RAIB
Rail Accident Investigation Branch

Rail Accident Report

Signal T172 passed at danger at Purley station, Surrey
18 August 2006

Department for Transport

Report 27/2007
August 2007

This investigation was carried out in accordance with:

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

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Contents

Introduction

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

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

3 Access was freely given by EWS, Southern and Network Rail to their staff, data and records in connection with the investigation.

4 Appendices at the rear of this report contain glossaries:

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

Summary

Key facts about the incident

5 On 18 August 2006 a freight train conveying empty wagons from Purley yard to Acton yard passed signal T172 at danger by 35 m (38.27 yards) following a *shunting move* at Purley station. See Figures 1 and 2.

6 The freight train was stopped following a *Train Protection Warning System* (TPWS) intervention. The driver immediately reset the equipment without speaking to the signaller and continued his journey towards Acton yard.

7 The freight train was finally stopped by the driver at signal T160 at Purley Oaks station, which had been changed to show a red aspect by the signaller at Three Bridges *Area Signalling Centre* (ASC).

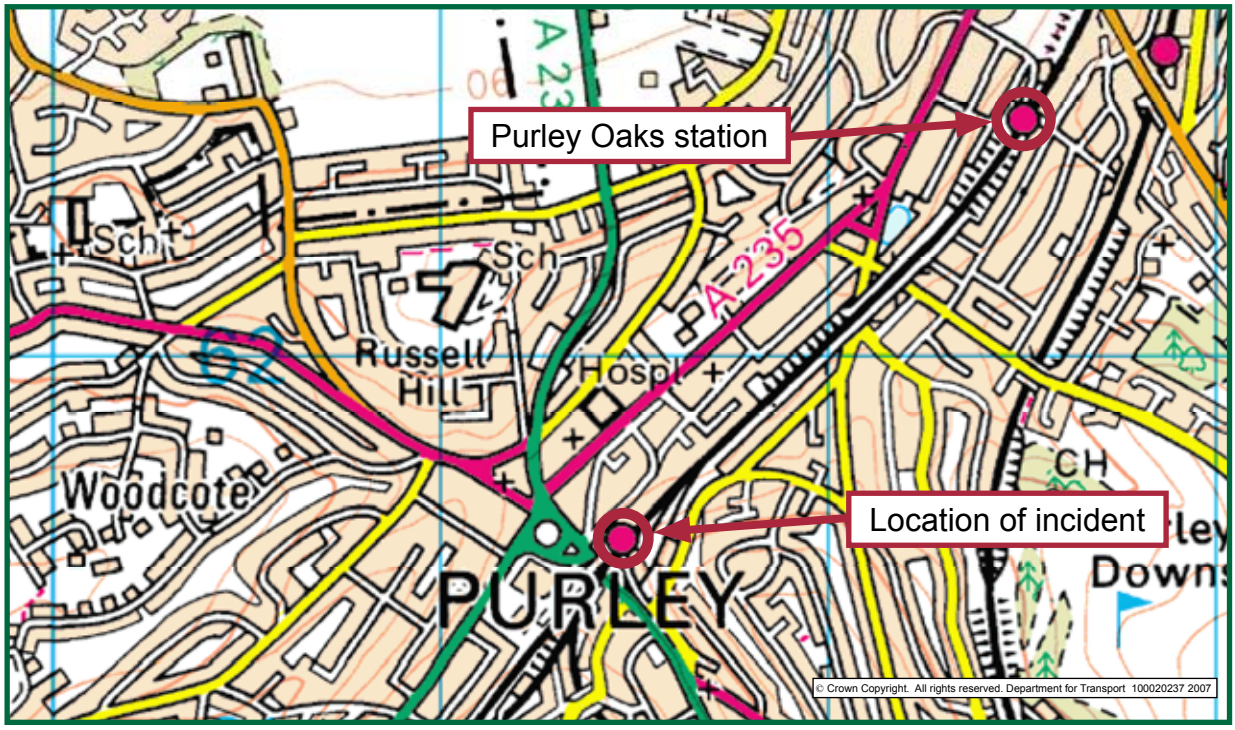

Figure 1: Extract from Ordnance Survey map showing location of incident

Immediate cause and causal factors

8 The immediate cause of the signal passed at danger (SPAD) incident was that the driver of train 6V66 incorrectly assumed that the adjacent signal (T174), which was at green, applied to him.

9 The main causal factors of the SPAD incident were:

- the driver had positioned his locomotive incorrectly and could not see signal T172 from where he had stopped; and
- no specific stop marker was provided on platform 4.

10 The immediate cause of the TPWS *reset and continue* incident was that the driver of train 6V66 did not apply laid down procedures and communicate with the signaller after the TPWS intervention.

11 The main causal factors of the TPWS reset and continue incident were:

- the driver was probably confused because he had previously operated the TPWS *train stop override* when leaving the yard;
- the driver incorrectly assumed that the adjacent signal (T174), which was at green applied to him; and
- the driver's lack of awareness and understanding of the functioning of the TPWS.

Severity of consequences

12 No one was injured as a result of the incident.

13 A set of *trailing point ends* were slightly damaged as a result of the freight train *running through* these points.

14 The freight train and the passenger train did not derail.

Recommendations

15 Recommendations can be found in Paragraph 190. They relate to the following areas:

- the installation of a specific stop marker 26 m (28.43 yards) on the approach to signal T172 on platform 4 at Purley station or the prohibiting of the use of platform 4 by freight trains leaving the yard;
- the provision of specific TPWS training for all drivers, new and experienced;
- the revision of the existing Method of Working statement associated with the briefing of EWS and Network Rail staff;
- steps to address the safety of shunters; and
- amendments to relevant Railway Group Standards.

Figure 2: T172 and T174 on the London end of platforms 4 and 5 at Purley station

The Incident

Summary of the incident

16 On the 18 August 2006 at 11:03 hrs, a freight train, reporting number 6V66, conveying eighteen empty wagons from Purley yard to Acton yard, passed signal T172 at danger by 35 m (38.27 yards). This was immediately following a *propelling* shunting move out of the yard and a change of direction at Purley station. The train consisted of locomotive 59 203 with one JFA and seventeen JHA *hopper wagons* attached.

17 Signal T172 is a four aspect colour light signal located at the northern end of platform 4 at Purley station, authorising train movements towards London. See Figure 3.

18 At exactly the same time that the freight train departed from platform 4, a passenger train, the 10:39 hrs from Tattenham Corner to Charing Cross, (reporting number 2Y52), had also begun to move away from platform 5 on a green signal (T174) in the same direction and on a conflicting route. The passenger train was a four-*car* EMU, numbered 377 123, a four-car *Electrostar*.

19 The driver of train 2Y52 became aware of the potential collision and brought his train to a controlled stop while still in platform 5 and 54.5 m (59.60 yards) before reaching T174 signal. The train had reached a maximum speed of 11.9 mph (19.15 km/h) before the driver applied the brake to the *full service brake position*.

20 The freight train was automatically stopped following a TPWS intervention, 35 m (38.27 yards) past signal T172.

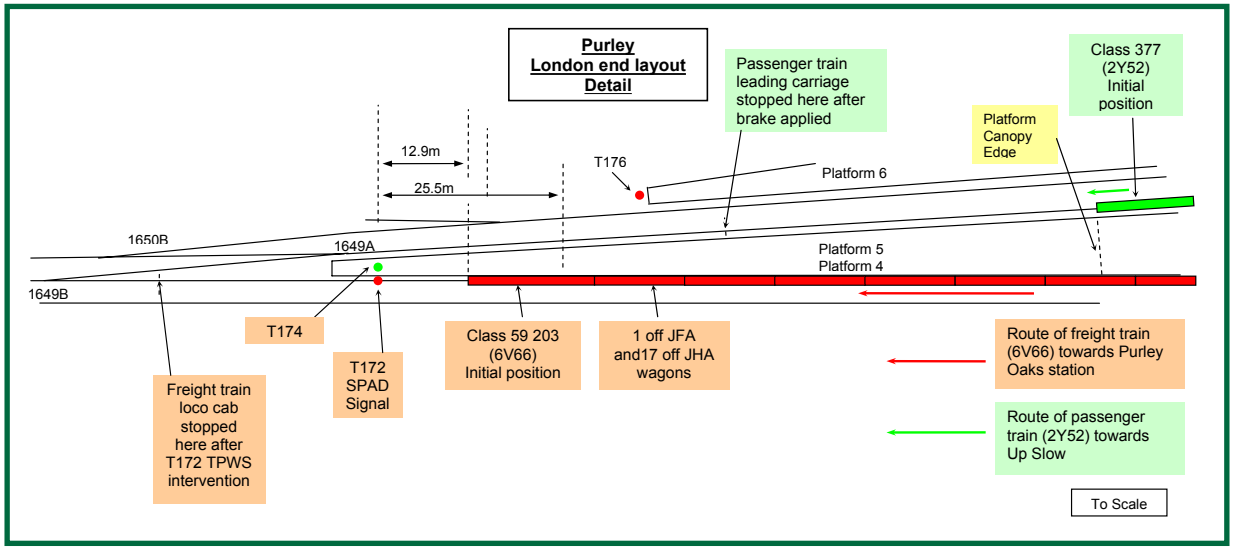

Figure 3: Detailed plan of incident site showing initial and final positions of trains at Purley station

21 The driver of train 6V66 reset the TPWS using his *reverser key,* without speaking to the signaller, and continued his journey towards Acton yard.

22 The signaller at Three Bridges ASC realised from his panel indications that the freight train was still moving and replaced signal T160 at Purley Oaks to show a red aspect. The driver stopped his train at this signal, 1650 yards (1508.76 m) after passing signal T172 at danger.

23 The driver of train 6V66 spoke to the signaller on the signal post telephone (SPT), at signal T160 and the signaller completed form *RT3189* with the driver in accordance with the *Rule Book*. The driver was then relieved of duty at Purley Oaks station. Another EWS driver drove the train to Acton Yard, departing at 13:40 hrs following brake tests.

24 The passenger train was terminated at Purley station. The train consisting of empty coaching stock (ECS*)* departed at 11:26 hrs. The driver was shaken by the experience and was relieved at East Croydon station by a driver manager. The driver manager drove the train to London Bridge station accompanied by the original driver of train 2Y52.

The parties involved

25 Network Rail is the infrastructure owner with responsibility for maintenance as well as managing the operation of signals on the network. Network Rail also manages Three Bridges ASC which is staffed by signallers controlling movements of trains from London through to the south coast.

26 English Welsh and Scottish Railways Ltd, (EWS) operated freight train 6V66 and also provides the ground staff, (shunter) at Purley yard.

27 Southern Railway operated passenger train 2Y52 and also manages Purley station.

Location

28 Purley station is a busy through station with main line services running from London to Brighton. It is also the junction for branch lines to Tattenham Corner and Caterham.

