Rail Accident Investigation Branch

Rail Accident Report

Autumn Adhesion Investigation
Part 2: Signal LW9 Passed at Danger at Lewes
30 November 2005

Department for Transport

Report 25 (Part 2)/2007
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This investigation was carried out in accordance with:

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

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Signal LW9 Passed at Danger, Lewes, 30 November 2005

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 This report contains the findings of the RAIB investigation into the incident that occurred at Lewes on 30 November 2005 when a train passed a signal at danger by approximately 150 metres. It is Part 2 of an investigation into adhesion-related incidents during autumn 2005.

4 On 25 November 2005, an incident occurred at Esher involving a train passing two signals at danger. The circumstances of that incident bore some similarity to the incident at Lewes. The drivers of both trains had alleged that severe adhesion problems had been the cause of the overruns. RAIB has also undertaken an investigation into the incident at Esher (reported in Part 1 of the autumn adhesion investigation).

5 During the early stages of the investigation into the two signal passed at danger (SPAD) incidents, it became apparent that there had been a higher number of adhesion-related SPADs and a much higher number of adhesion-related station overruns in autumn 2005 than had occurred in autumn 2004. A separate report, Part 3 of the autumn adhesion investigation, has been prepared to address the causes of the high number of adhesion-related incidents in autumn 2005. Some of the issues identified in the investigation of the incident at Lewes have much wider relevance than for that incident alone. Where relevant, this report into the incident at Lewes contains references to the analysis of performance during autumn 2005 reported in Part 3.

6 Access was freely given to staff, data and records by Network Rail and Southern Railway in connection with this investigation.

7 Appendices at the rear of this report contain:

- explanation of acronyms and abbreviations (Appendix A);
- explanation of technical terms (shown in *italics* the first time they appear within the body of this report) (Appendix B);
- a list of relevant *Railway Group Standards* (RGS), current at the time the incident occurred.

8 Reference is made in the report to levels of adhesion between wheel and rail. This is normally expressed as a coefficient of friction (symbol μ). The lower the value of μ, the lower the adhesion between wheel and rail. Typical values for μ for dry rail would be at least 0.20. In wet weather, this can fall to 0.10. Under severe low adhesion conditions, the value of μ can drop below 0.03. As trains rely on the coefficient of friction between wheel and rail to stop, the level of adhesion available is critical to the rate at which the train can decelerate. Many modern trains have four or five fixed braking rates available to the driver, the lowest of which will normally achieve a deceleration rate of 0.3 m/s^2 and the highest a rate of at least 1.2m/s^2. A braking rate of 0.3 m/s^2 can only be achieved if the value of μ is at least 0.03. The value of μ would need to be at least 0.12 to sustain an emergency braking rate of 1.2 m/s^2.

Summary of the report

9 The RAIB investigation into the SPAD at Lewes on 30 November 2005 which resulted in a 'near miss' with another train has been undertaken in parallel with an investigation into the SPAD incident at Esher on 25 November 2005 and a general investigation into the causes of adhesion-related station overrun and SPAD incidents during autumn 2005. This report focuses on the results of the investigation into the Lewes incident alone.

10 Refer to Figure 2 for a diagram of the location of the incident. At approximately 19:07 hrs on Wednesday 30 November 2005, train 2D45, the 18:54 hrs Southern Railway service from Brighton to Hastings passed signal LW9 at danger at platform 3 in Lewes station. Train 2D45 stopped over the crossover located to the east of Lewes station, passing signal LW9 by a distance of approximately 150 metres and *running through* 75 and 77 points. Signal LW9 was at danger to protect the movement of train 2F21, the 19:07 hrs service from Lewes to Seaford, which was departing from Platform 5 and routed through 76 and 77 points towards the *down line*. The driver of train 2F21 heard train 2D45 approaching in parallel on the down line and realising that the two trains were on a converging path, stopped train 2F21 at the tips of 77 points, some 30 metres from the potential point of conflict. The vigilance and prompt action of the driver of train 2F21 is commended.

11 Nobody was injured in the incident and there was no damage to the rolling stock. Points 75 and 77 were damaged when train 2D45 ran through them. After a conversation between the signaller and the driver of train 2D45, the train was moved clear of 77 points and the driver relieved of duty as part of Southern Railway's standard response to serious incidents. The driver of train 2D45 had made no allegation against the brakes on the unit involved and a Southern Railway fitter confirmed that the unit was in a safe condition to move. After a brake test, the train was taken at a maximum speed of 30 mph (50 km/h) to Glynde where it terminated and passengers were conveyed to their destinations either by following trains or by road transport. The train was taken empty to Eastbourne sidings.

12 The driver of train 2D45 was driving in accordance with the *professional driving policy* in force at the time within Southern Railway. The actions of the driver were neither causal nor contributory to the SPAD.

13 Southern Railway's Class 377 fleet is equipped with a *wheelslide prevention (WSP) system*, which has the objective of minimising stopping distances under low adhesion conditions.

14 The Class 377 unit was also equipped with a *sanding* system, designed to work with the WSP system to improve levels of adhesion. Before autumn 2005, Southern Railway had recognised a weakness in the sanding characteristics of the Class 377 unit (sanding was available for a maximum of 10 seconds, irrespective of the duration of WSP activity) and had started a programme to extend sanding times to a maximum of 60 seconds (when the WSP system was active). The unit involved in the SPAD at Lewes had not been modified at the time of the incident.

15 Post-incident testing of the unit involved in the SPAD at Lewes by Bombardier (the manufacturer of the Class 377 fleet) indicated that the key systems on the train, braking, WSP and sanding had performed in accordance with the specification for those items of equipment. The standards that apply to the design and operation of these systems, the Train Operating Company's (TOC) involvement with their specification, their optimisation for low adhesion conditions and the way in which they are tested to demonstrate that they are fit for purpose are issues that have been considered in the Part 3 report.

16 The treatment of the railhead by Network Rail on the line where the incident occurred involved water jetting and applying a layer of *Sandite* using a *Multi-Purpose Vehicle* (MPV). Railhead treatment of Falmer bank had been undertaken approximately eight hours before the SPAD occurred. Treatment commenced at a point approximately 800 metres beyond the location where train 2D45 started experiencing adhesion problems. The effects of Sandite are gradually eroded with the passage of trains. The time lapse and traffic density between treatment and the incident would have limited, if not negated, the benefit obtained over those parts of the bank that had been treated by the time train 2D45 passed.

17 *Railhead swabbing* of the area where the incident had occurred (which was undertaken soon after the incident) found localised and limited evidence of contamination from vegetation and hydrocarbons. It is likely that the effect of the contaminant was exacerbated by light rain, which commenced as train 2D45 approached Falmer bank.

18 Data gathered from the *On Train Monitoring and Recording* (OTMR) equipment from the unit involved indicated that train 2D45 experienced severe low adhesion conditions for a distance of approximately 2,500 metres. It is likely that available levels of adhesion were less than 0.02 (see paragraph 8), whereas normal dry rail would offer at least 0.20. Severe low adhesion conditions are discussed in the Part 3 report.

19 The actions of the signaller involved in the Lewes incident were neither causal nor contributory to the SPAD. However, there are lessons to be learned with relevance to the training of signallers in handling emergency *Cab Secure Radio* (CSR) messages and the circumstances under which Network Rail performs routine drugs and alcohol testing. There are also lessons to be learned with regard to co-ordination between Network Rail and TOCs following near-miss incidents.

20 Three recommendations specific to the Lewes incident are made to improve safety, all of which relate to matters arising from the incident, as referred to in paragraph 19. The Part 3 report contains a number of recommendations relevant to the causal and contributory factors associated with the Lewes incident, but with broader application.

