RAIB
Rail Accident Investigation Branch

Rail Accident Report

Fatal accident involving a train driver, Deal
29 July 2006

Department for Transport

Report 14/2007
May 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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Fatal accident involving a train driver, Deal 29 July 2006

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 to staff, data and records in connection with the investigation.

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

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

5 This report refers to a number of locations by reference to the mileage system adopted by the railway industry. In the case of the line between Buckland Junction and Deal all mileages are measured from London Charing Cross via Chelsfield and Canterbury West. This means that the railway mileages between Buckland Junction and Deal diminish in the down direction and increase in the up direction. This is the opposite of the normal railway convention.

Summary of the report

Key facts about the accident

6 At around 14:46 hrs on 29 July 2006 train 6Z25 arrived at signal EBZ41 on the *down line* between Dover Priory and Deal, near Deal station, Kent. Whilst checking that the brakes of one of the wagons were released the driver elected to enter between that wagon and the wagon behind with the objective of reaching the other side of the train. In doing so the driver came into simultaneous contact with the live *conductor rail* and the buffer of the wagon and was fatally injured.

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

Immediate cause

7 The immediate cause of the accident was the driver's leg coming into contact with a live conductor rail at the same time as his arm was in contact with the buffer thus causing an electric shock.

Identification of causal factors

8 The following factors are considered to be causal:

- the decision of the driver to pass between two wagons to avoid the walk around the train thus causing his leg to come into close proximity to a live conductor rail; and
- a subsequent misjudgement, loss of balance, or slip causing the driver's leg to drop into contact with the conductor rail.

9 It is possible that the following factors were also causal:

- the absence of specific rules prohibiting railway staff from stepping over a conductor rail whilst passing between coupled vehicles; and
- the absence of specific training on the procedures to be adopted when attending a train in an area of DC electrification.

Identification of contributory factors

10 The following factor is considered to be contributory:

- combustion of oil contamination on hot brake blocks during the descent of the steep gradient between Martin Mill and Deal.

Factors that may have influenced the behaviour of the driver

11 The reason that the driver elected to duck under the buffers with the intention of passing between the vehicles, rather than walking round his train, has not been identified. However, the investigation has identified a number of factors that may be relevant. These are as follows:

- the driver's judgement may have been impaired due to physical tiredness or due to the influence of alcohol;
- there is a lack of explicit statements in the Rule Book and other operating documents to explain that the conductor rail inside possessions is often left energised;
- at no point did the driver receive a briefing to expect the conductor rail to be live at all locations within the possession; and
- the wording in the Weekly Operating Notice (WON) as it relates to Direct Current (DC) isolations is potentially misleading.

12 Given the above factors, it is possible that the driver did not fully appreciate that the conductor rail inside the possession was energised.

Other factors for consideration

13 The following factors related to safety have been identified during the investigation:

- there is a need for improved clarity in the rules related to attending a train, and the use of insulating troughs, in areas of DC electrification; and
- the driver did not attend the safety briefing on arrival at his train.

Recommendations

14 Recommendations can be found in paragraph 220. They relate to the following areas:

- Improving information and training of staff related to the following topics:
  - safe working in areas of DC *third rail electrification* when the line is under possession; and
  - safe working practice when attending trains in proximity to the third rail (including clarification of the requirements in respect of insulating troughs).
- The control of oil contamination on brake blocks during lubrication.
- The wearing of long trousers by staff that may require to be on or near the track in an area of DC electrification.

The Accident

Summary of the accident

15 At around 14:46 hrs on 29 July 2006 train 6Z25 arrived at signal EBZ41 on the down line between Dover Priory and Deal, near Deal station, Kent. At the time the train was within an *engineering possession* that extended between Dover Priory and Deal. The driver (Driver B) stopped the train at this signal with the intention of using the signal post telephone to call the signaller to request authority to leave the possession. Driver B was then informed by another member of staff that smoke had been observed emerging from under a wagon midway along his train.

16 Whilst checking that the brakes of one of the wagons were released Driver B elected to enter between that wagon and the wagon behind with the objective of reaching the other side of the train. Whilst doing so Driver B came into simultaneous contact with the live conductor rail and the buffer of the wagon and was fatally injured.

