant under T3 arrangements
Railway Group standard GE/RT8000/S5	Passing a Signal at danger
Balfour Beatty Rail Infrastructure Services	Stage gate Planning process
Network Rail Company Standard NR/SP/CTM/021	Engineering Supervisor competence and training in track safety. Issue 1.2006
Network Rail ES Training pack	Engineering Supervisor Full Trainers Plan Issue 11
Network Rail company standard NR/SP/MTC/0086	The Network Rail company standard which outlines the business process and change control process of possession planning on the railway infrastructure.
NR/PRC/MT/0056	The Network Rail company standard which describes the series of meetings that are required to bring together the planning of the work and access to the railway infrastructure.
GE/RT8001 Publication (Post-incident)	Changes to National Operations Publications for August 2008 (issue 16 August 2008 – Rule Book amended Dec 2008)

Appendix D - Fatigue related incidents

Location	Date	Driver's booked start time (hrs)	Incident Time (hrs)	Signal	Distance passed (m)	Comment
Four Ashes	9 February 2006	See Appendix E				
Badminton	31 October 2006					
Purley	18 August 2006					
Maltby	28 June 2006					
Basford Hall	21 February 2006					
Brentingby	9 February 2006					
East Somerset Junction near Frome	8 February 2006	01:00	06:49	W275	400 approx	Driver had insufficient sleep before starting work.
Kirkdale South Junction	18 September 2005	21:35	08:35	ML200	10	Driver had not slept for 23 hours. Incident occurred during the first night shift.
Langley Green	5 October 2004	21:19	04:02	SJ31	170	Driver was fatigued due to shift roster pattern.
Stop Board at Stourbridge Junction	20 September 2004	03:50	10:10 approx	Stop Board	26 approx	Driver was fatigued due to insufficient sleep following a family bereavement. Incident occurred during first night shift.
Lewisham Vale Junction	19 September 2004	20:00	01:28	L249	21	The driver's sleeping pattern had been disturbed by work taking place at his home.
Kirkham	12 August 2004	14:00	19:22	KM51	24	The driver's previous sleep had been disturbed.
Stechford	5 July 2004	23:59	02:30	NS426	129	Driver was fatigued due to insufficient sleep.
Thingley Junction, Chippenham	19 April 2004	22:00	23:42	SN11	11	Driver had insufficient sleep before starting work.
Conway Park	15 March 2004	15:10	17:25	ML558	5	The driver had insufficient sleep before starting work.
Subway Junction	3 February 2004	04:49	10:47	SN36	18	The driver had not slept well before starting work.
Hexthorpe Junction	17 December 2003	20:00	03:24	D266	110	Driver had insufficient sleep and had declined to take a rest break.

Location	Date	Driver's booked start time (hrs)	Incident Time (hrs)	Signal	Distance passed (m)	Comment
Maryland	7 November 2003	04:28	06:15 approx	L292	4	The driver fell asleep but the reason why was not ascertained. Incident occurred during first night shift.
Mostyn	28 April 2003	00:33	08:31	Mostyn No.37	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.
Marsh Brook	7 January 2003	18:25	21:24	MB5	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.
Worcester Tunnel Junction	3 September 2002	08:15 (actual time was 08:46)	12:39	TJ19 and TJ16	1550 approx	Driver was fatigued due to his sleeping pattern.
St Catherine Junction	17 August 2002	16:55	00:27	D218	16	Driver had not had sufficient sleep before starting work.
Derby station	22 January 2002	01:28	06:38	D443	274	Driver had not had sufficient sleep, not taken an allocated rest break and the driving cab temperature was excessively high.

Appendix E - Work site related incidents

Glynde - 20 April 1997

1 At 09:20 hrs engineers' train 6Z36 travelling within a work site collided with a scaffolding tower. The incident occurred due to the PICOP and the train guide not reaching a clear understanding regarding a work site within the possession. The train then passed the work site marker boards at a speed from which it was unable to stop short of the obstruction.

2 Recommendations from the industry investigation into the Glynde industry relevant to the Leigh-on-Sea incident were:

- the PICOP should have detailed knowledge of the line; and
- the use of train guides should be discontinued (at the time this was only applicable to the Southern Zone of *Railtrack*).

3 The use of train guides was abolished in April 1998 and the use of the 'competent person' was then introduced into the Rule Book. A 'competent person' is a person who is passed as being qualified and has the required knowledge and skills to carry out a particular rule, regulation, instruction or procedure as described in paragraph 106.