29 Purley yard is managed by Day Aggregates, part of the Day Group Ltd, who supply primary and recycled aggregates for the construction and landscaping industry. These aggregates are transported to Purley yard by EWS, where they are unloaded from the wagons in siding 3.

30 There is no direct access from Purley yard to the running lines. All trains must enter and leave the yard via the *headshunt* at the north end of the station, which can be reached from platforms 4, 5 or 6. See Figure 4.

Signalling and operations

31 The movement of the EWS train from the headshunt of the yard into Purley station is controlled by a signaller at Three Bridges ASC. He decides when and to which platform the train will propel depending on actual train movements at the time.

32 The freight train 6V66, according to the Working Timetable, is booked to arrive at Purley station at 10:58 hrs from the yard and depart for Acton at 11:03 hrs.

33 Although the train is booked into platform 6 according to the *Working Timetable*, the majority of signallers prefer to signal the freight train into platform 4 to minimise the impact of the operation on other trains.

34 The signaller has the flexibility to route the freight train from the headshunt into either platforms 4, 5 or 6, depending on the timing and regulation of other trains in the area at the time.

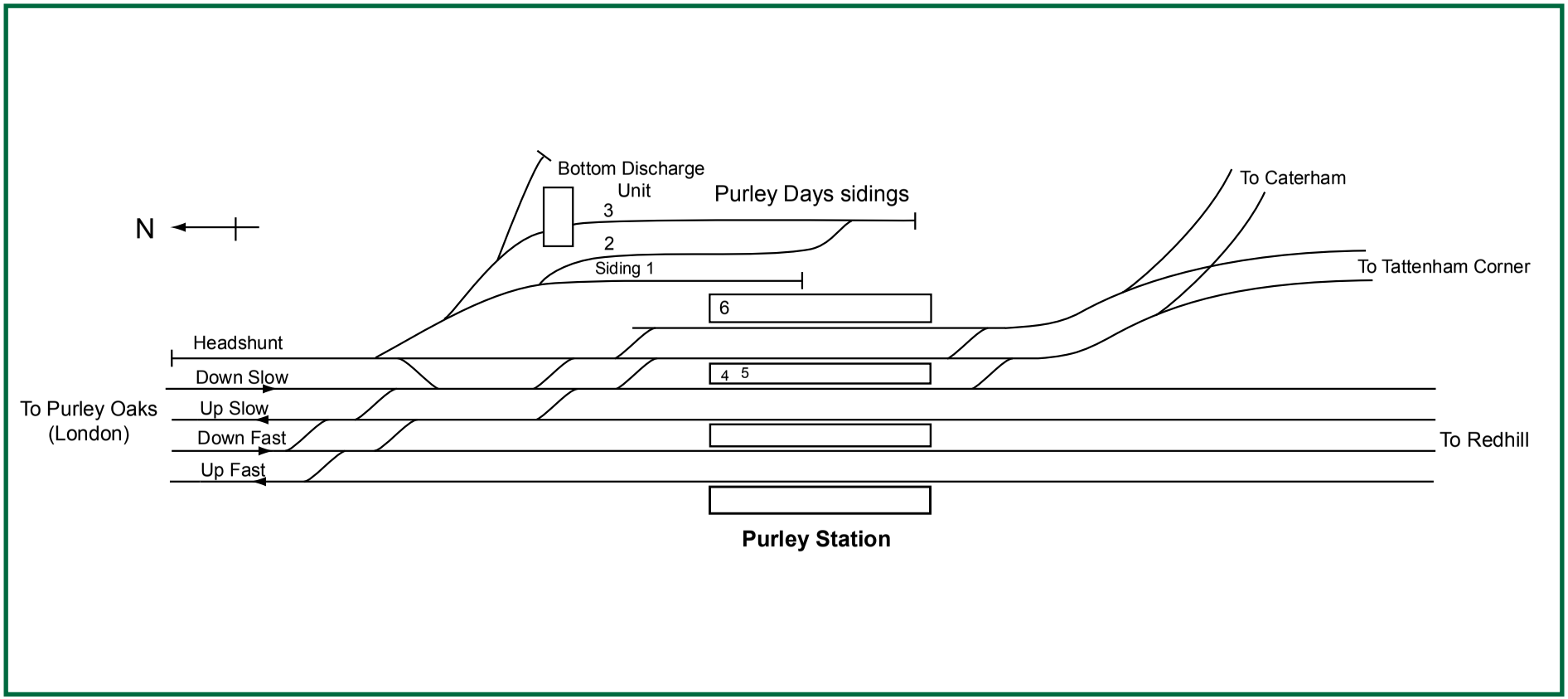

Figure 4: Purley station and Purley Yard showing headshunt at Purley Oaks end of station

35 There are two routes that can be set from signal T174 to the *up slow* line. The provision of two routes from platform 5 allows for simultaneous parallel departures from platforms 5 and 4 to the up slow and up fast lines respectively. The signalling is designed on the basis that trains will normally be routed from signal T174 to the up slow line via crossovers 1649 and 1645, (marked X in Figure 5). However, an alternative route is provided via crossovers 1646 and 1640, (marked Y in Figure 5).

36 There are no *signal box special instructions* at Three Bridges ASC that are applicable to Purley station or yard with respect to the control of movements of freight trains.

37 In the Network Rail *Sectional Appendix* (Southern), the only relevant instruction is that the signaller must be telephoned before any movements are made from the yard into the station.

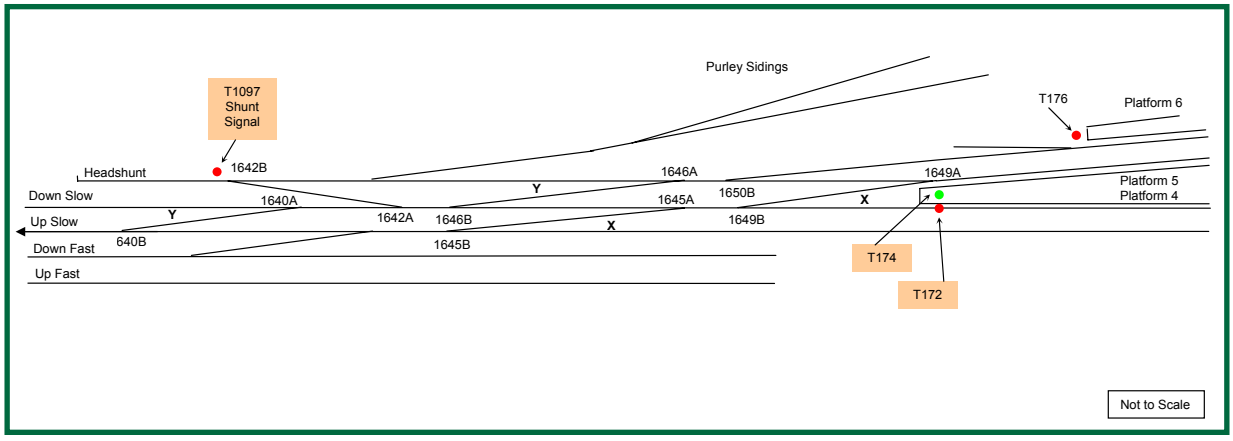

Figure 5: Purley station and the London end layout indicating point ends and crossovers

38 The signalling *relay room* at Purley contained a data logger that monitored the points, signals and tracks in the area.

Purley yard layouts

39 The layout at Purley yard has been subject to many alterations since its original installation, including changes to its method of operation as different companies have owned and managed the yard and methods of unloading wagons have changed.

40 Any changes to the layout and operations since 2003 have been documented in *Method of Working* (MOW) documents written by the relevant train operating companies.

41 Purley yard was remodelled during 2005 to cater for longer trains and to allow locomotives to run round their wagons in the yard sidings. The current method of working was introduced in 2006 (paragraphs 102 to 111).

Train(s)/rail equipment

42 Both the class 59 and the class 377 passenger train involved in this incident are fitted with an *On Train Data Recorder* (OTDR) which records the speed, brake, TPWS and control positions on the trains.

External circumstances

43 The weather at the time of the incident was hot and sunny with clear skies. The weather conditions were neither causal nor contributory to this incident.

Sequence of events

44 The sequence of events prior to and during both incidents, the signal passed at danger (SPAD) and the subsequent TPWS '*reset and continue'*, has been reconstructed from OTDR data, CCTV records and signalling data tapes and is shown in Table 1.

Time Hrs:mins:secs	Event (See also Figure 6)
11:01:00	The freight train, 6V66 exits the headshunt propelling 18 wagons towards platform 4. When the train is halfway down the headshunt, the driver isolates the TPWS for approximately 60 s using the TPWS train stop override push button. The freight driver is in the northern or London *no2 end cab* of the train. He is unable to see the shunter and is reliant on the use of *back to back radios* to receive commands from the shunter to control the shunting move.
11:02:02	Train 6V66 comes to a stand 12.9 m (14.10 yards) on the approach to signal T172. See Figure 3. (Note: The driver cannot see signal T172 when in his seat.)
11:02:02	The signaller sets the route from platform 5 to the up slow for train 2Y52 via 1649 points *normal*.
11:02:03	The TPWS train stop override automatically resets in the loco and is now fully active again.
11:02:04	Signal T174 changes from red to green.
11:02:07	Passenger train, 2Y52 (Tattenham Corner to Charing Cross) occupies the platform 5 *track circuit* and the driver sees signal T174 at green. The driver of train 2Y52 on his approach into platform 5 sees the freight train completing its propelling move into platform 4.
11:02:08	The shunter goes into driving cab of 59 203 to collect his radio and bag. The driver hands the items to the shunter. (They are normally handed to the shunter through the cab window.)
11:02:29	Train 2Y52 stops at the four *car mark* and releases the doors. The driver sees the freight locomotive under signal T172 gantry.
11:02:35	The shunter leaves the freight train cab and walks away with his back to driver.
11:02:37	The driver of train 6V66 leans out of the platform cab side window to say goodbye to the shunter.
11:02:47	The driver of train 6V66 re-sits in the driver's seat and sees signal T174 at green. He wrongly assumes that this signal applies to his train.
11:02:59	The driver of train 2Y52 takes power and moves forward, accelerating to 11.9 mph (19.15 km/h).
11:03:02	The driver of train 6V66 takes power and moves forward in the mistaken belief that the signal T172 has been cleared.
11:03:09	**Train 6V66 passes signal T172 at danger.**
11:03:13	The driver of train 2Y52 applies his brake into the full service position and his train comes to rest 54.5 m (59.60 yards) on the approach to signal T174 (See Figure 6).
11:03:14	Signal T174 goes to red by the occupation of the track circuit beyond signal T172 by train 6V66.
11:03:24	Train 6V66 is stopped 35 m (38.27 yards) past signal T172 by the TPWS intervention (See Figure 6).
11:04:01	**Train 6V66 moves away following the reset of the TPWS by removal and re-insertion of the reverser key.** No contact is made with the signaller.
11:04:42	Train 6V66 runs through 1646B points to take the up slow route towards Purley Oaks station (see Figure 6).