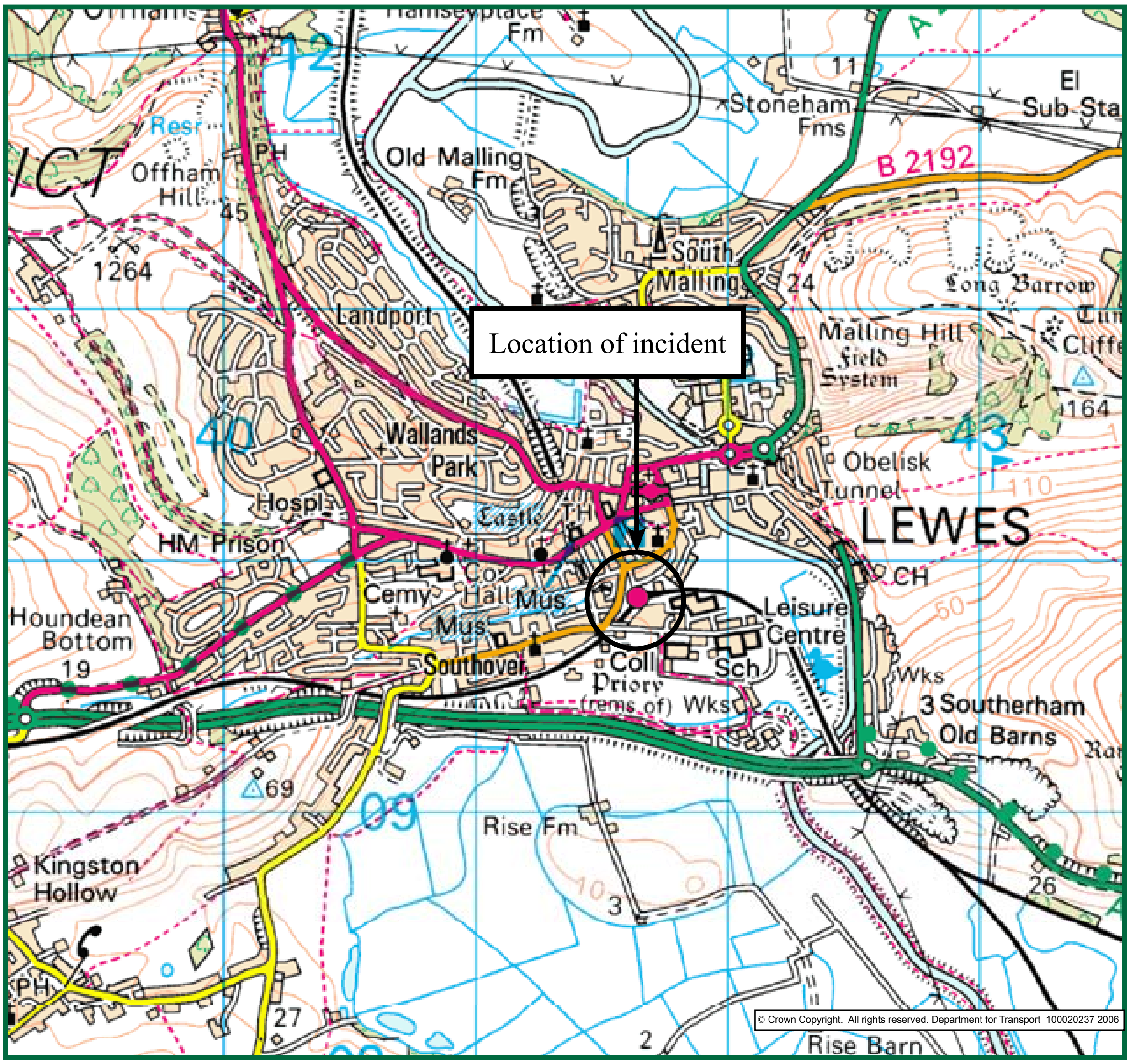

Figure 1: Extract from Ordnance Survey map showing location of incident.

The Investigation

Summary of the incident

21 Shortly after 19:07 hrs on Wednesday 30 November 2005, train 2D45 passed signal LW9, located at the end of Platform 3 at Lewes station, at danger.

22 Refer to Figure 2 for a diagram of the area. After passing Signal LW9 at danger, train 2D45 ran through 75 points which were not set for the passage of the train. Train 2F21 had departed from Platform 5 at Lewes station on time at 19:07 hrs and was approaching 76 points when the driver heard train 2D45 approaching and, realising that the two trains were on a conflicting route, stopped some 30 metres from the point of conflict. Train 2D45 ran through 77 points (which had been set for train 2F21 to depart from Platform 5 towards Seaford), stopping with the front of the train approximately 30 metres beyond the points.

23 Nobody was injured in the incident. Points 75 and 77 were damaged when train 2D45 ran through them.

Background

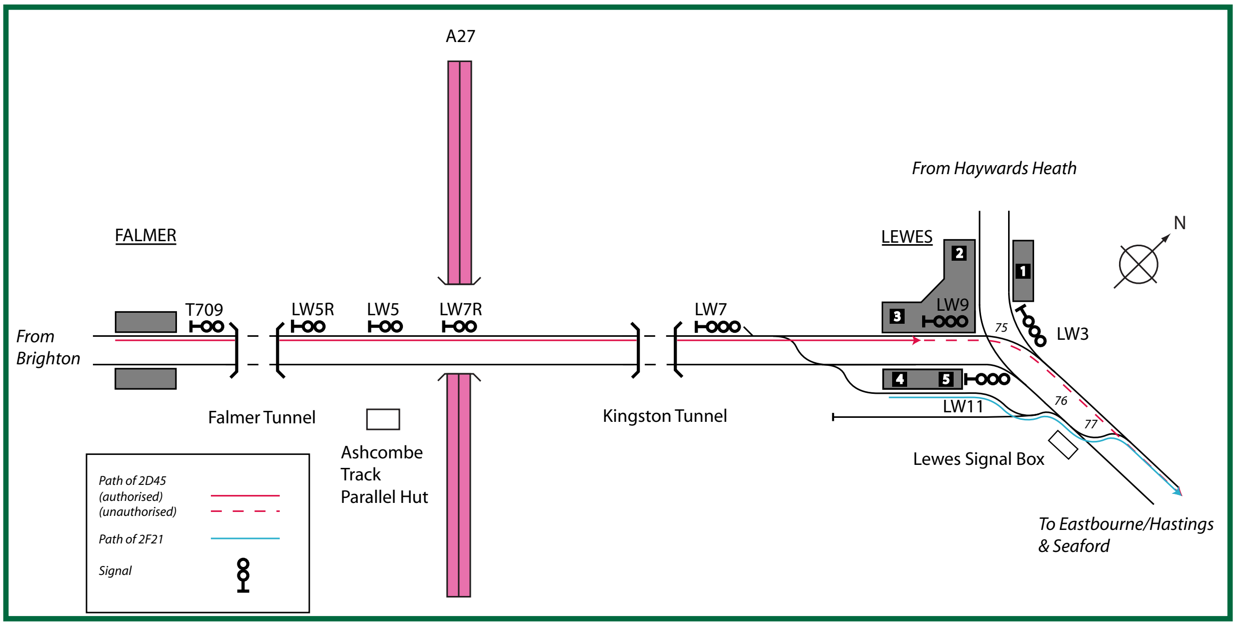

Figure 2: Track layout showing location of incident.

24 Figure 2 shows the general layout of the area where the incident occurred. Lewes is located at the junction of two routes, one from London via Haywards Heath and the other from Brighton. The two routes have their own platforms at Lewes, the junction being located to the east of Lewes station.

25 Lewes station has 5 platforms, with Platforms 1 and 2 being used by trains from and to London respectively and Platforms 3 and 4 being used by trains from and to Brighton respectively. Platform 5 can be used by trains running to and from Brighton but is also used by trains approaching from the east that terminate at Lewes.

26 Trains are signalled in accordance with the *Track Circuit Block regulations* and controlled by Lewes Signal Box. A mixture of *two and three aspect signalling* is provided in the area and the maximum line speed through Platform 3 at Lewes station is 10 mph (16 km/h) because of limited clearances between passing trains and a bridge that crosses over the line.

27 The train involved in the incident was the 18:54 hrs Southern Railway service from Brighton to Hastings. The *train reporting number* was 2D45. Train 2D45 comprised a Class 377 four-car '*Electrostar*' unit No. 377 456. Class 377 units are equipped with a brake controller with *step 1, step 2, step 3(full service) and emergency positions, a* WSP system and equipment for depositing sand to assist in braking or traction. The WSP equipment is a software-driven system which detects when the train is experiencing adhesion difficulties and modulates the braking effort on sliding wheels in an attempt to match the braking rate to the available adhesion. See paragraphs 79 and 80 for further information on the WSP system. The WSP system on the Class 377 also triggers sanding, providing that step 2, step 3 or emergency braking has been selected by the driver. At the time of the incident, the duration of sanding on unit 377 456 was limited to ten seconds for any discrete period of WSP activity.