17 The ambulance service arrived on site within 15 minutes of the first call and attempted resuscitation.

18 An overview of the site of the accident is to be found at Figure 2.

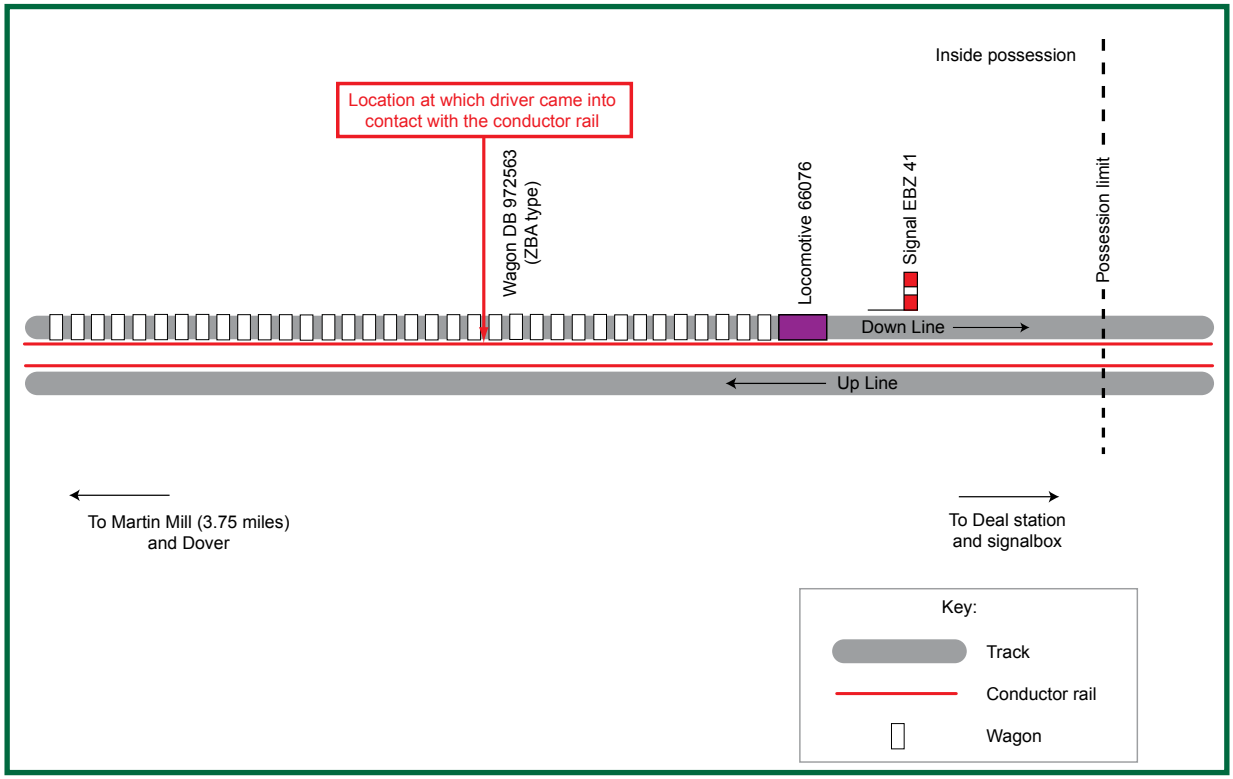

Figure 2: Overview of the accident site

The location

19 The accident occurred on the down line, on the approach to signal EBZ41, 700 metres south of Deal station (Figure 3). Signal EBZ41 is a semaphore type signal controlled from a signal box located north of Deal station.

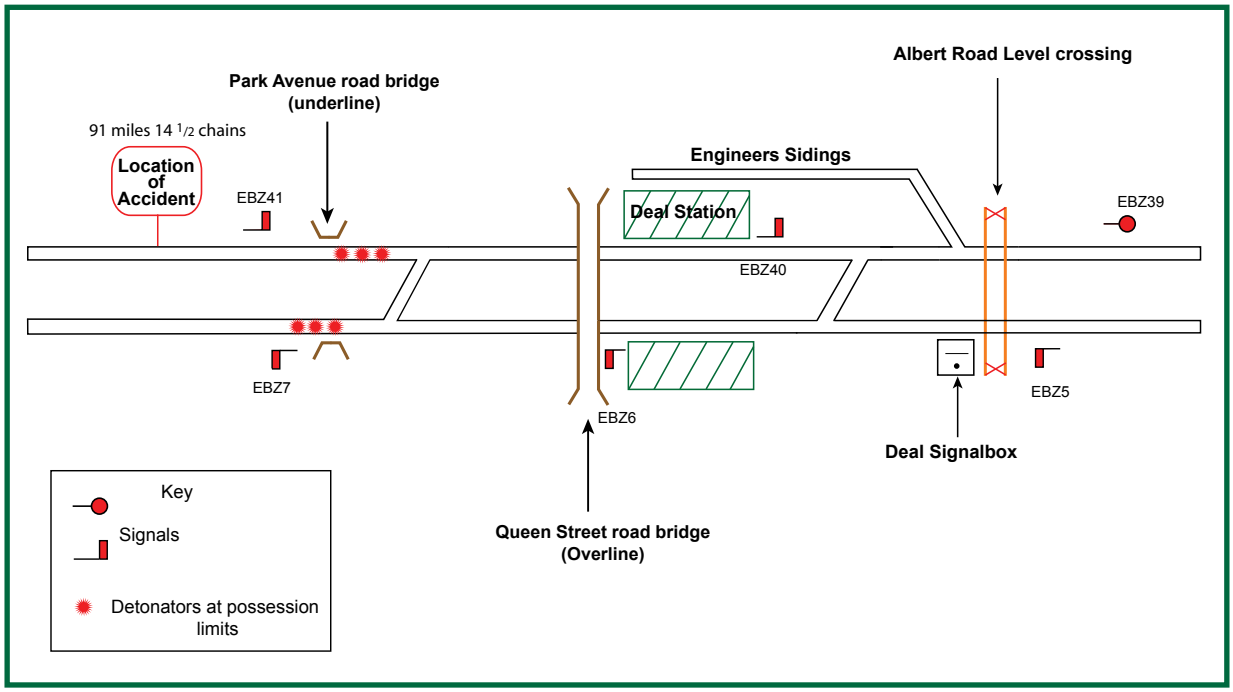

Figure 3: Deal station and environs

The parties involved

The train operator

20 English Welsh and Scottish Railway (EWS), is a major operator of freight trains in the UK. These include a large number of engineering trains conveying materials and equipment to and from *worksites.* EWS owned, and was responsible for the maintenance and operation of, the rolling stock involved in this event. EWS employed Driver B and several other personnel involved in this accident.