Table 1: Events preceding and during the incident

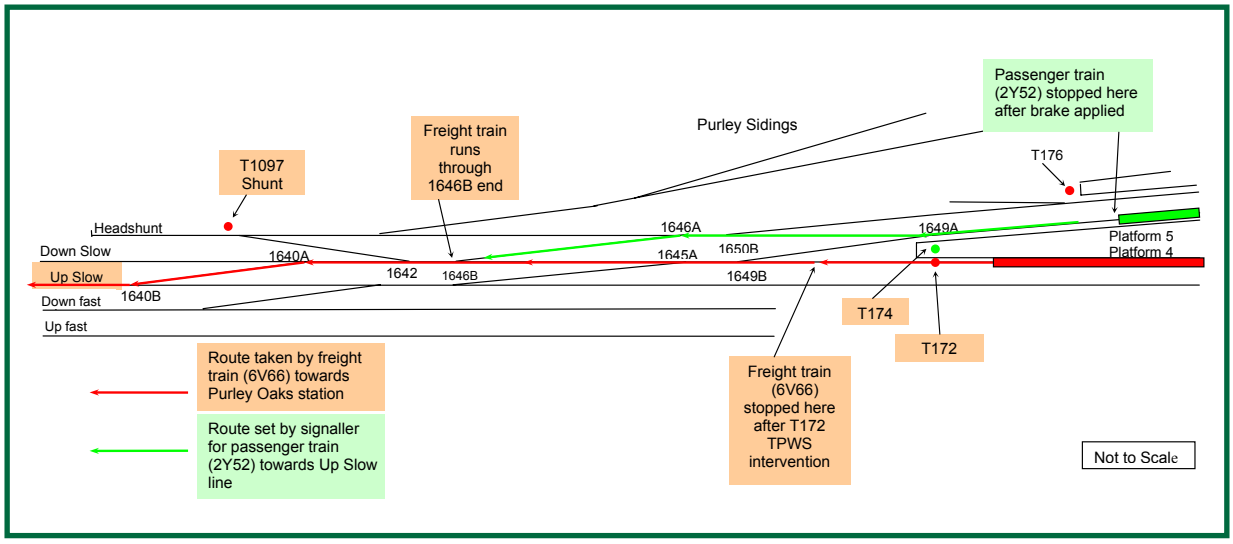

Figure 6: Purley staion and the London end layout showing routes set and taken of both trains

Consequences of the incident

45 Following the TPWS reset, the driver of train 6V66 continued travelling towards London on the up slow line. As a consequence, train 6V66 *ran through* 1646B points which had been set for the passenger train, 2Y52. The driver of train 6V66 did not see the points set against him and was unaware of the run through.

46 The run through of 1646B points caused some minor damage to the front *stretcher bar* and a broken stretcher bar bracket which initially left the points usable only in their *normal* position. This resulted in the blocking of the routes into and out of the London end of platform 6.

47 There was no damage to either train.

48 The driver of train 2Y52 avoided a possible collision with train 6V66 by controlling his train to a stop while still in platform 5.

49 The passenger train was travelling at 11.9 mph (19.15 km/h) when the driver braked.

Events following the incident

50 The signaller saw track circuits becoming occupied on his panel and realised that a SPAD had occurred. He immediately sent 'stop' messages through the *cab secure radio (CSR)* system to passenger trains, 2Y52 at Purley platform 5 and 2G29 on the *down* slow line at Purley Oaks station.

51 The signaller was unable to directly communicate with the freight driver because the class 59 did not have a CSR system fitted in either of the driving cabs. He did not send an emergency stop message by the *National Radio Network* (NRN) system to the driver for the following reasons:

- the train was moving away from Purley station (ie the immediate danger had passed); and
- the time taken to transmit using the NRN system, which would have involved a communication via Network Rail operations control, would introduce a time delay.

52 The signaller operated signal T160 at Purley Oaks on the up slow to red. This was the next available signal that could be set to red by the signaller to stop the freight train.

53 The driver of train 6V66 brought his train to a stand at signal T160 and spoke to the signaller via the signal post telephone. When informed by the signaller, he realised that he had made an error and passed the signal at danger. The signaller completed form RT3189 with the driver as detailed in section 15 of module TS1 of the Rule Book. The driver was then requested by the signaller to remain in his cab and not move his train.

54 The driver of train 6V66 was relieved by another EWS driver and taken back to Hither Green depot via road by his operations manager.

55 An EWS engineer attended to complete a functional brake check on the locomotive and wagons before the whole train moved onwards at 13:40 hrs.

56 At 11:26:44 hrs, train 2Y52 left Purley station, running empty, towards London. The driver was shaken by his experience and contacted another Three Bridges ASC signaller on his approach to East Croydon and asked to be relieved at Croydon.

57 At East Croydon station the driver was met by a driver manager and relieved. The driver manager drove the train and the original driver of train 2Y52 rode in the cab for the rest of the journey to London Bridge.

58 Network Rail staff were sent to site and undertook repairs to the damaged point end.

59 The OTDR download of locomotive 59 203 was completed at Acton yard on the 18 August 2006 when the train finally arrived from Purley.

The Investigation

Investigation process

60 The investigation examined:

- the technical and human factor issues surrounding the SPAD and the TPWS 'reset and continue' by the freight train driver;
- EWS management systems including the briefings and communication of method of working documents to all staff;
- train movements at Purley yard and shunting moves into Purley station; and
- EWS training and assessments of staff.

Sources of evidence

61 Sources of evidence were:

- witness statements taken by RAIB Inspectors;
- photographs and measurements taken by RAIB Inspectors of Purley station and a class 59;
- cab ride in a class 59 from Purley yard into platform 4 at Purley station at 11:00 hrs on 7 September 2006;
- OTDR information from the locomotive 59 203;
- CCTV footage of platform 4 and 5 at Purley station;
- signalling track, signal and points data from Purley station relay room data logger; and
- a review of the EWS competence management arrangements as they relate to TPWS.

Key Facts

The Personnel involved

62 The driver of train 6V66 had 36 years driving experience and had been involved in no previous SPADs. He had booked on at 05:04 hrs at Hither Green depot, before travelling by taxi to Purley yard to begin his duties at 06:00 hrs.

63 The driver of train 2Y52 had one and a half years driving experience and had been involved in no prior incidents. He had booked on at 04:14 hrs at Selhurst depot.

64 The shunter at Purley yard had twenty three years experience in the role of shunting and had also been a ground staff standards inspector for two years from 2003. He had booked on at 03:30 hrs at Three Bridges before travelling by train to Purley yard to begin his duties at 04:55 hrs.

65 The signaller at Three Bridges had over thirty years experience as a signaller and had been involved in no significant safety critical incidents. His shift had started at 08:00 hrs on the 18 August 2006.

Previous occurrences of a similar character

66 There have been two other SPADs at signal T172 at Purley since 1999.

67 On 25 January 1999, an EWS driver read the wrong signal (T174) and passed signal T172 by 1650 yards (1508.76 m). TPWS was not installed at the time.

68 On 21 November 2002, another EWS driver read the wrong signal (T174) and passed signal T172 by 20 yards (18.28 m) following a TPWS intervention. The driver did not 'reset and continue'.

69 Nationally at the time of this report, there have been 22 instances of drivers resetting the TPWS and driving on without authority since July 2001[1]. Eighteen have been by passenger train operators and four have been by freight operators, of which three have been by EWS.

70 Eight percent of the last fifty TPWS interventions associated with signals were followed by a 'reset and continue' incident.

71 All three TPWS 'reset and continue' incidents involving EWS occurred in 2006. The first was at signal N428 at Newport on 10 May where the driver misread the signal and passed it at danger. The TPWS intervened, but was reset and the driver carried on not realising he had had a SPAD.

72 The second instance was at signal R134 at Reading on 16 July where the driver was unfamiliar with the route whilst running round his train and on realising a SPAD had occurred, reset his TPWS and continued on believing he needed to move his train to a safer location.

73 From analysis of the reports on the above EWS 'reset and continue' incidents, there are no common factors between the R134 SPAD at Reading and the T172 incident.

[1] TPWS installation began in 2000 with signalling fitments becoming fully operational nationally by December 2002. The installation of TPWS at buffer stops and PSRs were subsequently completed by December 2003.

74 There are common factors between the N428 SPAD at Newport and the T172 incident. These are:

- in both cases, the driver read the wrong signal on the same gantry as applying to himself, having seen the aspect clear;
- the drivers were tripped by TPWS, which was reset in an irregular manner and they both carried on, unaware they had passed a signal at danger; and
- the TPWS indication panels in the locomotives were outside the drivers' primary field of vision. However the driver at Newport did not see the TPWS *brake demand* light that would have flashed on the panel and it would appear that the Newport driver never considered TPWS as being a cause of the brake application. This is a crucial difference with the Purley SPAD where the driver knew TPWS had intervened before he reset it.

75 The three EWS 'reset and continue' incidents are similar but unrelated.

76 Details of research carried out and strategy proposed by RSSB into TPWS 'reset and continue' incidents are detailed in Appendix E. The industry is due to decide in July 2007 whether to take forward the proposed modifications to the TPWS human-machine interface.

Information associated with the SPAD incident

Actions of the freight train driver

77 The driver of train 6V66 passed signal T172 at danger because he mistook signal T174 as being applicable to himself and when this signal changed to a green, (proceed) aspect, he reacted accordingly and took power.

78 The driver was well accustomed to driving to and from Purley yard before, during and after the remodelling of the yard layout in 2005. However, for the majority of the time, the driver was routed from the yard into platform 6. Moves from the yard into platforms 4 and 5 were less frequent.

79 A driver learns a particular route and all its possible combinations by travelling with other drivers over a period of time. In recent years, a driver's training has been supplemented by route learning aids such as pictorial route cards and DVD's. A driver then undergoes an assessment by an operations manager and, if successful, is *passed out* on that route.

80 The subsequent re-assessment of drivers and retention of this knowledge is dependent on the possible combinations of the route actually driven over.

81 When any *propelling move* is undertaken, the shunter is in charge, (Ref Rule Book, Module SS2). He gives instructions to the driver by radio, hand signals or face to face instructions. The shunter at Purley controlled the movements of the trains from Purley yard into the station and vice-versa by face to face instructions to the driver and via the radio. During this movement, he was located close to the locomotive and not at the leading end of the movement as required by the Rule Book module SS2.

82 The shunter, standing at the London end of platform 4, controlled the train into platform 4 by counting down the number of wagons past the signal for the drivers benefit. The shunter, on seeing the *leading cab* of the locomotive passing under the gantry had informed the driver of his position.

83 The driver of train 6V66 then stopped the front of the locomotive only 12.9 m on the approach to signal T172 signal. See Figures 3, 7 and 8. At this position the driver could not see signal T172 on the gantry directly in front of him, but could clearly see the incorrect signal T174, platform 5's starter signal.