28 The weather on 30 November was overcast and drizzly. At 19:00 hrs, the temperature in the area was around 8°C.

Evidence

29 The RAIB took evidence from the following sources:

- OTMR download from unit 377 456 for the period of the incident;
- OTMR download from unit 377 456 for the period covering dynamic testing of the WSP and sanding equipment on 7/8 December 2005;
- Staff involved in the incident;
- Network Rail;
- Southern Railway, the operator of train 2D45;
- Bombardier Ltd, who manufactured unit 377 456;
- Knorr Bremse, who supplied the braking, WSP and sanding equipment fitted to 377 456.

30 The RAIB also reviewed the investigation reports prepared by Network Rail and Southern Railway into the incident and discussed with the Investigating Officer from each company the contents of their report.

Events preceding the incident

31 On the evening of 30 November 2005, the train service in the vicinity of Lewes station was operating normally. At around 19:00 hrs, the timetabled sequence of departures eastwards was:

- Train 1F34 17:53 hrs Victoria to Hastings (scheduled departure 19:01 hrs) from Platform 1;
- Train 2F21 19:07 hrs Lewes to Seaford from Platform 5;
- Train 2D45 18:54 hrs Brighton to Hastings (scheduled departure 19:10 hrs) from Platform 3.

After the departure of train 1F34, the signaller at Lewes set the route for train 2F21 to depart from Platform 5.

32 Meanwhile, at around 19:03 hrs, train 2D45 departed from Falmer, its last stopping point before Lewes, approximately 4.5 miles (7 km) away. The route from Falmer to Lewes involves the descent of Falmer bank which at its steepest drops at a rate of 1 in 84. Line speed is 70 mph (112 km/h) for the first three miles and then reduces to 55 mph (88 km/h). After departing Falmer station on time, the driver used the *speed controller* to achieve and maintain the maximum line speed of 70 mph (112 km/h). The train did not slip and accelerated normally to line speed during the three minutes following its departure from Falmer. In the vicinity of Ashcombe *track parallel* (TP) *hut*, the driver applied the brakes in step 1 to reduce speed for the 55 mph (88 km/h) permanent speed restriction located 1000 metres ahead.

Events during the incident

33 As soon as the driver placed the controller into step 1, the WSP system became active indicating that the level of adhesion between wheel and rail was insufficient to support the level of braking required for a step 1 brake application. At this stage, the train was approximately 2500 metres from Lewes station and travelling at 70 mph (112 km/h).

34 Train speed fell only to 60 mph (96 km/h) over the next 700 metres at which point the driver (having used step 2 braking in the interim) employed full service (step 3) braking with the train still 300 metres from the start of the speed restriction and 1800 metres from Lewes station. A period of 23 seconds had elapsed between the driver selecting step 1 and step 3 braking. After a further 22 seconds, the driver selected emergency braking with the train approximately 1300 metres from Lewes station, and still travelling at 58 mph (93 km/h).

35 Had conditions been normal, the initial Step 1 brake application would have slowed the train for the 55 mph (88 km/h) speed restriction without the need for a higher braking step. Had the driver applied the same braking technique under normal conditions as was employed on the evening of 30 November, train speed would have fallen below 50 mph (80 km/h) over the 700 metres following the initial brake application.

36 As the train exited Kingston tunnel signal LW7 came into view showing a *single yellow aspect*. The driver made an emergency call via the CSR to the signaller at Lewes. At this stage, the train was approximately 1200 metres from Lewes station and still travelling at 55 mph (88 km/h). The call was made between 19:06 hrs and 19:07 hrs.

37 The driver alerted the signaller to the fact that train 2D45 was sliding and asked the signaller to clear the next signal (signal LW9 on Platform 3 at Lewes station, which protects the junction where the line from Brighton converges with the line from London). The signaller replied that another train (train 2F21) had already been signalled out of Lewes station and that it would not be possible to clear LW9 as train 2F21 was already departing.

38 The signaller attempted to make an emergency call via the CSR to stop train 2F21 before it reached 76/77 crossover and crossed into the path of train 2D45. The CSR emergency stop facility has two buttons, one red and one yellow. If a signaller wishes to send an emergency stop message to a specific train, the red button is pressed. The system then asks for the signaller to input the train reporting number of the specified train and, once confirmed, the message is sent. If a signaller wishes to stop all trains within the area controlled by the signal box (or within a designated zone), the yellow button is pressed and, once confirmed, the emergency stop message is sent to all trains.

39 During the incident at Lewes, the signaller intended to send an 'all trains stop' message, but pressed the red button on the CSR equipment in error. Thinking that the 'all trains stop' message had been sent, the signaller took no further action to stop train 2F21. The emergency message had not been sent to (or received by) train 2F21 as the CSR system was waiting for a train reporting number to be keyed in by the signaller. Train 2F21 continued out of Platform 5 towards 76 and 77 points (see Figure 2).

40 At around this time, train 2D45 entered platform 3 at Lewes travelling at a speed of approximately 40 mph (65 km/h). It passed signal LW9 at danger and ran through 75 points. As it ran through the points, the rate at which the train was slowing increased significantly.

41 The driver of train 2F21, which had departed from Platform 5 under clear signals, heard train 2D45 approaching and, realising that the two trains were on a collision path, applied the emergency brake on train 2F21. Train 2D45 ran through 77 points, stopping with the front of the train located 30 metres beyond the points. Meanwhile, train 2F21 had stopped with its leading wheels in the vicinity of 76 points, approximately 30 metres away from train 2D45.

42 From the time that the driver of train 2D45 first applied the brakes to the time that the train stopped, approximately 120 seconds had elapsed. During this period, the train travelled approximately 2750 metres. The length of the overrun beyond LW9 signal was approximately 150 metres.

Events after the incident

43 After train 2D45 had stopped, the driver and signaller conversed briefly. The signaller, who was the only person on duty in Lewes signal box, had a number of actions to perform as a result of which the *RT3189 signal passed at danger form* was completed approximately 75 minutes later. It is necessary for the RT3189 form to be completed before the train can be moved past another stop signal, which meant that passengers were detained on board during this time. In the interim, the driver of train 2D45 had been asked to move the train for a short distance to clear 77 points (which had also been run through) so that an assessment of the damage could be made.

44 It was necessary to decide whether train 2D45 should be allowed to continue in service. One of the questions asked during completion of the RT3189 form is whether the unit is fit to continue. The driver of train 2D45 did consider that the unit was fit to continue in service and the senior Southern Railway manager who attended the incident was aware by this stage that other trains had experienced low adhesion conditions on Falmer bank. A Southern Railway fitter confirmed that the unit was in a safe condition to continue. The train could not be taken the short distance back to Lewes station because it had damaged the points and was at risk of derailment if it reversed. The only other option would have involved evacuating passengers from train 2D45 down ladders onto the track in the dark, which would have been a hazardous operation.

45 The driver in charge of 2D45 was relieved on site as part of Southern Railway's standard response to a serious incident. Following a brake test, another driver took the train forward at a maximum speed of 30 mph (50 km/h) to Glynde, where it terminated and passengers were conveyed to their destinations either by following trains or by road transport.

46 The driver of train 2D45 underwent drugs and alcohol screening, the results of which were negative. The signaller was not subject to drugs and alcohol screening. This issue is discussed further in paragraph 98.

47 Network Rail undertook railhead swabbing on Falmer bank. A total of 50 swabs were taken between Ashcombe TP Hut and Lewes station, covering the entire section of line over which 2D45 had experienced low adhesion conditions.

48 Unit 377 456 was taken to Eastbourne for an OTMR download and stabling overnight. A static test of the WSP and sanding equipment was undertaken that night with a satisfactory result and the sand boxes were checked and found to be almost full. On the following day, the unit was returned to Lovers Walk Depot at Brighton for further testing.

49 Overnight on 7/8 December, and at the RAIB's request, dynamic testing of the WSP and sanding systems was undertaken on a test run between Brighton and Eastbourne and back. The run was was subject to special monitoring by the signallers involved to ensure that it could be undertaken safely.

Analysis – events during the incident

50 The RAIB determined that there were four principal issues to be investigated relating to this specific incident:

a) the actions of the signaller;

b) the actions of the drivers (trains 2D45 and 2F21);

c) the condition of the railhead;

d) the performance of the rolling stock.