The infrastructure manager

21 The railway infrastructure involved in this accident is owned, operated and maintained by Network Rail. In its capacity as infrastructure manager Network Rail employed the signaller at Deal, the *Electrical Control Operators* (ECOs) at Canterbury and the *Person in Charge of the Possession* (the PICOP). In addition, Network Rail contracted a qualified person to supervise the possession limits (a '*blockman*') located some 200 metres beyond signal EBZ 41 to the south of Deal station.

Main Contractor

22 The main activity within the possession was associated with the renewal of track on the *up line* between Buckland Junction and Deal (95 miles 3 *chains* to 98 miles 63 chains). The contractor undertaking these works was Balfour Beatty Rail Infrastructure Services (BBRIS). In its capacity as the main contractor BBRIS employed the Engineering Supervisor (ES), the *Controller of Site Safety* (COSS) and other staff with safety responsibilities within the worksite.

The railway infrastructure

23 The route between Dover and Deal is a two track railway. The up line (known as the 'up Deal' line) normally conveys trains in the direction of Dover. The down line (known as the 'down Deal' line) conveys trains in the direction of Deal and beyond to Sandwich and Ramsgate. At Buckland Junction (99 miles 05 chains) the route to/from Deal converges with the two track route from Canterbury.

24 A particular feature of the route between Buckland Junction and Deal is the severity of the gradients (see Figure 4). For trains travelling on the down line in the normal direction (i.e. northbound) there is 1 in 70 rising gradient for a distance of 3 miles from Buckland Junction. After passing the summit, down trains descend a 5 mile long gradient. The average gradient on the 3.5 miles between Martin Mill station and signal EBZ41 is 1 in 70.