84 Figure 7 shows the viewing range of a driver seated in his seat. It demonstrates that at 12.9 m (14.10 yards) from signal T172, the driver would not have seen the signal, and at 22.9 m (25.04 yards), only the red aspect could have been seen. For a driver to see a green aspect, (the physically highest aspect of signal T172), the locomotive must be 25.5 m (27.88 yards) from the signal. This distance was measured after a reconstruction of the move with a class 59 into platform 4 from Purley yard.

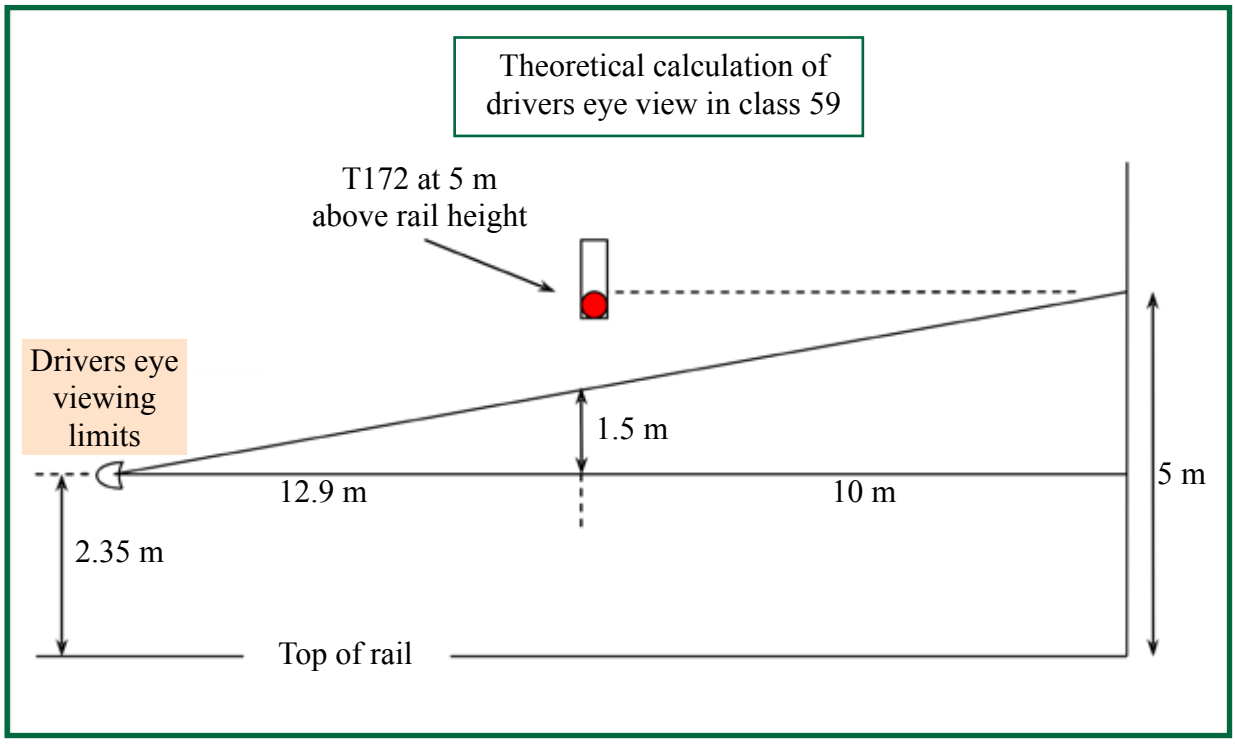

Figure 7: Elevation plan of driver's viewing range showing driver at 12.9 m and 22.9 m on the approach to signal T172

85 Figure 8 shows the relative positions of a class 59 at 25.5 m (27.88 yards) on the approach to signal T172 and where the locomotive stopped on the 18 August, only 12.9 m (14.10 yards) on the approach.

86 The correct route for the passenger train from Purley platform 5 to Purley Oaks, when set by the signaller, (after the freight train had come to a rest behind signal T172) had resulted in all signals on the route between those two points on the up slow line showing green. Two of these signals were visible to the freight train driver when at signal T172.

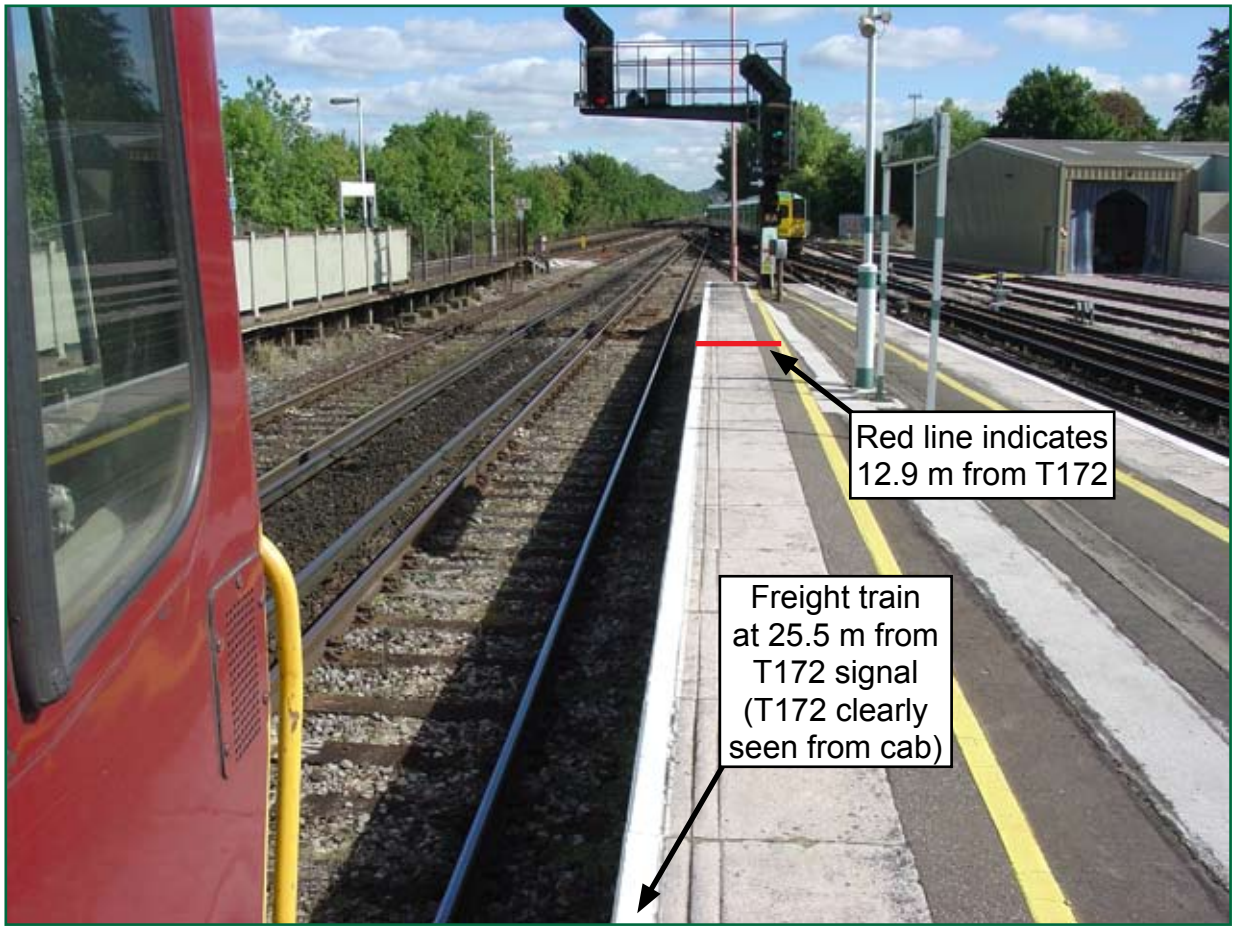

Figure 8: Photograph taken from platform 4, (adjacent to the driving cab and at the same height of a train driver seated in the driving seat) of the position of a Class 59 locomotive 25.5 m from signal T172

Freight train driver rostering and fatigue

87 When the incident occurred, the EWS freight driver was working his sixth turn of duty that was either a night shift or an early shift with a very early start. See Table 2. The driver's sleep had been interrupted by a thunder storm at 01:00 hrs, and he did not get back to sleep again until shortly before his alarm sounded to wake him up again at 03:45 hrs. He acknowledged that he had had very little sleep the night before the incident.

88 The driver did not leave the locomotive footplate at any time during his shift. He had a rostered break between 09:30 hrs and 10:30 hrs on the 18 August, but this was also spent in the cab.

89 The *Fatigue Index* (FI) value (as opposed to the Fatigue and risk Index), for the six continuous shifts that included the one in which the incident occurred exceeded the indicative value on three occasions is shown in Table 2 (see Appendix D).

Date	Time on duty (hrs)	Time off duty (hrs)	FI value	Indicative value	Comments
13-08-2006	01:55	09:55	18	35	
14-08-2006	04:00	12:00	21	30	
15-08-2006	01:30	12:26	36	35	
16-08-2006	01:40	12:21	38	35	
17-08-2006	05:21	14:40	28	30	
18-08-2006	05:05	16:20	32	30	Disturbed sleep prior to shift reported by driver

Table 2: Fatigue index results for the freight train driver

Infrastructure issues

90 On platform 4 at Purley station, there is no specific stop marker to indicate to freight train drivers the correct stopping position when shunting or propelling from the headshunt. Stop markers exist only for passenger trains and a 6/8 passenger *car stop marker* for platforms 4 and 5 exists positioned at about 60 m (65.61 yards) on the approach to signals T172 and T174.

91 The driver of the freight train was not aware of the correct stopping position associated with a propelling movement into platform 4 (paragraph 103).

92 Signal T172 at the London end of platform 4 is on a gantry 5 m (5.46 yards) above the left hand side running rail of platform 4 in the direction of travel for *up line* trains. See Figure 8. Paragraphs 83 to 86 describe that where the driver stopped on platform 4, he would not have been able to see signal T172 above him. However, the installation of signal T172 on a gantry above the rails was necessary to enable a clear view of the signal for other trains using platform 4 in an up direction.

93 Signal T174 at the London end of platform 5 was the signal that the driver of train 6V66 mistook as his after it had turned to green. This signal is at the freight train drivers' eye level, when he is seated in his driver's seat, even though it is to his right hand side and has a direction arrow pointing towards platform 5; this arrow plate was installed as part of the 2002 SPAD recommendations (paragraph 98).

94 As discussed earlier, the driver made more moves to and from platform 6 than from the other two platforms combined. Signal T176, at the London end of platform 6 is also on the right hand side of the driver after he has propelled back from the headshunt into the station. Signal T176 is also at the same height as signal T174. See Figure 9.