The actions of the signaller

51 The regulation of trains at Lewes around the time of the incident was in accordance with the working timetable.

52 Upon receipt of the emergency CSR message from the driver of train 2D45, the signaller had very little time in which to react. In the time available, the signaller attempted to stop train 2F21 by using the emergency call facility on the CSR. Paragraphs 38 and 39 explain why the message was not sent.

53 Signallers are trained in the use of CSR emergency equipment. Their competence is assessed before thay are appointed to a signal box and the assessment includes questions relating to use of the equipment in emergency scenarios. Following appointment, signallers are subject to continuous assessment to ensure that they remain competent for all duties. The assessment cycle covers three years and includes a mixture of formal assessment and gathering of evidence from situations that the signaller has encountered while at work. Every 13 weeks, signallers on Network Rail's Sussex route (where Lewes signal box is located) are released for a day to attend the signallers' training centre at Redhill for a safety briefing, discussion of specific issues relating to their job and to sit an assessment paper based on the topics selected for discussion.

54 Another element of the continuous assessment of signaller's competence involves Signalling Managers asking questions on how signallers would respond to specific scenarios, including the use of CSR equipment in an emergency. The signaller involved in the incident at Lewes had been subject to such an assessment on the use of CSR emergency equipment on 20 October 2005 (6 weeks before the incident) and had correctly answered all questions.

55 Questioning of experienced signallers on how they would respond to emergency situations can be undertaken in different ways. More benefit can be gained if the questioning requires the signaller to describe his or her actions in detail (e.g. requiring the signaller to describe **how** an emergency CSR call would be made rather than simply accepting the response that an emergency CSR call would be made). However, the use of any form of questioning has its limitations and particularly where it relates to the individual's response in the stressful circumstances of an emergency

56 Given that use of the CSR emergency equipment is comparatively rare, it is in general difficult for signallers to gain any practical experience. The Sussex Route's training centre for signallers at Redhill has a simulator, which enables the instructor to set up a range of operating scenarios for signallers to practise their skills. Operating scenarios involving use of the emergency CSR equipment can be simulated. Currently, the centre is not being used to assess signallers in use of the CSR emergency equipment during the training day they spend at Redhill every 13 weeks. The centre is rarely used by experienced signallers; its principal role is in training new signallers. The assessment of signallers in responding to emergency situations continues to be based on a set of theoretical questions

The actions of the driver – train 2D45

57 The actions of the driver of train 2D45, described in paragraphs 33-37, have been analysed using data obtained from the train's OTMR equipment.

58 As soon as the driver placed the brake controller into step 1, the WSP system became active, indicating that the level of adhesion available was insufficient to support the brake demand being made. The driver was aware that the speed of the train was not decreasing and progressively increased the brake to step 2, step 3 and emergency.

59 This technique was in accordance with Southern Railway's professional driving policy. The initial brake application had been well in advance (1000 metres) of the commencement of the speed restriction of 55 mph (88 km/h), although the route description issued by Southern Railway for the Brighton to Lewes route advises drivers to 'bring their trains under control' (ie perform a *running brake test*) at least one mile before the commencement of the speed restriction in autumn. Having started to experience WSP activity, the driver increased the braking effort and allowed the WSP system to manage the *wheelslide*.

60 In comparison with the actions of the driver involved in the SPAD at Esher on 25 November 2005 (see the Part 1 report) the driver of train 2D45 held each brake step for a relatively long period (11-12 seconds as compared with 6-7 seconds on the train involved in the Esher incident) before moving to the next step. However, the actions of the driver at Lewes were guided initially by the need to achieve only a modest reduction in speed from 70 mph (112 km/h) to 55 mph (88 km/h) for a permanent speed restriction whereas at Esher, the driver was braking to stop at a red signal.

61 On realising that there was a possibility that signal LW9 could be passed at danger, the driver made an emergency call to the signaller via the CSR. The RAIB has considered whether the CSR emergency message could have been sent earlier, which might have allowed the signaller to stop train 2F21 before it departed from Lewes. Figure 3, shows a timeline of the key events leading up to this incident:

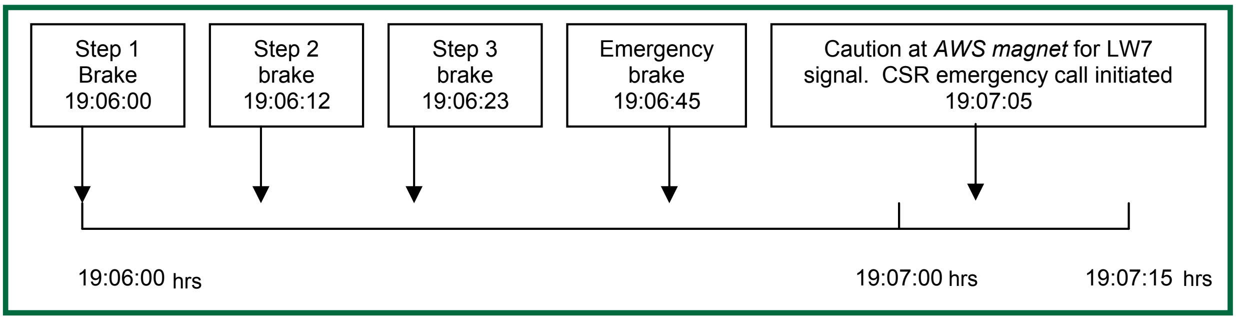

Figure 3: Timeline of key events before driver of 2D45 made CSR emergency call to signaller.

62 As signalling between Falmer and Lewes is of the three aspect variety, it was not until the signal preceding LW9 (signal LW7) was sighted that the driver knew whether there was a possibility of passing Signal LW9 at danger. The timeline in Figure 3 shows that within 20 seconds of selecting emergency braking, and at the same time as the train passed the *AWS magnet* located 183 metres from Signal LW7, the driver initiated the emergency call. But it was only within this period of 20 seconds that two key facts would have become apparent to the driver:

- the train was still decelerating at a very slow rate, despite the recent selection of emergency braking;
- signal LW9 at Lewes station was at danger.

63 The driver therefore had no reason to make an emergency call to the signaller earlier.

64 The driver did not sound the train horn as train 2D45 approached Lewes station. The driver was unable to control the speed of the train at this point and the *rule book*[1] states that in such circumstances, the driver should sound a series of long blasts on the horn.

[1] RSSB, *Rule Book GE/RT 8000, Module TW1, Preparation and movement of trains*, Clause 15.5. Issue 4, April 2005.

It is likely that the driver of train 2F21 would have been alerted earlier to the approach of train 2D45 had the driver of train 2D45 sounded the horn on passing through Lewes station. In the event, this had no effect on the outcome of the incident as the driver of 2F21 was alerted to the approach of train 2D45 by the noise of the *blowdown valves* operating on unit 377 456 as the WSP system applied and released the brakes. In other circumstances, it would have been more critical for the driver of train 2D45 to have complied with the rule book requirement as the train approached and ran through Lewes station.

The actions of the driver – train 2F21

65 The actions of the driver of train 2F21 almost certainly prevented a collision taking place. Having left Lewes station under a green aspect, the driver had every expectation of a normal journey towards Southerham Junction and the Seaford branch. When the noise of the blowdown valves operating on train 2D45 became apparent, the driver of train 2F21 realised immediately that the two trains were on a collision course and applied the brakes. The presence of mind and rapid reactions of the driver of train 2F21 were critical in averting a collision.

The condition of the railhead

66 Network Rail identifies low adhesion sites in the s*ectional appendix* that is prepared for each route. In order to qualify for inclusion in the sectional appendix, a site must have experienced more than two SPADs or more than four overruns in the last three years as a result of leaf-fall or must have been specifically identified as a low adhesion site through other means such as a review of OTMR data or feedback from maintenance staff or TOCs.

67 The down line between Falmer and Lewes is not included in the sectional appendix as a low adhesion site. However, Southern Railway issues route descriptions to drivers to provide them with key information about the routes over which they operate, including the general layout of the line, names of specific landmarks (e.g. footpath crossings) and the location and nature of hazards such as sections of the route where drivers might experience low adhesion during autumn. Falmer bank is identified as a low adhesion site by Southern Railway in the relevant route description. The driver of train 2D45 was aware that Falmer bank was a location that could be affected by low adhesion and while not exactly following the guidance provided by Southern Railway (see paragraph 59), still made a brake application well before the point at which it would have been necessary had the objective only been to slow for the speed restriction ahead.