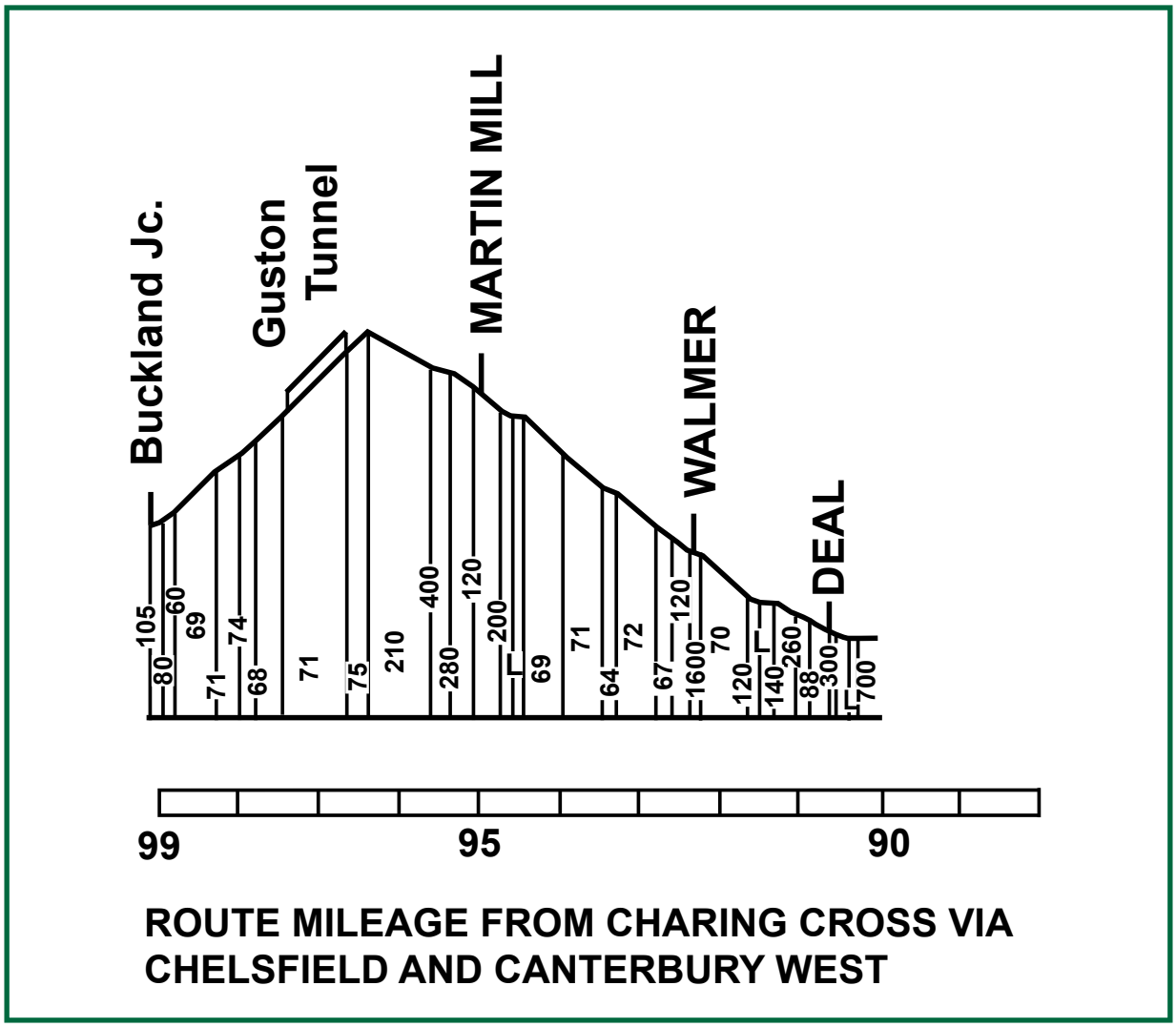

Figure 4: Gradient plan between Buckland Junction and Deal

25 The track forming the up line at the location of the accident is continuous welded rail and concrete sleepers laid in ballast.

26 The up and down lines are equipped with a conductor rail (this is often referred to as the 'third rail'). This rail sits on the outside of one of the running rails and conducts the electric current that is picked up by electric trains using collector shoes that slide along its upper surface. The conductor rail on these lines is of a standard 150 lb/yard type that is found on most other lines in the south of England. It is supported by insulators located on the end of every fourth or fifth sleeper.

27 At the location of the accident the conductor rail for both the up and down lines is located in the space between the two tracks (this space is known as the '*six-foot*'). The distance between the conductor rails is 900 mm (Figure 2).

28 The electricity is supplied to the conductor rail via a number of electric substations in the area. These are located at Walmer, Guston and Kearsney. The electrical supply to the section of conductor rail involved in this accident is normally fed from the substation at Walmer.

29 Substations convert the alternating current received from the national grid into direct current (DC). This is supplied at a voltage between 650 and 750 V.

30 The conductor rail is divided into a number of electrical sections. The electrical sections in the area of the accident are described at paragraph 67.

31 There are track parallelling huts (TP huts) located at Deal, Martin Mill, Dover East, Lydden, Kearsney and Buckland Junction. These contain the electrical equipment that is required to connect a number of *electrical sections.*

32 The accident occurred within the electrical section C106. This section extends between a circuit breaker located at Walmer substation and another circuit breaker located in Deal TP hut.

33 All of the circuit breakers and other electrical equipment within the area of the possession were monitored and controlled from an electrical control room (ECR) located in Canterbury.

34 Signals in the area of the accident are controlled from the signal box at Deal. The signals in the Dover and Buckland Junction area are controlled from a signal box at Folkestone East. There is also a signal box at Shepherdswell that controls signals on the southernmost section of the line from Canterbury.

Overview of railway activities at the time of the accident

The engineering works

35 On the day of the accident major track renewal works were taking place on the up line between Buckland Junction and Martin Mill. To facilitate this activity *worksite limits* were established on both the up and down lines at 95 miles 10 chains and 98 miles 75 chains (Buckland Junction to Martin Mill exclusive). These limits were marked by the provision of illuminated *worksite marker boards*.

36 The ES, a BBRIS employee, was in charge of work activities within the worksite limits. His duties included the authorisation of train movements on both lines within the worksite.

The engineering possession

37 The above worksite was contained within a possession taken in accordance with module T3 of the Rule Book (Railway Group Standard (RGS) GE/RT 8000). The limits of this possession had been published, as item 34, within the Kent and Sussex Route's WON, for the week concerned. The published limits were located as follows:

- north of Dover Priory (both lines blocked);
- south of Shepherdswell (both lines blocked); and
- south of Deal (both lines blocked).

38 The possession limits on the down line at Deal were specified to be placed on the approach to signal EBZ40.

39 The above possession was established at 02:02 hrs on Saturday 29 July 2006 and was due to be in place until 00:15 hrs on Sunday 30 July.

Operation of engineering trains

40 Five engineering trains passed through the item 34 possession. These are listed in Table 1.

Train ID	Train description (all formed by a locomotive pulling wagons)	Operator	Point of entry into possession (and actual time)	Point of exit from possession (and actual time)
6Z24	Hoo Junction to Martin Mill	EWS	Dover Priory (04:55 hrs)	Deal (14:10 hrs)
6Z25	Hoo Junction to Martin Mill	EWS	Dover Priory (08:40 hrs)	Deal (departure delayed by accident)
6Z26	Hoo Junction to Martin Mill	EWS	Dover Priory (12:13 hrs)	Deal (departure delayed by accident)
6Z27	Hoo Junction to Martin Mill	EWS	Dover Priory (13:30 hrs)	Deal (departure delayed by accident)
6G12	Hoo Junction to Martin Mill	GB Railfreight	Dover Priory (18:20 hrs)	Deal (departure delayed by accident)

Table 1: Engineering trains associated with the item 34 possession

41 All of the trains listed at Table 1 entered the possession at Dover Priory and were routed to site via the down line. All were scheduled to leave the possession via Deal.