Figure 9: Signal T176 at the London end of platform 6 at Purley showing similarity to T174 on platform 5

Signalling issues

95 As discussed in paragraph 34, the signaller had the flexibility to route the freight train from the headshunt into either platforms 4, 5 or 6 depending on the timing and regulation of other trains in the area at the time.

96 In this incident, the signaller routed the freight train into platform 4 for timetabling reasons to minimise delay to other passenger trains, especially train 2Y52 that was arriving into platform 5 at the same time. The signaller was also aware that the freight train was longer than any of the platforms at Purley and that platform 6 had a double bend in it. Platform 4 was also chosen because it was straight with consequent improved visibility. Platform 4 is approximately 41 m longer than platform 6 and 22 m longer than platform 5.

Previous SPAD report recommendations

97 Following a SPAD that occurred in November 2002, (paragraph 66) a report was produced by Railtrack Southern ref. QSR/2002/09/323 version Final. The report document included the Special Signal Sighting Committee (SSSC) summary report of December 2002.

98 Both the SPAD report and the signal sighting report made recommendations which are detailed below. The RAIB investigation has confirmed the status of these recommendations to be as follows:

- EWS to consider retraining the driver in the layout of the Purley area and to brief him on the necessity to stop at such a distance that would enable him to observe the correct signal from the driving cab. *Status: implemented*.
- Railtrack to consider the recommendation from the SSSC report that T174 signal should be provided with a 'line arrow' to identify to drivers the line to which the signal applies. *Status: implemented*.
- EWS to consider an additional instruction in the EWS method of working that, when propelling from Purley Down sidings to Purley station into platforms 4, 5 and 6, trains must stop with the London end cab 25 m (27.34 yards) from the approach side of T172, T174 and T176 signals. *Status: implemented in the May 2003 MOW, but later removed in the September 2005 issue (paragraph 103)*.
- EWS to consider reviewing all locations where the above instruction could apply when propelling moves of this type take place. *Status: EWS added a new driving technique to its professional driving policy (paragraph 101)*.
- The close range viewing sectors (*hot strips*) on T172 signal should be oriented to the 6 o'clock position. *Status: implemented*.

99 No freight input, either by EWS or Freightliner was obtained at the SSSC, even though they were invited to attend. Only representatives from the passenger train operating companies and Railtrack attended. Only the freight companies' drivers made the shunt moves between Purley yard and the station.

100 Following the 18 August 2006 SPAD and TPWS 'reset and continue' incident, a SSSC was convened on 7 September and it was concluded that there were no infrastructure related issues associated with the SPAD and only a level 1 sighting exercise was carried out. This is a desk top type exercise and not carried out on site, but was attended by representative from Network Rail, EWS and Southern.

101 The EWS professional driving policy new technique, (as referenced in paragraph 98) was, 'When making a movement behind a signal, bring it, (the train) to a stand a locomotive length away so that you have a clear view of the signal when you change ends'. The type of move that resulted in all the SPADs at Purley did not involve the driver in changing ends at any time (paragraph 150).

Method of Working documents for Purley yard

102 The first EWS method of working document, dated May 2003 replaced a Mainline Freight document dated January 1996. The EWS document described the layout at Purley yard and station, which at that time included a conveyor type discharge system installed in siding 3.

103 Movements between the yard and Purley station platforms 4, 5 and 6 were allowed and the locomotive run round occurred mainly at platform 6. The 'Train Departing' section of the document stated that, 'If the train is routed into platforms 4 or 5, the driver must stop his locomotive a full locomotive length in rear of the signal.' A class 59 locomotive length is 21.3 m (23.29 yards) long. This sentence was removed in subsequent method of working documents from September 2005 including the current one. The reasons for this alteration remain unclear.

104 Part 7 of the 2003 method of working looked at 'Other Risks'. It described many SPAD risks at Purley including T172 and stated, 'Departing trains standing on the down slow line (platform 4) at signal T172. The driver should take care not to be confused by signal T174 pertaining to the up Caterham loop (platform 5).' It also mentioned the risk of 3rd rail electrification on the main lines and the headshunt.

105 The second and third EWS methods of workings were dated June and September 2005 respectively and were titled, 'Interim MOW during remodelling'. These and the current MOW were written by an EWS operations manager, the direct line manager of the Purley ground staff.

106 The June 2005 MOW was a copy of the May 2003 MOW updated to say that certain sidings would be out of use during the remodelling. The documents 'Train Departing and Other Risks' sections remained the same.

107 In the September 2005 MOW, the 'Trains Departing' section of the document omitted any instructions with respect to platforms 4 and 5 and instead provided detailed instructions only for platform 6.

108 Part 7 of the September 2005 document, now entitled, 'Summary of risks', omitted the SPAD risk of signal T172 and also only mentioned 3rd rail issues at the 15 1/4 milepost positioned at the country end of the station.

109 The fourth EWS method of working was dated February 2006.

110 The 'Trains Departing' section of the document again omitted any instructions with respect to platforms 4 and 5 and instead provided detailed instructions for only platform 6.

111 Part 7 of the 2006 document, entitled, 'Summary of risks', omitted the SPAD risk of signal T172 and also again only mentioned 3rd rail issues at the 15 1/4 milepost.

Briefing of MOW to EWS ground staff

112 The method of working documents produced by EWS for Purley are intended for use by all EWS staff employed in undertaking train operation and shunting duties there.

113 The introduction to the current method of working document states that, 'All employees issued with this document must familiarise themselves with this MOW and adhere to the instructions contained within it'.

114 EWS ground staff at Purley, including shunters, are not personally issued with this document. When a new document is produced, it is left on a desk in the shunters cabin or at a booking on point to be read. Although verbal communication to shunters of the document may have been undertaken, the method of leaving the document on a desk and expecting everyone to read it is not good practice. No written record was made of the ground staff having read, received or understood the method of working.

115 During the re-modelling of Purley yard, the shunters cabin was moved from its original position and became unusable. EWS arranged to use the Days office for their drivers and ground staff, and a copy of the MOW was then placed there.

116 In practice, the Days office was not used and ground staff used a room on platform 6, shared with Southern platform dispatchers to charge their radios and take refreshments. No MOW was displayed in this room.

117 The shunter involved with the propelling move from the yard into the station had not seen the new method of working, but he had discussed the method of working movements into platform 6 with his operations manager.

Briefing of MOW to EWS drivers

118 EWS drivers are not personally issued with the method of work. When a new or updated document is produced, a notice is displayed in the drivers *new notice case*, stating that a MOW has been written and displaying a brief summary of the changes. The MOW is displayed in wall mounted plastic files adjacent to the notice cases and near to the driver's signing in point, and as part of his booking on, a driver is given 10 minutes at the start of every shift and expected to read these notices and instructions.

119 No written record is made of a driver having read or understood the method of working, but a driver will sign his *route card*. In the view of the operations manager, this signature implies that he is also signing for any methods of working for the route to be worked.

120 The driver involved in this incident was aware of where MOWs were displayed at his depot but unaware that an amended one had been written for Purley or how these are brought to his attention. The driver relied solely on the ground staff advising him of new working instructions.

Information associated with the TPWS 'reset and continue' incident

121 The impact of the SPAD at signal T172 was exacerbated by the driver circumventing the TPWS intervention that occurred by closing down the driving cab controls and then re-activating them. The driver did not realise that the reason why the intervention occurred was because he had passed signal T172 at danger. This action removed the protection provided by TPWS.

TPWS train stop override and temporary isolation functions

122 A train stop override button control is provided in each cab of a class 59 as part of the driver's TPWS control panel. The button is used to prevent the train stop sensor functioning so that the locomotive may pass a signal at danger under the authority of the relevant signaller. The override is automatically cancelled when the signal at danger is passed or after 60 seconds have elapsed since the button was pressed which ever is the earlier.

123 A temporary isolation switch is provided at the no1 end of a class 59. The switch is used to temporarily isolate the train stop and *overspeed sensor* functions in situations such as a train entering an engineering possession where a sequence of red signals would be passed at danger or in the event of a fault with the TPWS.

Actions of the freight train driver

124 The driver on his exit from the headshunt, (driving from the *no2 end cab*) to the station, depressed his TPWS train stop override push button. He did this because he believed that the TPWS would activate during the shunting movement. This belief was reinforced by two previous false activations he had experienced at Purley, for reasons that the RAIB has not been able to ascertain.

125 When TPWS did intervene correctly after signal T172 was passed at danger, the driver believed that this was another false intervention by the system.

126 If the override system had not reset itself by the time signal T172 was passed, then there would not have been a TPWS intervention and the train would not have been brought to a stop.

127 The Rule Book, module TW1, section 13 covers propelling movements. Clause 13.4, (Before the propelling movement starts) states that, 'If the train or traction unit is fitted with TPWS, you must temporarily isolate the TPWS before the propelling movement starts and reinstate the TPWS when the movement has been completed.' This rule to isolate and reinstate was not completed by the driver correctly.

128 The use of the wording, 'temporarily isolate' in the Rule Book may be interpreted in two ways by a driver either by the use of the temporary isolation switch or by the use of the override button.

129 Following the SPAD of signal T172 by the freight train and the subsequent TPWS intervention bringing the train to a stop, the driver of the freight train did not see the lie of 1646 points ahead. If the driver had looked ahead at the track, he might have seen the points set against him and may have realised he had passed the signal at danger. This is likely to have reminded him to contact the signaller immediately before resetting his TPWS and continuing.

130 The driver of train 6V66 was also unaware of the passenger train on platform 5 at any stage. The driver, even though he looked out of his platform 4 side window to say goodbye to the shunter prior to departing, did not look out of any of his side windows at any time after that.

131 Once the driver of train 6V66 had been stopped by the TPWS, he could see green signals on the up slow line ahead on the route he knew he would be taking.

132 When the TPWS intervenes and the train automatically comes to a stop, the driver is instructed by the Rule Book (Module TW5) to immediately contact the signaller. The driver of train 6V66 did not at any time contact or try to contact the signaller.

133 The driver of train 6V66 also reset the TPWS by the removal and re-insertion of his reverser key. This is not the approved method, but the quickest method which takes approximately 30 seconds and is also used by other freight train drivers following a TPWS intervention.

134 The approved method is to firstly acknowledge the brake demand by depressing the *Automatic Warning System* (*AWS)* cancel button before communicating with the signaller. The brakes will then be released 59 seconds from the time of initiation of the brake application. By using the reverser key method, the cab is shut down and then reset immediately. The time taken to re-charge the *brake pipe* with air is the overriding factor is this method.

EWS Management Systems (TPWS)

Original TPWS training and material for drivers

135 At the time of the incident, EWS had produced the following training material and safety briefings on TPWS:

- a TPWS training video in 1999. The video does not mention that the signaller must be contacted following a TPWS intervention;
- TPWS traincrew manual in December 2000. This was not a controlled document and not signed for by individuals;
- TPWS safety brief: Management of unsolicited brake applications (TPWS), dated April-July 2003;
- TPWS safety brief: TPWS update and changes to Rules dated Dec 2004 – March 2005; and
- TPWS safety brief: TPWS update including 3 EWS case studies dated Sept-Dec 2006.