68 Network Rail includes the down line between Falmer and Lewes in its *railhead treatment programme*. On 30 November 2005, the MPV had run according to schedule, passing over the down line between Brighton and Lewes at around 11:00 hrs, water jetting and laying Sandite from Signal LW7R to Lewes station. There was no rail head treatment of the first 800 metres over which train 2D45 experienced adhesion difficulties. However, given that the effects of Sandite are gradually eroded with the passage of trains, the time lapse between treatment and the incident and the frequency of services operated over the route would have reduced, if not eliminated the benefit from rail head treatment.

69 During the autumn period, Network Rail operates a predictive system for railhead conditions throughout the country, based on information supplied by the specialist environmental and weather organisation, ADAS UK Ltd. The prediction takes account of the likely influence of weather conditions (rain, frost, high winds) on leaf fall and the extent of leaf fall is used as the means for predicting railhead conditions. The network is divided into 16 areas and the prediction is area-specific. Network Rail takes further precautions such as providing additional railhead treatment in known problem areas when severe conditions are forecast. However, for 30 November 2005, no specific adhesion problems were forecast for the Lewes area.

70 Railhead swabbing was undertaken almost immediately after the incident, covering the area from Ashcombe TP hut (where the driver first made a brake application) to signal LW9 at Lewes station. The results of the analysis were as follows (refer to Figure 2 for locations):

- Ashcombe TP hut to signal LW7R, a distance of approximately 700 metres. There was evidence of degraded leaf litter/vegetation and also sand. There was also some evidence of hydrocarbons (diesel fuel oil).
- A27 road bridge to signal LW7, a distance of 1000 metres. Virtually no contamination was found, but there was evidence of sand or Sandite.
- Signal LW7 to signal LW9, a distance of approximately 500 metres. Limited evidence of leaf litter/vegetation with sand/Sandite found on the same swabs. Two swabs showed trace elements of hydrocarbons (diesel fuel oil).

71 It has not been possible to establish why hydrocarbons were present in the swabs. The analysis indicated that the source was diesel oil rather than mineral oil. It is possible that diesel could have been dropped from a locomotive, the MPV or other *on-track machine*. It is unlikely to have come from a *diesel multiple unit* because no diesel services were scheduled to operate on the route at that time.

72 A wheel flange lubricator is provided in the vicinity of Kingston tunnel (approximately 1200 metres from Lewes station) for the purposes of minimising abrasion of train wheels on the curves approaching Lewes station. After the incident it was found that the lubricator was dispensing too much grease and Network Rail took it out of use. The evidence from the OTMR download did not indicate any change in braking performance in this area which, in any case, would only have affected the latter stages of the slide.

73 Overall, it is clear from the swab analysis that some railhead contamination was present.

74 As the train experienced problems as soon as the driver selected step 1 braking, this indicates that the level of adhesion available at the wheel/rail interface was below 0.03. The braking rate in step 1 is 0.3 m/s^2 and requires an adhesion level of at least 0.03 to be available for braking to be effective (see paragraph 8). The braking rate of train 2D45 (as indicated in Figure 4), shows that it encountered severe low adhesion conditions over a distance of approximately 2500 metres.

75 The level of adhesion available for train 2D45 changed just before its descent of Falmer bank. The train that ran over the same route before 2D45, the 18:34 hrs Southern Railway service from Brighton to Seaford, also experienced WSP activity on Falmer Bank. However, this train, which comprised a three car Class 377 unit, did not experience WSP activity until the brake controller was placed in step 2 (braking rate 0.6 m/s^2). The point at which the two drivers braked was almost identical. It can therefore be inferred that adhesion conditions had deteriorated from a value between 0.03 and 0.06 when the previous train passed to below 0.03 when train 2D45 passed.

The most likely explanation for this change is that the drizzle that had commenced after the passage of the previous train had exacerbated the impact of the rail head contaminants present.

76 The only other explanation for the difference in performance between train 2D45 and the preceding train is that the wheels of train 2D45 were contaminated. It has not been possible to establish whether this was the case as the wheels were not swabbed immediately after the incident. When the unit was inspected at Eastbourne sidings the following day, discolouration was found on the wheels, which might have been evidence of contamination. However, the train had been moved from Lewes to Eastbourne before the wheels were inspected and because it would not have been possible to establish when the possible contamination had occurred, swabbing was still not undertaken.

77 The RAIB considers that wheel contamination is unlikely to have been a cause of the incident because:

- the train had not experienced any problems with wheel slip or slide immediately before the incident;
- the preceding and following trains also suffered adhesion difficulties on Falmer bank, suggesting that the source of the contamination was the rails rather than train wheels;
- if the source of contamination had been the wheels alone, the action of the WSP equipment in releasing and applying brakes and creating friction between wheel and rail would probably have had the effect of cleaning the wheels over a distance shorter than the length of slide experienced by train 2D45 on 30 November.

The performance of the rolling stock

78 The Class 377 unit is equipped with *dynamic* and *friction brakes*, a WSP system and sanding. The two types of braking are *blended.* The dynamic brake, acting through the traction motors, applies initially. The friction brake is blended in as the train slows down. The dynamic brake is inhibited and the train continues on friction braking alone if WSP activity commences.

79 Once active, the WSP system seeks to monitor the continued presence of wheelslide by releasing the brakes on a 'test' or 'reference' wheelset. Using measurements of speed and acceleration derived from this wheel, the WSP system is able to estimate the true speed of the train, which is then compared with the speed of the other wheels (which still have brakes applied). In this way, the degree of wheelslide can be measured.

80 When wheelslide activity is detected, the WSP system endeavours to maximise and influence the adhesion available to the train by applying and releasing the train brakes. Wheel rotational speed is not permitted to drop below real speed by more than 20% before the brakes are released. Wheel rotational speed is allowed to climb back towards 'real' speed and the brakes are applied again. The process of applying and releasing the brakes is achieved through blowdown valves, which manage the rapid changes in air pressure needed for the process. It has the effect of limiting wheelside while permitting a degree of *conditioning* of the railhead, thereby providing a slightly cleaner rail surface for later vehicles on the same train.

81 Figure 4 shows estimated train speeds during the incident derived from the following sources:

- Calculated speeds based on the times at which the train passed the AWS magnets, which are located on the approach to the signal (Curve 1, green). This has been used as a measure of train speed that is independent of the figures estimated by the WSP system and reflected in the OTMR data.
- 'Actual' train speed derived from the OTMR (Curve 2, purple). In practice, this value is an estimate of ground speed based on information about the performance of the reference wheelset (see paragraph 79) obtained from the *brake control unit* (BCU).