42 The above method of operation avoided the need for trains to be split and joined within the worksite or possession. Nevertheless, trains had to be inspected after loading on site to ensure that the wagons remained in a fit state to leave the possession. EWS had provided a member of ground staff who was qualified to prepare the train and confirm that wagons were fit to travel following loading. This arrangement allowed all of the EWS trains to be operated to and from the possession without the need for an additional member of staff to accompany the driver.

43 Train 6Z25 was driven from Hoo to the worksite by an EWS driver (Driver A). This driver remained with the train until relieved by another EWS driver arriving by taxi from Hoo Junction (Driver B). Driver B drove the train from the worksite towards Deal.

The train involved in the accident

44 Train 6Z25 was scheduled to leave Deal at 17:00 hrs en route to Hoo Junction via Ramsgate, Chatham and Strood.

45 Train 6Z25 was formed by 35 ZBA '*Rudd*' type wagons. These wagons have two axles, a low-sided box body and are provided with a *continuous airbrake*. Brake force is applied to the wagons wheels by means of brake blocks that are linked to the brake cylinder by an array of push rods and levers. Brake blocks are identified by the 'corner' of the wagon with which they are associated. Wagon 'corners' are identified by means of painted codes A1, B1 at one end of the wagon and A2, B2 at the other (see Figure 6).

46 The train was hauled by a single class 66 type diesel locomotive (66 076).

47 At the time of the accident all 35 wagons were loaded with spoil. The actual weight of the train (excluding the locomotive) was about 917 tonnes.

The weather

48 The weather was dry on the day of the accident. At 15:00 hrs the temperature in the Deal area had reached 26 ºC. There was no significant wind movement. The sky was reported to be overcast with high cloud.

The sequence of events

49 The sequence of events associated with this incident, and associated times, have been identified using the best available evidence. The sequence of events relevant to this incident is presented in Table 2, overleaf.

Date	Time	Event
28/7/06		Wagon DB 972563 is subject to Pre-planned Maintenance at Hoo Junction. This includes the oiling of the brake rigging and the replacement of the brake block (on corner 1A).
29/7/06	Shortly before departure	The rolling stock to form train 6Z25 is examined and a successful *continuity brake test* is performed.
	05:39 hrs	Train 6Z25 departs from Hoo Junction (driven by Driver A). The departure is observed by a ground staff team member (GSTM) to be in good order.
		Train 6Z25 is routed via Sidcup, Lee Spur Junction, Chislehurst Junction, Swanley, Maidstone East, Ashford, Continental Junction and Folkestone.
	08:19 hrs	Train 6Z25 arrives at Dover Priory.
	08:40 hrs	Train 6Z25 enters possession with authority of the PICOP.
	08:52 hrs	Train 6Z25 arrives at the worksite (Buckland Valley).
	c.12:00 hrs	Driver B arrives at his depot, Hoo Junction, reports on duty with the Trains Master at Hither Green and takes taxi to the worksite.
	c.13:00 hrs	Driver B arrives at Martin Mill (close to the worksite limit). He enters the worksite but does not report for a safety briefing. Drivers A and B meet. Driver A returns to Hoo Junction by taxi. Driver B takes over driving of train 6Z25.
	c.14:00 hrs	Train 6Z25 is examined by the GSTM and a completed form is issued to Driver B.
	14:13 hrs	Train 6Z25 pulls up to the *worksite marker board*.
	14:29 hrs	Train 6Z25 leaves worksite and proceeds towards Deal.
	14:46 hrs	Train 6Z25 arrives at EBZ 41 signal at Deal (down line).
	14:47 hrs	Driver B calls signaller on the signal post telephone.
	c.14:51 hrs	The blockman located close to the EBZ41 signal informs Driver B that he has seen smoke from under a wagon midway along the train.
		The blockman and Driver B walk along the train on the side adjacent to the up line.
	c.14:53 hrs	Driver B and the blockman observe a "red" coloured brake block on corner A1 of wagon DB 972563 (14th wagon from the locomotive).
		Driver B returns to loco with intention of releasing the train brake.
	14:55 hrs	Driver B releases then *overcharges* the train brakes (the *straight air brake* remains applied). The blockman observes brake block releasing from the wheel tread. The wagons roll forward by a short distance.
	c.14:55 hrs	Driver B leaves the locomotive and returns to wagon DB 972563.
	c.14:57 hrs	Driver B arrives at wagon DB 972563.
		Driver B kicks the *brake rigging* to check that the block on corner A1 of the wagon has released.
		Driver B tells the blockman that he is going to check the blocks on the other side of the wagon (i.e. the side of the train adjacent to the *cess*).