136 There is no EWS comprehensive drivers' manual, nor a specific TPWS section.

Training for new drivers

137 TPWS training is covered in material for new drivers both in a classroom, simulator and practical environment. This TPWS training is assessed by EWS trainers during these situations.

Briefings

138 All training sessions by EWS are assessed, whereas safety briefings are not.

139 From 2001, EWS provided its staff with regular safety briefings from eight regional centres throughout the country. All staff had to attend within certain timescales to receive their brief. The freight driver in this incident received his briefings from a centre in Wembley

140 Since the beginning of 2006, safety briefings are given by local operation managers at local depots to the staff involved.

Training and briefings for the driver of train 6V66

141 The driver of train 6V66 received some training in TPWS when the system first became operational on board locomotives in 1999, but there are no records on his training file.

142 The driver of train 6V66 had the following safety briefings:

- Aug 2001 – TPWS briefing received – at local depot
- 11 April 2003 – Safety brief received – at Wembley
- 19 Jan 2005 – Safety brief received – at Wembley
- 07 Sept 2006 – Safety brief received - at local depot

143 The content of safety briefings includes information provided by EWS headquarters, supplemented by local information. However, the method of working for Purley and its amendments had not been included in these safety briefings.

144 The adequacy of these local safety briefings are not subject to audit and are not routinely monitored or recorded by EWS management.

145 The local operations manager of the driver involved had been trained to give safety briefs but had never been trained or received any safety briefs in TPWS. Despite this, the operations manager's work involved the assessment of drivers both in theory and practice.

146 The operations manager's training had ceased in 1998, when he was promoted from a driver to traction inspector.

Safety issues arising

Network Rail and EWS joint instructions for movements

147 There was no joint Network Rail and EWS instructions for the movement of freight trains between Purley station and Purley yard.

148 Although EWS had a method of working which identified only platform 6 to ground staff and drivers (the train was booked to use platform 6 and the Working Timetable also confirmed the use of platform 6), the Network Rail signallers preferred to route the train into platform 4.

149 There had been some correspondence during 2005 between EWS and Network Rail about the writing and implementing of method of workings at Purley including signal box instructions for the use of platform 6 only at Purley. These were never agreed or implemented.

EWS shunting arrangements

The driver

150 The freight driver propelled his train from the northern or London end cab of the train. He was unable to see the shunter and was therefore reliant on the use of the *back to back radio*s to receive commands from the shunter to control the safety critical workings of the train movements.

151 According to the Rule Book, Module TW1, section 13.6, (During the movement), 'A driver may drive the train from a driving cab other than the leading driving cab if he will have a better view of signals and handsignals'. In this case the driver was in the London end cab at all times during the incident and was therefore facing signals T172 and T174 as the train came to rest in platform 4.

152 Due to noise from passing passenger trains, the freight driver had to keep his cab windows closed at all times in order to hear the voice commands from the shunter via the radio.

The shunter

153 Shunters controlling movements of trains propelling back into platforms 4 or 5 are forced to cross over two running lines and one live conductor rail to reach platforms 4/5 when carrying out shunting moves. Other methods are available to them, but none are written down, and these would involve the movement taking much longer, with the resulting delay to other trains in the vicinity.

154 There were no specific instructions in the new method of working for platform 4 (or 5) operation concerning the crossing of running lines and conductor rail.

The use of the radio

155 The back to back radios used at Purley for communication between the shunter and driver are of a Motorola type. These radios are specifically designed for shunting as they have a continuous confidence tone feature.

Communication between signaller and freight train drivers

156 There are two main systems of communication on the rail network. These are the CSR and NRN systems.

157 The passenger train 2Y52 was fitted with the CSR system which allowed the signaller to directly communicate and immediately with the driver.

158 The freight train 6V66 was fitted with the NRN system which allowed only Network control to speak directly to the driver. A signaller may communicate with the driver, but this would have to be done via the network control. This therefore entails a delay in any emergency communication that may be required.

159 A new system, known as Global System for Mobile communications - Railways (GSM-R) is currently being trialled in Glasgow in 2007.

160 The project is expected to be operational by 2013. It will provide a single national system of secure train driver to signaller communication with contact being quickly established in emergencies. This will replace the current NRN and CSR systems.

Analysis

Factors associated with the SPAD

161 The driver of train 6V66 misread the green aspect of signal T174 as applying to his train. This was a causal factor in the incident. The explanation for the error is credible given the following factors:

- T172, the signal that should have been cleared in order to authorise a movement out of platform 4, was not visible from his driving position. This also was a causal factor in the incident.
- T174, the signal that the driver could see from his driving position was at the driver's eye level. In addition, the position of the signal T174 relative to the driving position was similar to that of signal T176, the signal that controls movements out of platform 6 (the platform with which the driver was most familiar) (paragraphs 83 and 93).

162 The inability of the driver to see signal T172 was because the locomotive stopped only 12.9 m (14.10 yards) from signal T172. The driver stopped at this position because he was unaware of the need to stop the front cab of his locomotive at least 25 m (27.34 yards) from signal T172 in order to view the aspect. There was no stop marker to indicate the correct stopping position on platform 4 nor was he reminded by the shunter (paragraphs 84 and 90). The fact that there was no stop marker was a causal factor to the incident.

163 The driver's belief that signal T174 applied to his train was reinforced by his sighting of green signals on the up slow line ahead, but he failed to realise that these applied to the passenger train 2Y52, that was standing in platform 5. This was a contributory factor to the incident (paragraph 86).

164 It is probable that the incident would not have occurred if the driver had been briefed on the method of working to and from platform 4. However, the driver had not received a briefing on the correct method of working. The specific instructions relating to platform 4 had been removed from the method of working in September 2005. These factors were contributory to the incident (paragraph 118).

165 Two other factors may also have contributed to the driver's error. The first of these was fatigue. The driver's hours of duty in the days preceding the incident have been assessed by EWS using the fatigue index tool for evaluating the potential impact of fatigue (see Appendix D). This indicates that the driver's hours of duty and shift patterns were approaching the level at which his performance might be affected. The driver also stated that his sleep had been disturbed on the previous night, (a factor that is not allowed for in the EWS evaluation of fatigue). The extent to which this level of fatigue contributed to the incident cannot be assessed with any accuracy. However, it is identified as a possible contributory factor to the error made by the driver of train 6V66 (paragraph 87).

166 The second factor is the driver's lack of familiarity with the movement via platform 4. The significance of this factor is difficult to evaluate since the driver had been routed via platform 4 on previous occasions without incident. The lack of familiarity could also have been mitigated had the driver been aware of the correct method of working. This is also identified as a possible contributory factor to the incident (paragraph 78).

167 The relationship and categorisation of the factors associated with the SPAD are described in the casual analysis diagram in Figure 10.

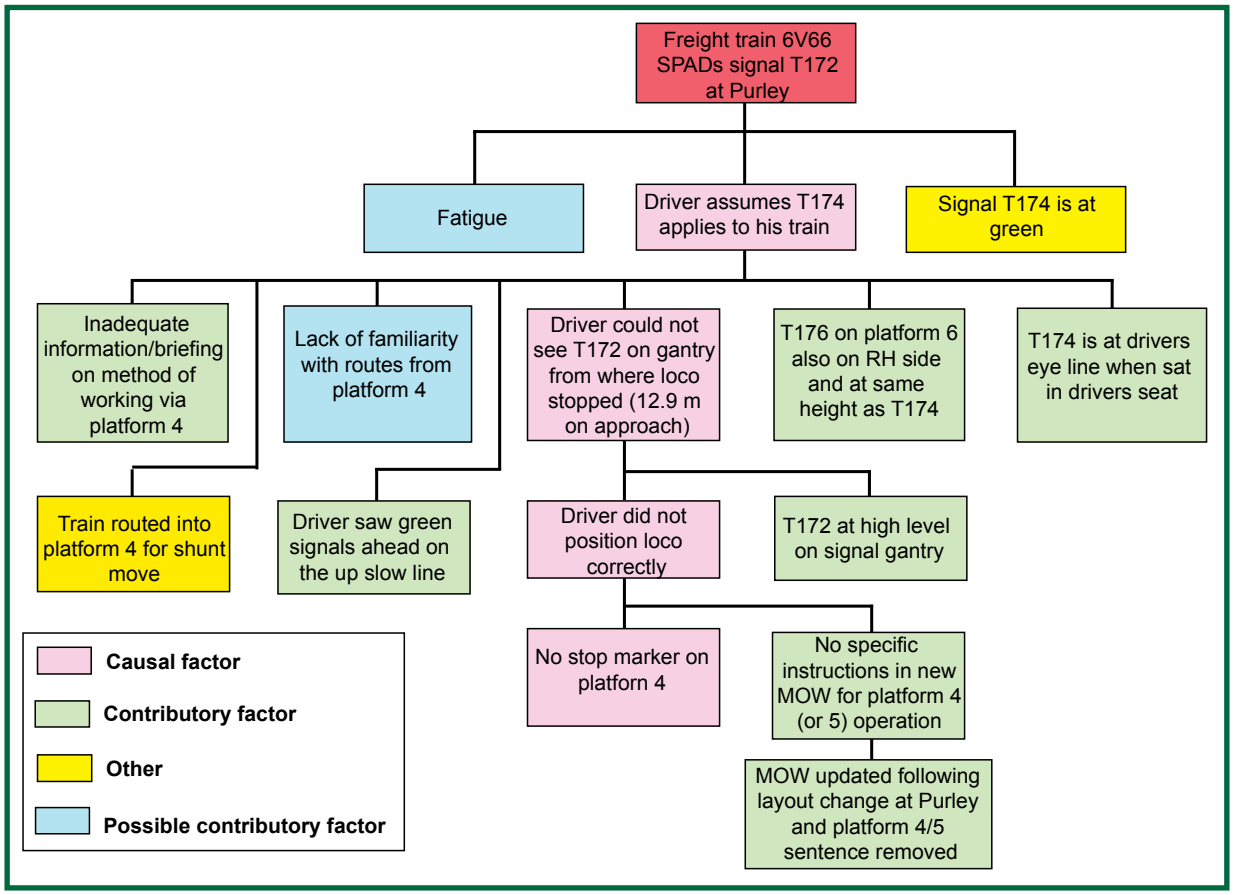

Figure 10: Causal analysis diagram of the SPAD

Factors associated with the incorrect resetting of the TPWS following the SPAD

168 The driver was unable to explain his reasons for resetting the TPWS and driving forward after passing signal T172 at danger. However it is likely that the driver assumed that the automatic intervention of the brakes was spurious. It is also likely that he was confused as a consequence of his earlier activation of the TPWS override function in the heads-hunt. The driver's probable confusion about the reason for the brake activation was a causal factor to the incident (paragraphs 124 and 125).