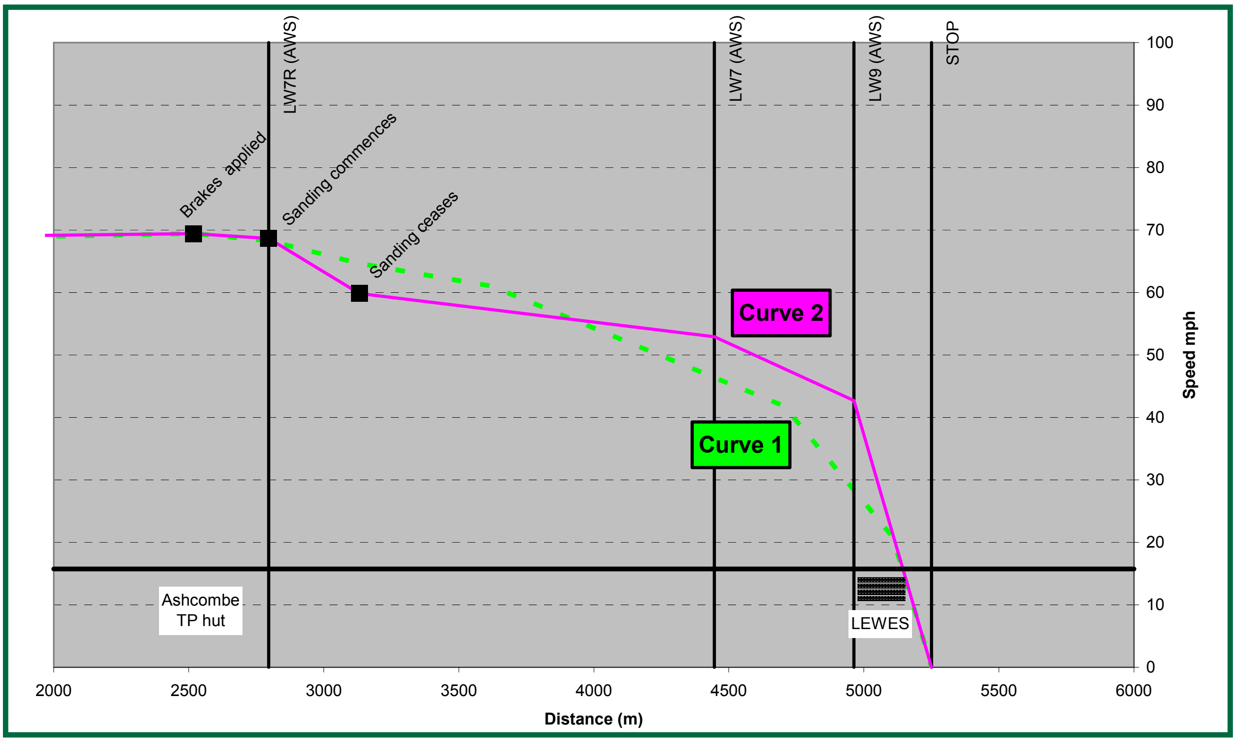

Figure 4: Distance speed graph depicting the events at Lewes on 30 November 2005.

82 Figure 4 shows that:

- At the point the brakes are applied in step 1 the train encountered very low levels of adhesion. The rate of retardation is very slow until the driver selects step 2 braking (which is shown on Figure 3 as 'sanding commences' – the unit commences dispensing sand at the time that the driver selects brake step 2, providing that the WSP system is active).
- Once step 2 braking is selected the automatic operation of the sanding is initiated. This produces an improved rate of deceleration over a period of 5-10 seconds (sanding was limited to 10 seconds by the configuration of the system (see paragraph 88), but this includes system build-up time when sand is not dispensed at the maximum rate).
- After 10 seconds the sanding ceased to operate and the rate of deceleration reduced significantly.
- The rate of deceleration remains very low until the train is approaching Lewes station when the train appears to have encountered improved adhesion.

83 Southern Railway's analysis of OTMR and BCU data indicates that:

- At the point the brakes were applied the rotational velocity of the wheels dropped rapidly. However, within a distance of around 100 metres the rotational velocity of the wheels increased. This is consistent with the controlled release of the brakes as the WSP system intervenes and is evidence that the WSP system was functioning correctly.
- The transition between dynamic braking and friction braking (see paragraph 78) was accomplished in accordance with the design requirement for dynamic braking to be inhibited when WSP activity is detected.
- After an initial period of compensation the WSP was able to control the speed of the wheelsets such that they were never more than 20% below actual train speed. This is consistent with the design intent.
- There was a marked increase in the effectiveness of braking during the period that sand was applied (i.e. the WSP system was permitting the brake force cylinders to build up to high levels before releasing the brake). This is evidence of the value of sand in improving the adhesion available to a sliding train.
- Rail head conditioning occurred when the extent of the slide was being controlled by the WSP system. In particular, the level of adhesion encountered by each wheel set was increased by the passage of previous wheelsets on the same train. Southern Railway's analysis shows that adhesion levels encountered by the last wheelset were higher than those of the leading wheelset, based on the individual readings of train braking performance at different ends of the train.

84 The levels of adhesion that the train was encountering over different sections of the line have been estimated from the OTMR data and summarised in Figure 5:

85 The natural levels of adhesion at Lewes (without modification by the application of sand) were less than 0.02 for a distance of approximately 2500 metres.

Section of route	**Average deceleration**	**Adhesion levels present** *(allowing for the benefit of sanding)*
Initial braking (Ashcombe TP hut) to LW7R	0.1m/s^2	~0.01
LW7R to LW7	During operation of sander 0.37m/s^2	0.03-0.04 (with contribution of sand)
	When sander not operative 0.05m/s^2	<0.01
LW7 to LW9	0.17m/s^2	0.01-0.02
LW9 to STOP	0.65m/s^2	0.06-0.07

Figure 5: Estimated deceleration and associated average adhesion levels encountered by train 2D45 at Lewes on 30 November 2005.

86 Sanding equipment is provided on the leading and trailing vehicles on the Class 377 in front of the third wheelset (in direction of travel). Sand is only applied by the equipment on the leading vehicle in direction of travel, irrespective of the number of vehicles in the train.

87 Southern Railway's professional driving policy in force at the time emphasised the need for drivers to brake their trains 'earlier and lighter' during low adhesion conditions in accordance with guidance[2] from the *Association of Train Operating Companies* (ATOC). Drivers were expected to respond immediately to restrictive signals and in good time for stations stops or speed restrictions, using a gentle brake application. This would translate to initial use of step 1 braking for Class 377 units. However, as the Class 377 unit delivered sand in brake step 2 (or greater), sand was not available during the initial stages of an 'early and light' brake application.

88 At the time of the Lewes SPAD, once active, sanding on unit 377 456 was configured to apply for ten seconds and then stop. Further sand could only be provided if WSP activity ceased and restarted. WSP activity might cease for two reasons:

- the train experiences adhesion levels sufficient to support the deceleration required by the brake step selected, or
- the brake is released, in which case no deceleration is required.

89 Train 2D45 suffered continuous WSP activity from the time that brake step 1 was selected to the time the train passed through Lewes station. This meant that the driver of train 2D45 had only minimal assistance from sanding throughout the duration of the slide. In the light of the benefit to be obtained from sand in low adhesion conditions (see Figure 4 and paragraph 83), the stopping distance of train 2D45 would probably have been reduced if the driver had released and reapplied the brake during the slide. This would have resulted in further applications of sand. However, this technique would have been counter to Southern's professional driving policy and would not have been necessary on units that had already been adapted to apply sand for 60 seconds (see paragraph 90), thereby requiring drivers to brake differently depending on whether the unit had been modified or not. Given that this information was not readily available to drivers, it would have been impractical to employ unit-dependent approaches to braking.

90 Throughout autumn 2005, Southern Railway was in the process of increasing sanding times on its Class 377 units from 10 seconds to 60 seconds in recognition of the desirability of a longer period of sanding. The Electrostar fleet operated by South Eastern Trains in Kent (Class 375) had already been modified and the modification to the Class 377 would restore consistency in sanding times between the two fleets.

91 Unit 377 456 was not modified until January 2006. The unit that preceded train 2D45 down Falmer bank on 30 November (see paragraph 75) had already been modified to 60 seconds sanding and did not experience the same adhesion difficulties as train 2D45 although this is also attributable to the weather conditions which changed between the passage of the two trains.

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[2] Association of Train Operating Companies, *ATOC/GN007, ATOC Guidance Note - Defensive Driving Techniques*, Clause 5.6. Issue 1, May 2003.

92 Following the SPAD, unit 377 456 was subject to testing by the manufacturer (Bombardier). A static test of the sanding equipment while the unit was stabled at Eastbourne was satisfactory. The sand boxes were almost full. They had last been filled at Littlehampton on 28 November 2005 and the OTMR data for the unit in the day leading up to the incident showed little WSP activity. The quantity of sand found in the boxes when they were inspected at Eastbourne after the incident was consistent with the operating history of the unit in the preceding period.

93 The on-board computer showed that no braking or WSP faults were logged onto the system. Dynamic tests of the sanding equipment were carried out on the night of 7/8 December. The tests demonstrated that the sanding equipment functioned normally. From this evidence and data obtained from the BCU and OTMR (see paragraphs 81-83), the RAIB has concluded that unit 377 456 performed during the incident in accordance with its specification.

94 In the absence of any relevant faults being found on the unit despite the severity of the overrun, the more fundamental issue of the characteristics and configuration of some of the systems within the unit have been examined. The questions below, which have wider relevance than the Lewes SPAD alone, are addressed in the Part 3 report:

- Are RGS which govern WSP systems and braking and sanding equipment conducive to minimising stopping distances under low adhesion conditions?
- Is the figure of 20% for maximum wheelslide used in the configuration of modern WSP systems the optimum for minimising stopping distance under severe low adhesion conditions?