Date	Time	Event
	c.14:58 hrs	Driver B ducks between wagon DB 972563 and the wagon behind it.
		Blockman sees Driver B convulse. Driver B reaches out and grabs the chain of the coupler. He then falls forward, twists and lands on the ground with his head on the rail next to the cess with one foot against the conductor rail.
	c.14:59 hrs	Blockman reports incident to PICOP. He asks if the power is off. The PICOP says he is not sure but will arrange for it to be turned off.
	c.14:59 hrs	PICOP informs the signaller and asks for him to alert the emergency services.
	15:00 hrs	Signaller informs the emergency services. He is unaware of the best access point and is still awaiting confirmation that the conductor rail is isolated. He therefore reports the location as the signal box (Albert Road, Deal).
	15:00 hrs	The PICOP rings the Electrical Control Room (ECR) and requests an emergency isolation.
	15:02 hrs	The operator in the ECR opens circuit breakers and confirms that power is off between Martin Mill and a location east of Deal (Bettshanger).
		Blockman attempts to resuscitate Driver B.
	c.15:12 hrs	Kent Ambulance staff arrive at the signal box and are directed to an access point at Ravenscourt Road.
	15:15 hrs	Kent Ambulance arrive on site.

Table 2: Sequence of events

The Investigation

Sources of evidence

50 The key sources of evidence include each of the following:

- records of witness interviews;
- on-site sketches and photographs;
- data obtained from the *on-train data recorder* (OTDR) located on the locomotive;
- possession and worksite records (e.g. completed forms);
- completed planning documentation and forms related to the isolation of the conductor rail;
- signal box train registers and occurrence books;
- voice recordings of safety critical communications;
- emergency service logs;
- draft pathology, histology and toxicology reports provided with the permission of HM Coroner for Kent;
- reconstruction of Driver B's actions when passing between the vehicles; and
- detailed review of the operating documentation current at the time of the accident.

Factual Information

Previous occurrences of a similar character

51 The RAIB has found no records of an incident or accident of a similar nature since 1990.

Issues associated with protection of the engineering works

The relevant rules – general safety in areas of DC electrification

52 General rules concerning safety around conductor rails are contained in module G2 of the Rule Book. This module describes the risk and defines the terminology associated with conductor rails and the DC electrification system. This module is applicable to all railway staff and mandates compliance with the following key rules:

Dangers of conductor rails

You must not go on or near a line with conductor rails unless you are competent in PTS for DC lines and your PTS certificate is endorsed to show this. However you may go on or near the line if you have been briefed on how to:

- get the electricity supply switched off in an emergency;
- carry out electric shock rescue.

When you are on the or near the line, you must:

- always consider the conductor rails to be live at all times and extremely dangerous to life;
- not step on, touch or allow your clothing, tools or any equipment you are carrying to touch the conductor rails or its connections;
- not put your foot between the conductor rail and the adjacent running rail;
- whenever you can, cross the line at a gap in the conductor rail or where protective boarding is provided;
- not step into flood water which may be in contact with the conductor rail;
- not allow any object to come into contact with the conductor rail;
- not direct a jet of water or other liquid onto the conductor rails;
- not touch the collector shoes or their connections on any train including when the conductor shoes are not touching the conductor rails.

53 Of particular importance in the above extract is the requirement that staff should consider the conductor rails to be live at all times. This requirement is also reflected in the railway industry's personal track safety booklet (Ref. RT3170).

The relevant rules – protection of engineering works

54 The rules relevant to the protection of engineering work are contained in the Rule Book. In particular, Module T3 of the Rule Book defines the rules applicable when the line is blocked to trains in order that engineering works can be carried out (i.e. when the line is under possession).

55 At the time of the accident the rules relevant to the isolation of the conductor rail for the purpose of protecting a worksite were contained in a document entitled 'DC Electrified Lines Instructions' (Ref. GO/RT3091).

56 On 6 December 2006 the rules relating to DC electrification systems were transferred to new documents. Those of a general applicability were transferred to a new module of the Rule Book, module DC. More detailed instructions applying to persons working on or near conductor rail equipment and Electrical Control Operators are now contained in a Network Rail Company Standard entitled 'DC Electrified Lines Working Instructions' (NR/WI/ELP/3091). The intention of these changes was to improve the clarity of presentation by separating the general requirements from instructions directed at specialised staff.

57 The roles of the persons responsible for protecting the worksite and associated electrical isolations in areas of DC electrification are summarised in Table 3.

Working arrangements associated with WON item 34 (week 18)

58 The details of the possession had been published in the WON as item 34 for week 18. This showed the planned limits of the possession (see paragraph 37). Immediately underneath the listing of possession limits was a section related to the 'isolation of electrical sections'. This section limits the description of the isolation limits to the following statement:

'CURRENT WILL BE AFFECTED'

59 The meaning of this entry is unclear. One possible interpretation is that the current was planned to be isolated throughout the possession limits.

60 Despite its lack of clarity the above presentation of information relating to DC isolations was in line with normal practice in areas of DC electrification.