169 He did not consider he had passed a signal at danger. He was convinced that he was proceeding with the authority of a green signal and this conviction was reinforced by sighting two green signals ahead of him on the up slow line. The sighting of the two green signals was a contributory factor to the incident (paragraph 131).

170 As indicated in paragraph 132, the driver, following TPWS activation did not comply with the correct procedure and contact the signaller. This was a causal factor.

171 The actions of the driver following the SPAD incident are likely to be associated with a lack of understanding of the reasons for the brakes applying. This lack of understanding arose from a conviction that he had authority to proceed combined with a lack of general awareness of the functionality and rules to be applied when TPWS intervenes. This lack of awareness has arisen despite briefings provided by EWS, and was a contributory factor to the incident (paragraph 141).

172 The relationship and categorisation of the factors associated with the incorrect resetting of the TPWS are described in the casual analysis diagram in Figure 11.

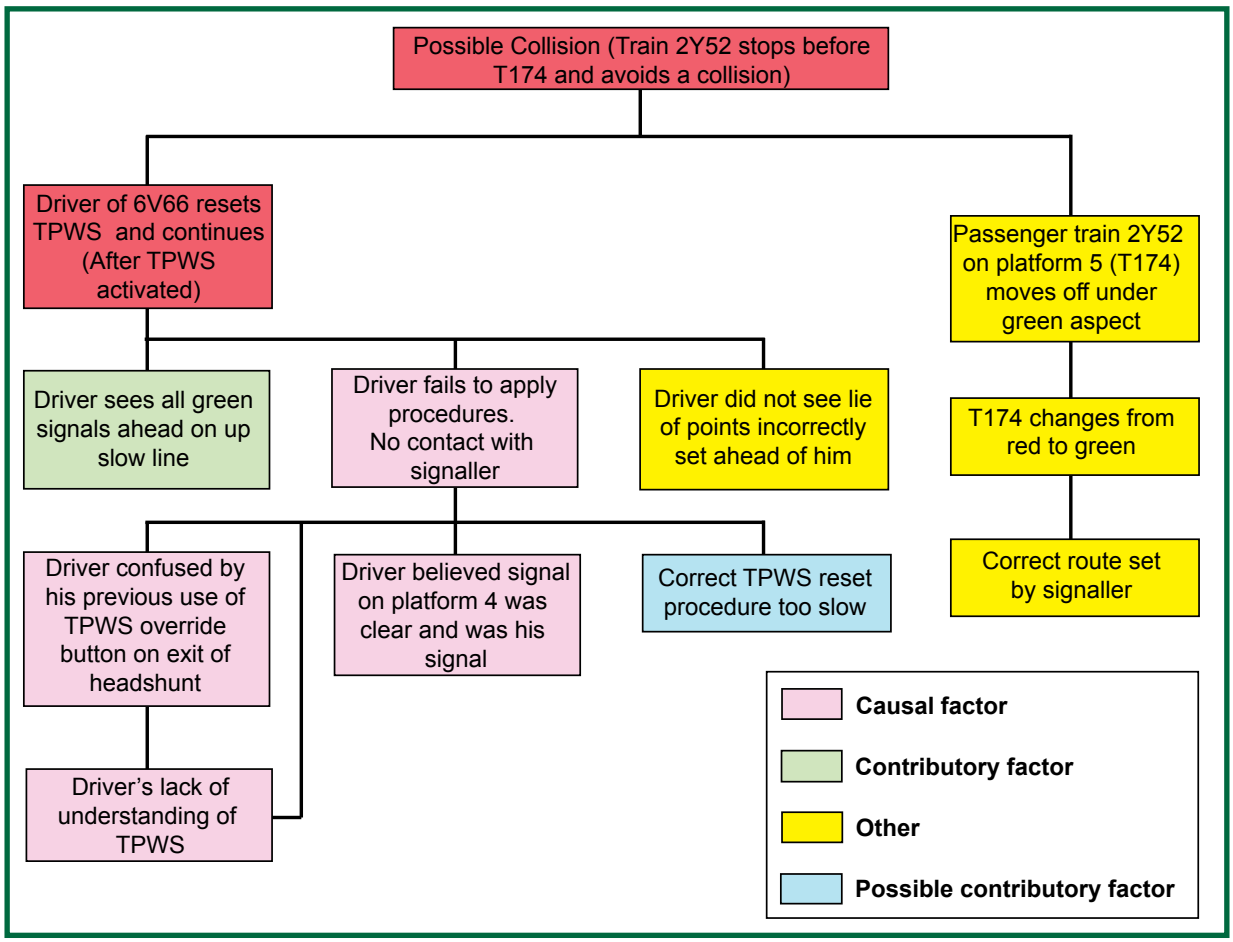

Figure 11: Causal analysis diagram of the incorrect resetting of the TPWS following the SPAD

General safety issues arising from the investigation

173 Paragraphs 147 through to 160 identify a number of general safety issues of concern. These are summarised below:

- a failure to brief method of working documents to drivers and ground staff;
- the ground staff at Purley are routinely crossing running lines and conductor rails;
- the lack of a joint Network Rail and EWS instruction for the movement of freight trains at Purley; and

Conclusions

Immediate cause

174 The immediate cause of the signal passed at danger (SPAD) incident was that the driver of train 6V66 incorrectly assumed that the adjacent signal (T174), which was at green, applied to him (paragraph 161) (**Recommendation 1**).

175 The immediate cause of the TPWS 'reset and continue' incident was that the driver of train 6V66 did not apply laid down procedures and communicate with the signaller after the TPWS intervention and before continuing his journey (paragraph 170) (**Recommendation 2**).

Causal and contributory factors

Signal passed at danger (paragraphs 161 to 167)

176 The main causal factors of the SPAD incident were:

- the driver had positioned his locomotive incorrectly and could not see signal T172 from where he had stopped (**Recommendation 1**); and
- no specific stop marker was provided on platform 4 (**Recommendation 1**).

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

- signal T176 was also on the right hand side and at the same height as signal T174;
- signal T172 is at a high level on its gantry;
- signal T174 is at the driver's eye line when the driver is seated;
- the driver saw all green signals ahead of him on the up slow line; and
- there was no specific instructions in the current MOW for platform 4 operation as the reference to platform 4 had been removed from the previous version.

178 There was a weakness in the briefing of the MOW to EWS drivers and ground staff: (**Recommendation 3**).

- there was no structured briefing of the MOW to both the driver and shunter;
- there was no record of the shunter receiving, reading or understanding the MOW; and
- the driver was unaware of the changes to the MOW.

179 It was also possible that the freight driver was fatigued. If so, this was a causal factor in the incident. The issues associated with fatigue are addressed in more detail in the report into the accident at Brentingby on the 9 February 2006 (Ref: RAIB report 01/2007).

180 A further possible contributory factor was the driver's lack of familiarity with routes from platform 4 (**Recommendation 1**).

TPWS ‘reset and continue’ (paragraphs 168 to 172)

181 The main causal factors of the TPWS ‘reset and continue’ incident were:

- the driver was probably confused because he had previously operated the TPWS train stop override when leaving the yard (**Recommendation 2**);
- the driver incorrectly assumed that the adjacent signal (T174), which was at green applied to him (**Recommendation 1**); and
- the driver’s lack of awareness and understanding of the functioning of the TPWS (**Recommendation 2**).

182 In addition, the following factor was considered to be contributory:

- the driver saw all green signals ahead on the up slow line; and
- the driver perceived that the correct procedure of TPWS resetting was too slow.

Additional observations

183 It is difficult for drivers to differentiate between brake demands when TPWS, AWS or the Vigilance device have been activated (**Recommendation 4**).

184 The shunter was forced to cross over two running lines and one live conductor rail to reach platforms 4/5 to control the movement of the propelling train (paragraph 153) (**Recommendation 5**).

185 There was no joint Network Rail and EWS instructions for the movement of freight trains between Purley station and Purley yard (paragraph 147) (**Recommendation 1**).

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

186 Due to the ongoing potential risks, the RAIB wrote to EWS on 14 November 2006 about carrying out a risk assessment into staff having to cross live running lines to reach platforms 4/5 during shunting movements.

187 EWS have produced and completed a TPWS safety briefing, dated September to December 2006 which includes all three case studies of EWS TPWS 'reset and continue' incidents this year including the incident at Purley.

188 The driver of train 6V66 involved with this incident has undergone EWS training on a simulator which included TPWS assessments.

189 The railway industry led by the Rail Safety & Standards Board, (RSSB) has been studying the problem of TPWS 'reset and continue' and has devised a strategy to prevent incidents occurring (see Appendix E).

Recommendations

190 The following safety recommendations are made[2]:

Recommendations to address causal and contributory factors

1 EWS should install a specific stop marker 26 m (28.43 yards) on the approach to signal T172 on platform 4 at Purley station to mark the point at which the driver of a freight train should stop his front cab when propelling from Purley yard; or

in consultation with Network Rail, EWS should prohibit the use of platform 4 by freight trains exiting from the yard (paragraphs 174, 176 and 181).

In both cases above, a revised MOW for drivers, ground staff and signallers should be produced by EWS, in conjunction with Network Rail, for all train shunting movements at Purley. EWS should also ensure that the *route knowledge* of all relevant drivers includes an awareness of the signalling arrangements and any associated stop markers at Purley (paragraphs 180 and 185).

2 EWS should deliver a specific TPWS training module for all drivers and assessors; new and experienced. This should include the correct procedures in the case of TPWS intervention (paragraphs 175 and 181).

3 EWS should put in place a company process for the initiating, checking, authorising, issuing and briefing of local method of work instructions (paragraph 178).

Recommendations to address other matters observed during the investigation

4 RSSB should make a Proposal, in accordance with the Railway Group Standards Code, to amend Railway Group Standards as appropriate to:

- mandate that in-cab TPWS should specifically identify a TPWS activation associated with a SPAD, (if reasonably practicable)(paragraph 133); and
- prevent the use of the driver's reverser key to reset TPWS once activated (Appendix E).

5 Subject to the retention of arrangements for shunting into platforms 4 and 5, EWS should review the method of working instructions for ground staff in order to eliminate the requirement for staff to cross over a live conductor rail (paragraph 184).