Analysis – events following the incident

95 While railhead swabbing was undertaken in the immediate aftermath of the incident, wheel swabbing was not. A potentially valuable source of information was therefore lost as the possibility of determining whether contamination had been transferred into the Falmer/Lewes area by the unit was not available. This is a significant omission because wheel contamination, although unlikely (see paragraphs 76 and 77), is the other possible explanation why train 2D45 initially experienced more severe adhesion difficulties than the train that it followed down Falmer bank. It is understood that Network Rail Mobile Operations Managers (MOM) working within the Sussex Route will not perform wheel swabbing unless a current isolation is undertaken because of the possibility of residual current being present.

96 After the train had stopped over 77 points at Lewes, the driver and signaller discussed the steps to be taken. Passengers were held on the train for more than 90 minutes while the RT3189 form was completed and a relief driver found to take train 2D45 forward. In addition, it was necessary to confirm that it was safe to move the train. Train 2D45 had run through no. 77 points and stopped over them. The points were damaged and until an inspection had taken place and the points were confirmed as being in a safe condition, the train could not be moved in either direction. The Network Rail inspection confirmed that the option to move the train back into Lewes was not available because train 2D45 was at risk of derailment if it reversed. Southern Railway provided a fitter to assess the condition of the unit, who confirmed that it was in a safe condition to move.

They also, in accordance with their own procedures which required the on-call Driver Manager to decide whether the driver should be allowed to continue, provided another driver to take the train forward. With the incident affecting train movement in the Lewes area, the provision of another driver took over an hour to arrange.

97 The decision to take the train forward at low speed to Glynde and terminate it there was correct. The driver had made no allegation against the brakes on the train and there was no brake fault showing on the train's on-board computer system. A brake test was performed by the relieving driver before the train departed from Lewes. By the time that the decision was taken to move the train, it was also known that the driver of the train following train 2D45 down Falmer bank had experienced low adhesion conditions. All these factors pointed towards adhesion problems rather than a brake defect being the cause of the incident. The alternative to allowing the train to continue at low speed to Glynde would have involved the hazardous evacuation of passengers down ladders to track level in the dark and a walk over uneven ground to Lewes station.

98 Network Rail's *Rail Incident Officer* (RIO) decided not to have the signaller tested for drugs and alcohol because the signaller had not been a direct cause of the incident. Network Rail's Occupational Health & Safety Manual, which governs testing for drugs and alcohol requires staff to be tested if they have directly contributed to an accident or serious incident through their actions or omissions. RIOs responding to incidents are required to interpret the term, 'directly contributed to an accident or serious incident'. In the case of the Lewes incident, the RIO considered whether the signaller had directly contributed to the SPAD and decided against drugs and alcohol testing on the basis that the signaller's actions did not do so. However, under slightly different circumstances, it might have been critical for the signaller to send an emergency CSR message to train 2F21 during the incident. Had the driver of train 2F21 not been so alert, the incident could have become an accident, in which case the signaller's omission in not sending an emergency CSR message might have been critical to the outcome. For this reason, the RAIB believes that the signaller should have been subject to drugs and alcohol screening.

99 Although the signaller correctly informed the Network Rail Controller in the Sussex Route Control Centre that train 2F21 had been involved in the near-miss, the dissemination of information from that point was inconsistent. There is nothing within Network Rail's Control Manual that requires the identification of all staff involved in an incident. The involvement of train 2F21 was not mentioned by the Network Rail Controller when communicating with the MOM who attended the incident. It was mentioned in the Controller's conversation with the on-call Signalling Manager, albeit with the suggestion that train 2F21 was ahead of train 2D45 (in which case it might have been inferred that the driver of train 2F21 would have known nothing about the incident). As Network Rail's communications with Southern Railway are made face-to-face in the Sussex Route Control Centre, it cannot be established whether the involvement of train 2F21 was mentioned.

100 The driver of train 2F21 was permitted to drive a train back to Brighton in passenger service, having just been involved in a serious incident. As with the decision over allowing the driver of train 2D45 to continue driving after the incident, it would have been at the discretion of Southern Railway's on-call Driver Manager whether the driver of train 2F21 had been allowed to continue driving. But the on-call Driver Manager did not have the necessary information regarding the involvement of train 2F21 in the incident and was not able to intervene before train 2F21 departed from Lewes.

Conclusions

101 The immediate cause of the incident was low adhesion on the rail head of the down line between Falmer and Lewes.

102 Causal factors were:

- The presence of contaminants on the rail head of the down line resulted in an average level of adhesion of less than 0.02 adhesion being available over the section of line where train 2D45 was braking (paragraphs 70 - 73). The issue of severe low adhesion conditions is addressed in the Part 3 report.
- The configuration of the sanding system of the Class 377 unit only allowed for ten seconds sanding throughout the entire period that train 2D45 was sliding (paragraph 88). The Part 3 report addresses the issue of sanding parameters for minimising stopping distances under low adhesion conditions.
- The change in weather conditions immediately before train 2D45 ran over the down line between Falmer and Lewes exacerbated the effects of the contamination that already existed on the rails (paragraphs 75-77). The Part 3 report addresses factors that influence adhesion.

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

- The professional driving policy of Southern Railway, which did not take account of the benefits of rapidly increasing braking under low adhesion conditions (paragraph 87). The Part 3 report addresses professional driving in low adhesion conditions.
- The gradient of 1 in 84 on Falmer Bank (paragraph 32).

104 The systems on board the Class 377 unit appear to have performed in accordance with their specification (paragraph 93). Wider issues relating to the design and performance of braking and WSP systems are addressed in the Part 3 report.

105 While neither causal nor contributory to the incident, the following factors were identified during the course of this investigation:

- The signaller pressed the wrong button on the CSR emergency equipment which meant that no emergency stop message was sent to train 2F21, which was on a conflicting path with train 2D45 (paragraphs 38, 39, 55 and 56 and see Recommendation 1).
- The signaller was not tested for drugs and alcohol after the incident despite not sending a CSR emergency stop message to the driver of train 2F21 (paragraph 98 and see Recommendation 2). Under slightly different circumstances, such a message could have provided the critical means for preventing train 2F21 entering onto a collision path with train 2D45.
- The driver did not sound the horn on the approach to Lewes station (paragraph 64). In the event, this had no bearing on the outcome of the incident. Under slightly different circumstances, it could have provided the critical means by which the driver of train 2F21 was made aware of the fact that train 2D45 was on a potentially conflicting path. This matter has already been satisfactorily addressed by Southern Railway (paragraph 112).

- Communications between Network Rail and Southern Railway after the incident did not highlight the involvement of train 2F21 (paragraph 99), thus resulting in the driver of train 2F21 driving a train in passenger service after having been involved in a near miss incident (Recommendation 3).
- Potentially valuable information was not gathered after the incident (Recommendation 3). The Part 3 report addresses post-incident data gathering.

Actions already taken or in progress relevant to this report

106 Southern Railway initially completed a programme of modification to the sanding systems on their Class 377 units to increase the duration of sanding to a maximum of 60 seconds (when WSP is active). Southern Railway has now further extended sanding duration on the Class 377 unit to 180 seconds. The revised figure is based on the time it would take to stop a train from 100 mph (160 km/h) on the level using Step 1 braking alone.

107 Southern Railway has provided its drivers with more information regarding the operation of key systems on the Class 377 unit such as brakes, WSP and sanding in order to ensure that they have a better understanding of how these key items of equipment function.

108 Southern Railway arranged for a series of trial runs to be undertaken between Dorking and Horsham on 6 August 2006 to test the effect of increasing the maximum sanding rate from 2 kg/minute to 3 kg/minute. Following consideration of the outcome, Southern Railway has increased the sanding rate on its Class 377 units to 3 kg/minute.

109 Southern Railway has provided guidance to its drivers on performing running brake tests during low adhesion conditions so that drivers can gain an early indication of whether such conditions are present.

110 Southern Railway has modified its Professional Driving Policy to require drivers of all types of rolling stock to make their initial brake application in step 2 rather than step 1 during the autumn low adhesion season. This will ensure that sanding is immediately available if WSP activity is experienced.

111 ATOC has reissued its guidance on defensive driving and includes more detail on the optimum way to drive during low adhesion conditions. The revised Professional Driving policy adopted by Southern (paragraph 110) is consistent with the ATOC guidance.

112 Southern Railway has re-briefed all of its drivers to sound the horn when they need to draw attention to the fact that they are unable to control the speed of the train (paragraphs 64 and 105).