Title	**Role- protection from trains** (as defined in Rule Book module T3)	**Role - safety briefing of persons on site**	**Role - isolation of the conductor rail** (as defined in the DC. Electrified Lines Instructions - Procedure A)
Signaller	Blocks the line to trains by holding specified signals to danger.		Notes limits of isolation (or electrical sections) on form DS.
Person in Charge of the Possession (PICOP)	• Arranges possession with signaller(s) in accordance with details published in the WON. • Arranges for the provision of local protection (possession limit boards and three detonators) at the possession limits. • Authorises any Engineering Supervisors to start work when the possession is granted and local protection is in place.	Ensure, that the blockman and any other staff working under his authority are appropriately briefed.	• Once the possession is established the PICOP must: o inform the signaller of the limits of traction current isolation; o request the Electrical Control Operator to arrange for the electricity to be switched off in the electrical sections specified on *form B2*; and o once the power is switched off, arrange for any manual switches to be operated (as specified on form B2). • Once the isolation is confirmed the PICOP should request the ES to test the conductor rail.
Blockman	• Place local protection to mark the limits of the possession (3 detonators and possession limit boards). • Lift protection to permit the passage of trains when authorised to do so by the PICOP/signaller.		
Engineering Supervisor (ES)	Arrange for the marking of the worksite limits using illuminated boards.		• Arranges for the testing (using a *testing device*) of the conductor rail to confirm that it is not live. • When testing is complete he arranges for the application of *short circuiting straps* at each end of the worksite and any additional straps specified on form B2. • When straps have been applied he issues a *Conductor Rail Permit* (CRP) to the persons in charge of any work to be undertaken.
Controller of Site Safety (COSS)		Ensures safety arrangements are in place within the worksite in accordance with the requirements of the Rule Book. These include the briefing of all staff.	• Ensures work does not start until the CRP has been issued • Keeps the CRP until the work is complete. • Ensures that all persons are clear and briefed before returning the CRP to the ES.
Strapman			Person tasked with applying the short circuiting strap when so instructed by the ES.
Electrical Control Operator (ECO)			• When requested by the PICOP operate remote switches in substations and TP huts in accordance with the switching schedule shown on form B2. • Record details in the electrical control room log book.

Table 3: Summary of roles (as defined on 29 July 2006)

61 A pre-possession briefing was held on Thursday 27 July, at Ashford. All involved parties other than train operators were in attendance. During this meeting a comprehensive and clearly presented briefing pack was issued. This included all key planning documentation, such as:

- contact lists;
- checklist for the briefing of protection staff such as blockmen;
- details of planned works trains;
- form for recording the movement of works trains;
- extracts from the WON;
- PICOP form DP for recording electrical isolation arrangements;
- form B2 showing numbers of circuit breakers and hook switches to be operated and the location of short circuiting straps to be applied;
- diagrams showing track/signalling layout and limits of protection; and
- possession monitoring log sheets.

62 The copy of the pack issued to the PICOP was obtained following the accident. On inspection it was found that the various forms had been correctly filled in and the information entered was accurate.

63 In general, the protection and isolation arrangements associated with WON item 34 on the 29 July 2006 were planned and implemented in accordance with the relevant rules and the DC Electrified Lines Instructions.

64 However, neither the signaller at Deal nor the signaller at Folkestone East recorded the limits of the isolation on a form DS as was required by Procedure A contained in the DC Electrified Lines Instructions. Both signallers instead completed a special form labelled 'Rule Book Module TIII incorporating DS form'. When completed, these forms contained the correct information concerning T3 protection arrangements but not a record of the limits of the isolation.

65 The conductor rail isolation associated with the WON item 34 possession had been planned by the Network Rail Isolation Assistant based at Ashford. The extent of the isolation was planned to encompass only the worksite (i.e. the section of the up and down lines between 95 miles 10 chains and 98 miles 75 chains). This required the isolation of electrical sctions C109, C110, C111, C112, C113, C114, C51 and C52. In addition there was a requirement for the northernmost subsection of C53 and C54 to be isolated by opening manual switches (hook switches) near Charlton tunnel, HS4670 and HS4669. This left six live electrical sections within the possessions. These included electrical section C106 on the down line between Walmer and Deal (see Figure 5 for details).

66 The extent of the isolation created by the above switching arrangements is typical of an isolation within an area of DC electrification and was compliant with the requirements of the DC Electrified Lines Instructions. These instructions, and the current Network Rail standard, state that the extent of the electrical isolation need only be sufficient to safely protect the work limits. Network Rail's planners will generally endeavour to limit the extent of the isolation so far as possible. This policy limits the need for the opening of remotely operated and manual switches. Since isolation procedures also require the testing of the conductor rail (using a testing device), and the subsequent application of short circuiting straps[1], this policy also limits the need for 'strapmen and *testers*' to be deployed.

67 A diagram of the WON 18 item 34 possession limits, the worksite and the associated conductor rail isolation is to be found at Figure 5.