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

Appendices

Glossary of abbreviations and acronyms — Appendix A

ASC	Area Signalling Centre
AWS	Automatic Warning System
CSR	Cab Secure Radio
ECS	Empty Coaching Stock
EMU	Electric Multiple Unit
FI	Fatigue Index
JFA	J: Bogie private owner wagon
	F: Aggregate hopper wagon, LTF bogie
	A: Air braked only
JHA	J: Bogie private owner wagon
	H: Bogie aggregate hopper wagon
	A: Air braked only
MOW	Method Of Working
NRN	National Radio Network
PSR	Permanent Speed Restriction
RSSB	Rail Safety & Standards Board
SPAD	Signal Passed at Danger
SPT	Signal Post Telephone
SSSC	Special Signal Sighting Committee
TPWS	Train Protection Warning System

Glossary of terms — Appendix B

Automatic Warning System	A safety system for alerting drivers about the signal aspect or speed restriction ahead, sounding a horn in the cab for a red, single or double yellow aspect or a bell to indicate a green signal.
Back to back radio	A handheld communication system between 2 persons.
Brake demand (TPWS)	The brakes on the train are applied automatically by TPWS and are indicated to the driver by a flashing red indication in the cab.
Brake pipe	The pipe that is connected throughout the train that is required to contain air at a certain pressure to allow the brakes to be released. If the air escaped, brakes would be applied.
Cab secure radio	A radio system allowing direct and one-to-one communication between a signaller and a train driver.
Car	Term which is equivalent to coach or carriage.
Car stop marker	A sign indicating to a train driver the position at which he should stop his train. The mark will show a number or letter which will apply the number of coaches the train consists of.
Down line	Normally the line taking trains away from London.
Electrostar	An electric type multiple unit passenger train used by Southern Railways.
Fatigue Index	A quantifiable method used by employers to assess the risks associated with shift work.
Full service brake position	The maximum service brake position that can be applied before the driver may select the emergency brake position.
Headshunt	A portion of dead end track that is used by trains to access sidings by firstly coming into the headshunt before propelling back into other connected sidings.
Hopper wagon	A wagon which discharges its load through doors in the bottom area of the wagon.
Hot strip	Feature of a signal lens which directs a beam of light down towards the track immediately next to the signal head. This makes it possible for a driver standing at the signal to read the aspect shown.
Leading cab	When a locomotive is being driven, the leading cab is the cab at the front of the train in the direction of travel.
Method of working document	A document that describes the method of operation and risks of tasks that will be carried out at a particular location.
New notice case booking on point.	A notice board holding only new notices displayed at a drivers

Normal (points)	The normal position of points is determined by the signalling plan. By convention points in the normal position are set to give optimum protection to other routes.
No2 (1) end cab	A locomotive normally has two cabs at either end and are known as either no1 or no2 end cab. The cabs number is marked to indicate the cab end.
National Radio Network	A dedicated National Radio Network operated and maintained by Network Rail that allows direct communication between driver and network controller.
On Train Data Recorder	A data recorder fitted to traction units collecting information about the performance of the train.
Overspeed sensor	Trackside equipment on the approach to a fitted signal. If a train approaches a TPWS fitted signal at a speed such that it is likely to pass the signal, TPWS will apply the emergency brake.
Passed out (driver)	The driver being certified as possessing the required route knowledge.
Permanent speed restriction	A permanent reduction of speed below the published linespeed.
Propelling move	Moving a train using a locomotive at the rear of the movement.
Ran or run through (of points)	The movement of a train through a set of trailing points not set for that movement resulting in the wheel flanges forcing the stock and switch blade apart.
Relay room	A building housing signalling electrical and electronic safety critical equipment that interfaces with trackside equipment such as points and signals.
'reset and continue' (TPWS)	The action by a driver in his cab to reset the TPWS and continue driving.
'reset and continue' incident	The failure of a driver to follow correct procedures before resetting the TPWS and restarting (eg failure to seek authority from the signaller).
Reverser key	A brass key used by the driver of a freight train which is inserted in the cab desk to allow the engine of the locomotive to start and run.
Route card	A driver, once passed out on a particular route by his manager, signs a route card for that route.
Route knowledge	A driver's knowledge of a particular route including positions and aspects that could be shown by all signals on that route.
RT3189	A Network Rail form completed by the signaller with the driver of a train that has passed a signal at danger.
Rule Book	Railway Group Standard GE/RT8000, which incorporates most of the rules to be observed by general railway staff for the safe operation of the network.

Sectional appendix	Network Rail document containing local rules and instructions and details of the rail network for a given part of the network.
Set speed (TPWS)	The minimum train speed(s) at which an OSS will demand a brake application on passing trains.
Signal box special instruction	Network Rail instructions that may exist in a specific signal box that are only applicable to that box and are supplementary to the rule book.
Shunting move	A move other than the normal movement of trains along the running line (eg to/from the running line to/from a siding).
Stock rail	The fixed rail at each side of the points.
Stretcher bar	A bar linking the two switch rails in a set of points connected by a bracket to each rail.
Switch rail	The moving portion of rail on each side of a set of points.
Track circuit	An electrical or electronic device using the rails in an electric circuit that detects the absence of a train on a defined section of line.
Trailing point ends	The end of the points where the switch rail meets the stock rail and where lines converge in the direction of travel.
Train protection and warning system	An automatic trackside and trainborne system which safely stops trains that pass signals at danger so as to avoid a collision.
Train stop override/ Train stop override push button (TPWS)	The activation of the button prevents the TPWS train stop functioning for 60 s which would allow a train to pass a TPWS fitted signal at danger.
Train stop sensor	Trackside equipment at a signal that is capable of displaying a red/ danger aspect. If a train passes a TPWS fitted signal at danger, TPWS will apply the brake. If the signal is showing a proceed aspect, TPWS will have no effect
Up line	Normally the line taking trains towards London.
Up slow line (at Purley)	The line that normally conveys slow trains towards London.
Working timetable	A document that details actual timetable workings and other details of all trains including freight trains as opposed to the passenger timetable.

Key standards current at the time — Appendix C

Rule book — GE/RT 8000 T2

Rostering and Fatigue — Appendix D

EWS uses the Fatigue Index (FI) to assess the risks associated with shift work. This was developed by the Centre for Human Sciences at the Defence Evaluation and Research Agency (now known as QinetiQ) in a research project commissioned by the Health and Safety Executive (HSE) and reported upon in the HSE's contract research report 254/1999, available from HSE Books 1999 ISBN 0 7176 1728 9. It can be used to compare different shift patterns and to identify peaks in fatigue within a shift pattern. It is based on five main factors known to affect fatigue: shift start time; shift duration; length of interval between finishing one shift and starting the next; breaks; and number of consecutive shifts. For day or evening shifts, an FI value exceeding 30 is likely to indicate that fatigue is too high, whereas for night shifts, the corresponding figure is 35 or more. A limitation of the FI is that it does not take account of a person's lifestyle outside work such as the amount of sleep obtained prior to a shift.

The FI has been further developed under work commissioned by the HSE and undertaken by QinetiQ in collaboration with Simon Folkard Associates. The report on this was published in 2006 as HSE contract research report 446 and is available from www.hse.gov.uk. The research considered issues such as cumulative fatigue, time of day, shift length, the effect of breaks and the recovery from a sequence of shifts. A review was also undertaken of the trends in risk associated with shift work. The outcome of this work was the Fatigue and Risk Index (FRI) containing two separate indices; one relating to fatigue and the other relating to risk. The main difference between the two indices relates to the time of day: the peak in risk occurs close to midnight whereas the peak in fatigue occurs about five hours later. The FRI is more sophisticated than the FI. In the assessment of fatigue, it considers factors such as commuting time, workload, attention and the duration and frequency of breaks. Values of the FRI sufficiently high to cause concern are still under evaluation given its limited use to date.

If fatigue levels are assessed as being too high, employers must, in accordance with the Railways and Other Guided Transport Systems (Safety) Regulations 2006, introduce control measures such as designing and constructing a shift system that conforms to good practice. This includes restricting successive nightshifts and/or very early shifts to four consecutive shifts. Very early shifts are likely to lead to a person's sleep being truncated and therefore worsen fatigue.

Research on TPWS 'reset and continue' Appendix E

As of the end of March 2007, there has been a 92% reduction in SPAD risk since March 2001. TPWS has been responsible for most of this reduction, but this is being undermined by the TPWS 'reset and continue' incidents that have occurred. Work by the RSSB has indicated that TPWS 'reset and continue' is causing a loss in benefit of 13% of the remaining SPAD risk.

The railway industry (Network Rail and the train and freight operating companies) led by the RSSB has been studying the problem and has devised a strategy to prevent TPWS 'reset and continue' incidents occurring. RSSB research considers that their occurrence is influenced by the following factors:

- The number of TPWS brake demands that have occurred correctly by system design, but which are viewed as being operationally unnecessary. These include brake demands on the approach to *permanent speed restriction*s (PSRs) and on the approach to buffer stops in terminal platforms. The industry considers that these have affected drivers' perception of the reliability of TPWS.
- The clarity of the in-cab indications when a brake demand occurs. It can be difficult for a driver to distinguish between a brake demand caused by TPWS as opposed to one caused by the AWS, because the indications on the TPWS panel in the driving cab are the same (a flashing red brake demand light). In addition, where TPWS has been retrofitted to rolling stock in service before the introduction of TPWS, the TPWS panel is often outside the driver's primary field of vision, so he may simply not notice the flashing brake demand light.
- The reluctance of drivers to report a TPWS brake demand as required by the Rule Book, particularly those occurring on the approach to PSRs and buffer stops, because of the need to contact the signaller immediately and then complete a written report. The RSSB estimates that the total number of brake demands is about three times the number that are correctly reported; the unreported brake demands occurring on the approach to PSRs and terminal platform buffer stops.
- The manner in which TPWS is reset to enable a driver to re-take power. The system is designed to time out 60 s after implementing a brake demand to ensure the train brakes to a stand. After that, the driver can re-take power without contacting the signaller. Drivers have found that they can reduce the 60 s period by taking measures such as closing down the cab controls and then re-activating them again.

The industry's strategy determined in 2004 is as follows:

- To change the rules relating to the requirements on drivers to report TPWS brake demands and so minimise the level of system disruption occurring after brake demands on the approach to PSRs and buffer stops. This change was made in 2005.
- To seek methods to reduce the number of unnecessary brake demands on the approach to PSRs and buffers stops. For PSRs, Network Rail has applied to HM Railway Inspectorate to remove approximately 40% of TPWS fitments and to optimise the positioning of the remainder. For buffer stops, the *set speed* is being adjusted to enable a train travelling at an indicated speed of 10 miles/hr to pass over the loops without initiating a TPWS brake demand. HMRI has granted Network Rail an exemption against the requirement for about 300 PSR fitments on plain line curves. Network Rail is doing further work to seek to get about 100 PSR fitments in place for asset protection to be also covered by the exemption.

Of the remaining approx 700 fitments, Network Rail is to optimise the speed setting based on the braking of new rolling stock. For buffer stops, the set speed change is about 70% complete and programmed for completion by the end of this year.

- To identify and rectify the causes of unwarranted brake demands due to technical causes. Good progress is being made to identify and rectify technical causes causing unwarranted brake demands.
- To investigate changes to the human-machine interface in the driving cab with the aim of enabling drivers to better distinguish between AWS and TPWS brake demands, those brake demands occurring at TPWS overspeed sensors as opposed to TPWS *train stop sensor*s and to prevent unauthorised resetting following a TPWS brake demand.

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