Aldridge - 29 June 1997

4 The incident occurred when an Engineering Supervisor assumed that a ballast train had left a T3 possession. He then authorised another engineers' train, towards the possession protection, which struck the rear end of the first train within the PICOP controlled section of a T3 possession. When the driver departed towards the possession protection he knew that he was due to be relieved by another driver. However, en-route he saw his relief driver on a bridge, so he stopped there instead, and the relief driver took over the train.

5 Two main causes of the incident were identified. Firstly, the PICOP had allowed the second train to enter a portion of possession under his control when he had not confirmed that the first train had reached the protection limits at the end of the possession. Secondly, due to the length of the possession the driver of the second train had proceeded at a speed that meant he was unable to stop the train short of any obstruction on the line.

Fosse Road, Leamington Spa - 24 April 2005

6 The incident occurred when an engineers' train 6P27, consisting of a locomotive and 40 loaded ballast wagons collided with wagons of another train, 6P26, standing in a work site in a possession (Figure 12).

7 The train had travelled just over one mile (1.6 km) from the work site marker boards, reaching speeds of up to 17 mph (27 km/h). It was alleged that there was no tail lamp on the stationary vehicles at the time of the collision, and the locomotive driver did not see the rear of the train until it was too late to stop. The collision occurred at 5 mph (8 km/h); there were no injuries. The investigation concluded that the cause of the incident was the train driver travelling within a long possession and the driver not having accurate knowledge of the train location. The speed of the train was such that the driver was unable to stop short of the obstruction.

Figure 12: Image of derailed rear wagons of train 6P26 caused by the collision

8 The communication process between the Engineering Supervisor and an Engineering Supervisor's agent / competent person may have been a factor.

9 The industry investigation considered that the driver of the rear train had not asked who the Engineering Supervisor's agent was when he had authorised him to commence the movement of his train into the work site. Correspondingly the 'competent person' had not identified himself to the driver as the agent of the Engineering Supervisor and he also did not have any form of "identification" to make this clear more readily. No armband or badge that might make the 'competent person' easily identifiable is stipulated within the Rule Book. In addition, the investigation identified that there is no laid down set protocol for the 'competent person' to follow when authorising trains to proceed into a work site and no specific competency requirement. The investigation team agreed that a recommendation should be made to clarify the 'competent person's role and identity.

10 Network Rail also considered whether instructions in the Rule Book relating to movements within engineering work sites should be consolidated into a single section for ease of reference. The intention of this was to allow the relevant details to be located more easily by the staff requiring to refer to them, rather than their having to look in a number of modules. This recommendation was not implemented.

11 The cause of the incident was the driver of train 6P27 failed to control the speed of the train that would have enabled it to stop short of any obstruction ahead.

12 The underlying causes were identified as:

- the driver had concentrated on the line ahead rather than taking cognisance of the train's speed;
- it was alleged that the rear wagon of the train ahead did not possess a tail lamp at the time of the incident;
- the driver of the train had been looking for the rear of the train ahead and was convinced that it would be showing illumination by way of a tail lamp;
- the driver of 6P27 had become confused as to the exact location of the train ahead; and
- the driver did not comply with the Freight operators Professional Driving Policy with regard to the speed that trains should be driven within possessions.

13 Other factors identified that relate to the Leigh-on-Sea incident were:

- there was no laid down "specific" speed at which trains should travel within engineering work sites;
- there is no formal competency or certification for the role of "Engineering Supervisor's agent" and more specifically the member of staff who authorises trains to enter an engineering work site;
- the 'competent person' is not required to wear any form of identification that might highlight to other members of railway staff working within the possession the role he is undertaking; and
- matters relating to movements within engineering work sites are found in a number of modules T3, T7, T11 and S5 - of the Rule Book.

14 The industry investigation made recommendations to consider the introduction of a formal competency and identification requirement for the role of the 'competent person' (referred to in the report as an Engineering Supervisor's agent). The competency should include a set protocol for the role to follow when authorising trains to proceed into a work site. This would include the advice to a train driver of the speed of the engineers' train authorised by the Engineering Supervisor. The intention of the recommendation was to ensure that the 'competent person' can be readily identified by all appropriate staff and that he is fully trained in carrying out the role's duties.

15 Network Rail did not implement the proposed recommendations from the investigation. The recommendation relating to the definition of the 'competent person' was rejected on the basis that the standard requires a 'competent person' to have a level of competency to do the job, rather than specifying a particular role (paragraph 203). The recommendation for the proposed amalgamation of the Rule Book modules in relation to the working of engineers' trains within a possession and work site was rejected on the basis that the information was included within Module GE/RT/8000 T11.