Recommendations

113 The following safety recommendations are made[3]:

Recommendations to address causal and contributory factors

114 The Part 3 investigation report contains recommendations that are relevant to the causal and contributory factors associated with the incident at Lewes on 30 November 2005. All of these factors have a wider applicability than the Lewes incident alone.

Recommendations to address other matters observed during the investigation

1 **Network Rail to:**

- conduct a review of the approach used to assess the competence of new and existing signallers in their use of emergency equipment and amend it as necessary to ensure that the questions used probe a signaller's understanding of how they would use the emergency equipment provided;
- use the training simulator at Redhill to test signallers employed in the Sussex Route periodically on their response to rarely-experienced scenarios such as the need to stop all trains and specific trains in an emergency;
- review and modify as appropriate their current practice on other routes to exploit the availability of simulators for testing signallers periodically on their response to rarely-experienced scenarios such as the need to stop all trains and specific trains in an emergency (see paragraph 105).

2 **Network Rail** to enhance Clause 5.2 of the Occupational Health & Safety Manual (NR/SP/OHS/00119) to include the requirement for staff to be tested for drugs and alcohol when their actions or omissions, under slightly different circumstances, could have resulted in or contributed to the occurrence or consequences of an accident or serious incident (see paragraph 105).

3 **Network Rail, Sussex and Southern Railway** to jointly review, and modify as appropriate, their Control Room procedures governing the communication of incident details to ensure that they correctly identify the key information, including details of all staff involved and ensure that appropriate action is taken to promote the welfare of staff and the safety of the railway (see paragraph 105). The review should consider the need to amend procedure C32 of the Network Rail Control Manual, and if appropriate arrange for the necessary amendments to be made and implemented.

[3] 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

ATOC	Association of Train Operating Companies
AWS	Automatic Warning System
BCU	Brake Control Unit
CSR	Cab Secure Radio
MPV	Multi Purpose Vehicle
MOM	Mobile Operations Manager
OTMR equipment	On Train Monitoring and Recording equipment
RAIB	Rail Accident Investigation Branch
RGS	Railway Group Standards
RIO	Rail Incident Officer
SPAD	Signal Passed at Danger
TOC	Train Operating Company
TP Hut	Track Parallel Hut
WSP system	Wheelslide Prevention system

Glossary of terms **Appendix B**

Association of Train Operating Companies	Umbrella organisation representing train companies to the government, regulatory bodies, the media and other opinion formers on transport policy issues and providing its members with a range of services that enable them to comply with conditions laid on them in their franchise agreements and operating licences.
AWS Magnet	Part of the equipment associated with the Automatic Warning System which, inter alia, provides information to a driver on whether the next signal is showing a clear (green) or restrictive (yellow or red) aspect.
Blended (braking)	The simultaneous use of two types of train brake (dynamic and friction) for the purposes of slowing or stopping the train. The contribution from each type of brake can be varied to achieve the demanded level of retardation.
Blowdown Valves	Air valves provided at the interface between the WSP and braking system that control the release and reapplication of train brakes as a method for controlling wheelslide during low adhesion incidents.
Brake Control Unit	Interface between the driver's brake controller and the train brakes, WSP equipment and sanding, converting brake demands from the driver into brake cylinder pressures (via an analogue control unit). The BCU also contains a microprocessor which manages the brake blending process and logs any faults that have occurred within the braking, WSP and sanding systems.
Braking (step 1, step 2, step 3 (full service), emergency)	Different positions on the driver's brake controller on the Class 377 unit representing progressively greater brake demands, e.g. brake step 1 is analogous to a retardation rate of $0.3m/s^2$ and brake step 2 to a retardation rate of $0.6m/s^2$.
Cab Secure Radio	A radio system allowing direct and one-to-one communication between a signaller and a train driver.
Conditioning (the railhead)	The process by which a contaminated railhead may be cleaned by the friction caused by train wheels passing over. WSP systems promote conditioning of the railhead by release and application of train brakes, which causes rapid changes in wheel rotational speed.
Diesel Multiple Unit	A self-contained diesel-powered train comprising one or more vehicles that can be coupled to other compatible diesel multiple units to form longer trains.
Down Line	Title applied to the line running from Brighton to Lewes and to the line running eastwards from Lewes.
Dynamic Brake	A brake which operates by using the traction motors as electrical generators to slow down a train.
Electrostar	Generic name for a family of electric multiple units manufactured by Bombardier Ltd.

Friction Brake	A brake which operates by using friction to slow down a train, e.g. tread brakes which involve a metal block making contact with the tread of the wheel or disc brakes which involve contact between a pad and a disc located on the axle.
Multi-Purpose Vehicle	Two power units placed at either end of a fixed formation train conveying, for example, containers or tanks. For the purposes of railhead treatment in Sussex during autumn 2005, they conveyed two containers, one with water which is jetted at high pressure onto the rails to clean the railhead and one with Sandite which is applied to the rails to improve adhesion.
On-track machine	Rail mounted self-propelled machines used for track maintenance and similar tasks.
On Train Monitoring and Recording Equipment	An on-board computer that records the status of different items of equipment in real time and enables a plot of train performance and driver actions to be downloaded .
Professional driving policy	A policy prepared by TOCs that describes, inter alia, train driving practices that the company expects its drivers to adopt in order to ensure safe and efficient train operations.
Rail Incident Officer	Network Rail employee who takes charge of the overall management of railway operations at the scene of a rail incident or accident.
Railhead Swabbing	A process of wiping the rail surface with cotton wool pads to gather evidence regarding the presence or otherwise of contamination. Swabs taken from the railhead are analysed in specially equipped laboratories.
Railhead Treatment Programme	Network Rail's programme of water jetting and Sandite application to discrete parts of the main line rail network to mitigate the effects of leaf-fall on the railway during autumn.
Railway Group Standards	Mandatory technical or operational document which sets out what is required to meet system safety responsibilities on Network Rail's infrastructure.
RT3189 signal passed at danger form	A form completed by a signaller in collaboration with a driver after a train has passed a signal at danger without authority.
Rule Book	A book which incorporates most of the rules to be observed by general railway staff for the safe operation of the railway.
Running Brake Test	A brake application made by the driver at specific locations (e.g. on the approach to steep gradients and terminus stations) or at a specific time (e.g. shortly after commencement of a journey) to confirm that the brake is working effectively.
Running Through (Points)	The movement of a train through a set of points in the trailing direction which are not set for the passage of the train.

Sanding	The application of sand either automatically or manually to assist with adhesion during traction or braking.
Sandite	A suspension of sand and steel particles in a gel applied to the railhead by MPVs and Rail Head Treatment Trains during the autumn leaf-fall season to improve adhesion conditions for trains.
Sectional Appendix	Network Rail document containing local rules and instructions and details of the railway for a given part of the network.
Single yellow (signal) aspect	An indication to the driver that the following signal is displaying a red (stop) aspect.
Speed Controller	A device fitted to the Class 377 unit that allows the driver to select a given speed, which the train will achieve and maintain without further intervention from the driver.
Two Aspect Signalling	A method of regulating train movement using signals that are capable of displaying red and green lights, with advance warning to drivers of the aspect displayed through the provision of 'repeating' signals capable of displaying yellow and green lights.
Three Aspect Signalling	A method of regulating train movement using signals that are capable of displaying red, single yellow and green lights.
Track Circuit Block Regulations	A set of rules that apply to the operation of trains over a section of line that is signalled using the occupation of track circuits as the means, inter alia, for determining the signal aspects displayed to drivers.
Track Parallel Hut	A building containing high voltage electrical switchgear and the equipment used for connecting together a number of sections of third rail equipment.
Train Reporting Number	A unique code that identifies each specific train, made up of four characters, the first of which designates its class, the second its destination and the third and fourth comprise a sequential number.
Wheelslide	Condition where the rotational speed of the wheel is lower than the actual speed of the train.
Wheelslide Prevention system	A system which, when active during braking, identifies when train wheels have started to slide and releases and reapplies brakes to: ● optimise braking rate to the level of adhesion available; ● condition the rail head (see separate definition).

Key standards current at the time — Appendix C

GM/RT 2044	Braking System Requirements and Performance for Multiple Units
GM/RT2045	Braking Principles For Rail Vehicles
GM/RT2461	Sanding equipment fitted to multiple units and on-track machines
GE/RT8000	Rule Book (Modules TS1, Signalling General Instructions and TS2, Track Circuit Block Regulations)

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