Weybridge - July 2006

16 The incident occurred at Weybridge when an engineers' train 6Z40 and a Road Rail Vehicle (RRV) collided. The RRV had been standing on the down slow line after the Engineering Supervisor had authorised the movement without correctly establishing that the work site was clear and safe for train movements. The train movement was made at excessive speed in a location where the curvature of the track made it impossible to see the line as clear ahead and for the train to be able stop short of any obstruction at that speed.

17 There was no industry report and an investigation was conducted by the contractor. The two immediate causes of the incident were:

- the Engineering Supervisor authorised the movement of train 6Z40 without ensuring the line was clear within the work site; and
- the train driver failed to control the speed of the train which would enable it to stop short of any obstruction.

18 The report into the Weybridge incident recognised similarities to the incident that occurred at Aldridge in 1997, and recommended that clarification was required on the current Rule Book instructions regarding speed of movements within engineering possessions and their associated work sites.

19 The report also identified that there was no competence and certification for the role of 'competent person' who would have authorised the train to proceed into the work site. The contractor's findings were incorporated into the Industry investigation of the Fosse Road incident.

20 The incident was not investigated by the RAIB as the incident was not notified under the Railways (Accident Investigation and Reporting) Regulations 2005.

Brentingby - 9th February 2006 (RAIB Report 01/2007)

21 The incident occurred at 05:31 hrs when a freight train operated by English Welsh and Scottish Railway passed a signal at danger and the locomotive and first three wagons derailed at the *trap points* beyond the signal. The immediate cause was that the driver had a microsleep approaching the signal at danger and was only woken up again after the train had derailed.

22 Causal factors included:

- the driver suffering from fatigue because he had not slept for about 22 hours; and
- the time of the day when the incident happened coincided with the period when levels of alertness are naturally low.

23 Contributory factors included:

- the shift roster pattern during the week of the incident consisted of spare turns where the driver was required to work two early turn duties where the driver's sleep was likely to have been shortened, followed by a day shift where he was not required for duty followed by a night turn of duty where it would be difficult to get sleep prior to the shift;
- the main driving task was in the second half of the shift when the risk of fatigue was greatest;
- the roster 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;
- train drivers could normally (in the absence of a random fitness for duty check) book on at an unsupervised depot without any check as to their fitness for duty;
- the driver did not obtain sufficient prior sleep to maximise alertness during the turn of duty during which the incident occurred; and
- a briefing on coping with shift working 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.

24 Relevant recommendations that were made related to:

- English Welsh and Scottish Railway's fatigue management system and the implementation of counter fatigue measures such as breaks for napping if the assessed risk of fatigue is high;
- initiating 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;
- producing 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;
- implementing a system to re-brief at intervals the guidance issued on lifestyle and include the families of drivers in the briefing if possible; and
- initiating 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.

25 The Office of Rail Regulation has closed all ten recommendations.

Basford Hall Yard, Crewe - 21 February 2006 (RAIB Report 06/2007)

26 On the 21 February 2006, train 6D51 from Crewe to Toton was stopped as it hauled wagons that had been identified with unsecured loads of redundant track panels.

27 The wagons should not have been included in the train as it had not been properly prepared for dispatch from Basford Hall Yard in Crewe. The RAIB investigation concluded that the shunter who made the despatch error may have suffered from fatigue due to the shifts that he had previously worked, together with his off duty activities.

28 A factor to prevent the possible cause of fatigue was the use of a forward rotation (morning/afternoon/night). One recommendation was made to the freight operator. This was to put in place a company process to assess and take account of fatigue arising from the shifts that members of staff work. Action should include consideration of amending staffing levels and roster patterns where appropriate.

29 The Office of Rail Regulation has closed all five recommendations.

Maltby - 28 June 2006 (RAIB Report 24/2007)

30 On 28 June 2006 train 6C51, a freight train operated by Freightliner Heavy Haul, was conveying coal from Redcar, near Middlesbrough, to West Burton power station, near Gainsborough. The train was travelling along the South Yorkshire joint line between Doncaster and Worksop when it approached Maltby from the north at 03:00 hrs. The line is single track but there are two loops at Maltby which allow trains to pass. The train was being routed from the main line into one of these loops when it became derailed.

31 A contributory factor was the length of the shift being worked by the signaller at Maltby that may have made him prone to fatigue. A recommendation was made to Network Rail to design a roster pattern for signal boxes that are manned by a single person to prevent the signaller being subjected to possible undue fatigue.

32 The Office of Rail Regulation has closed all four recommendations.

Purley - 18 August 2006 (RAIB Report 27/2007)

33 On 18 August 2006 a freight train conveying empty wagons from Purley yard to Acton yard passed signal T172 at danger by 35 m following a train movement at Purley station. The freight train was stopped following a Train Protection Warning System intervention. The driver immediately reset the equipment without speaking to the signaller and continued his journey towards Acton yard.

34 The RAIB investigation identified that it was also possible that the freight train driver was fatigued and this was a causal factor in the incident. No recommendations in relation to fatigue were made.

Badminton - 31 October 2006 (RAIB Report 30/2007)

35 At approximately 22:54 hrs on Tuesday 31 October 2006 two self-powered track maintenance machines, a tamping machine and a *ballast regulator*, collided near the site of the former station at Badminton, between Bristol Parkway and Swindon station. The section of line was closed to normal traffic for track renewal work.

36 The tamping machine was travelling at about 35 mph (58 km/h), and the ballast regulator was stationary. All four people on board the machines, the drivers and two machine operators, were injured, two of them seriously.

37 The RAIB investigation identified that the immediate cause of the incident was that the driver of the tamper had not controlled the speed or had not reacted to the presence of the stationary ballast regulator on the line ahead, so as to be able to stop short of it.

38 A causal factor relevant to Leigh-on-Sea was:

- the fatigue experienced by the driver, which may have made it difficult for him to remain alert.

39 In addition, the following factors relevant to the Leigh-on-Sea incident were considered to be contributory to the severity of the incident:

- the custom of driving at more than 20 mph (32 km/h) within work sites; and
- the lack of a defined speed limit for movements in work sites.

40 The investigation also observed that the extreme length of the work site resulted in an arrangement which permitted the two machines to travel long distances on the same section of line simultaneously, with neither the protection of the signalling system nor suitable operational measures to control the risk of a collision.

41 In addition to this, the lack of a definition of a work site in the Rule Book and the length of the work site made it difficult for the Engineering Supervisor to comply with the Rule Book requirements and increased the risk to people working.

42 The RAIB report of the Badminton collision was published on 22 August 2007. Recommendations from the Badminton report relevant to the Leigh-on-Sea investigation included the implementation of a process to ensure the PICOP and Engineering Supervisor are able to easily identify any inconsistency between the location of the work site and the extent of the possession and that the Network Rail planning procedure NR/PRC/MTC/PL0056 should be enhanced by providing clear guidance on who is responsible for processing the requests for any changes and additions to work sites.

43 A recommendation that the length of work site should be kept as short as possible was initially rejected by both Network Rail and the RSSB. However, in July 2008 the recommendation was accepted and published within GE/RT8001 Changes to National Operations Publications (issue sixteen) in August 2008.

44 Changes were made Rule Book Amendment No 03/08 (December 2008) Rule Book to Module T3. The new clause stated that:

'each work site must be kept as short as possible'.

45 The Office of Rail Regulation has closed all four recommendations.

Four Ashes, Stafford 27 November 2008

46 At 01:58 hrs on 27 November 2008 a ballast regulator working within a possession collided at slow speed with a trolley at Stafford Trent Valley Junction. There were no injuries reported and no significant damage sustained. The causal factor of the incident was due to the Engineering Supervisor who authorised the movement of the ballast regulator without knowing the location of the trolley or briefing the driver about its presence. The RAIB did not investigate this incident in view of the minor nature of the incident and because the RAIB had previously made recommendations from previous incidents which were still under consideration / being implemented.

Appendix F - Research publications on fatigue

Office of Rail Regulation	Managing fatigue in safety critical work Railways and Other Guided Transport Systems (Safety) Regulations 2006 July 2006
Rail Safety and Standards Board	Review of coping strategies to mitigate fatigue of train drivers
Health and Safety Laboratory	Evaluation of the UK Rail Sector Initial Fatigue & Risk Index Thresholds: Identifying Good Practice RSU/08/03
Health and Safety Laboratory HMSO Crown Copyright	Fatigue Index (FI) Calculator 2.2. Fatigue Index guidance issue 2.1. http://www.hse.gov.uk/research/rrhtm/rr446.htm
Railway industry Advisory committee (RIAC)	Fatigue and Shift Patterns
Health and Safety Executive reference: 188/1998	Assessing the risks associated with fatigue in railway safety critical tasks.
Medical Research Council	New dimension discovered in body clock rhythm-16 May 2008
Rail Safety and Standards Board	Operations Appendix 1: Working patterns of train drivers –implications for fatigue and safety
Rail Safety and Standards Board	Human factors study of fatigue and shift work - rostering culture. / Evaluation of current tools and techniques use for estimating risks associated with shift patterns.

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