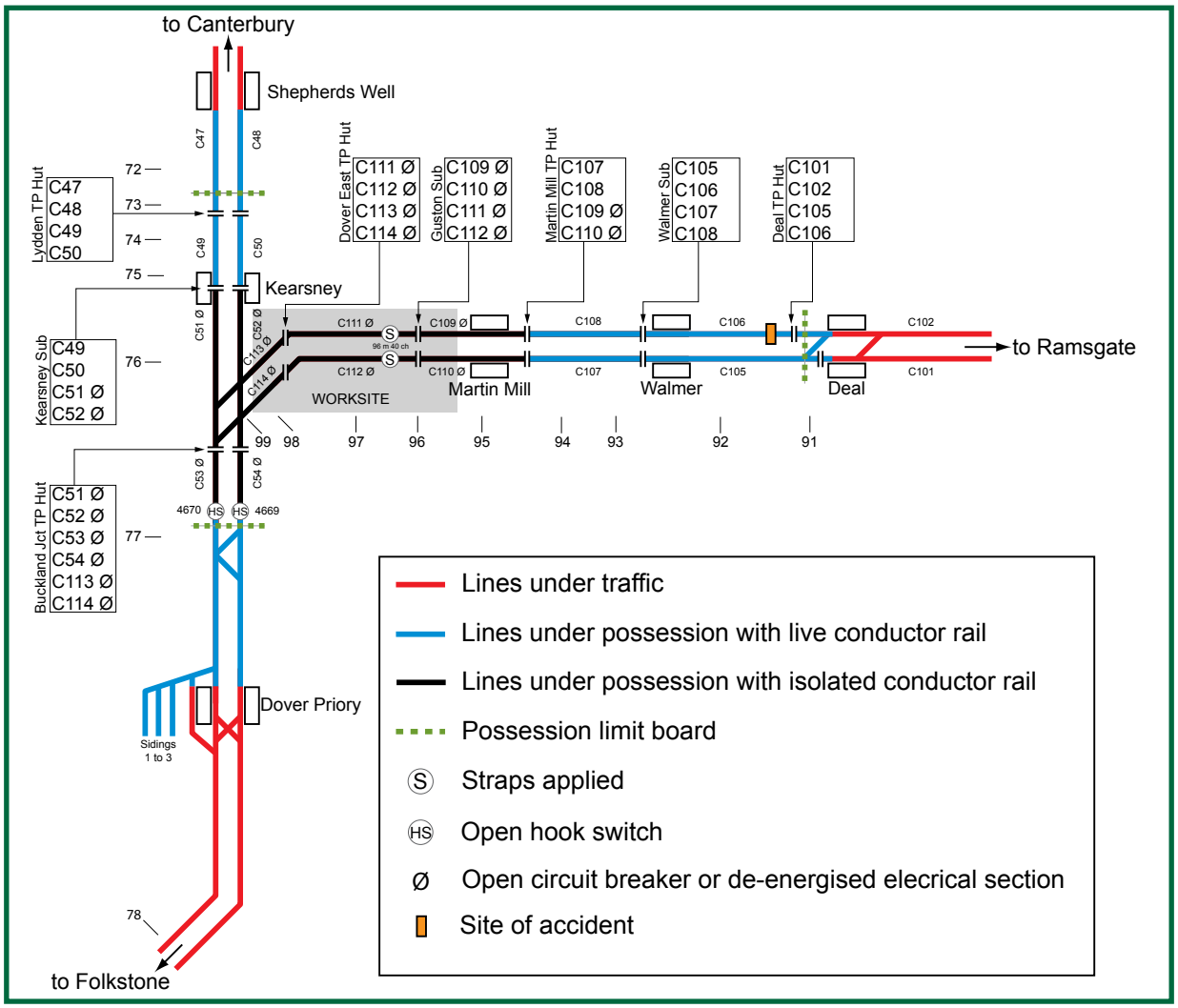

Figure 5: Protection of the engineering works associated with WON 18 item 34 on Saturday 27 July 2006

[1] These straps are applied on either side of the worksite (and otherwise as specified on form B2). A short circuiting strap is a device used to connect the conductor rail to the traction return rail to stop the conductor rail being accidentally made live during an isolation.

Worksite safety

68 The testing of the conductor rail was carried out and short circuiting straps applied under instruction from the ES.

69 A van for use to provide briefings had been provided at the main site access point at Old Park Bridge, in Buckland. The company controlling the worksite, BBRIS, required all staff entering the site to be given a safety briefing at this location. This briefing covered a range of hazards on the site. However, electrical hazards were not covered as part of this briefing, other than the identification of the conductor rail as a tripping hazard.

70 The location of the access point at old Park Bridge was notified to EWS who in turn notified their drivers by means of an entry on the work sheet for the day.

General awareness of the status of the conductor rail within the possession

71 Two of the staff involved with the possession expressed surprise when they heard that sections of the conductor rail had been live within the possession. Both claimed that they had always understood that the conductor rail would be isolated throughout the possession limits. However, both also stated that they always treated the conductor rail as live even when they understood it to be isolated.

72 One of the above individuals was qualified to act as a COSS and had prepared and signed a COSS Record of Arrangements and Briefing Form. This pack of safety information includes the following statement as part of a checklist:

*'If no permit to work is held electrified lines are live……**Treat all Lines as Live**'*

73 There are a number of operational and training documents that refer to conductor rail safety. All instruct railway staff to treat the conductor rail as live, and that no work should be carried out without a Conductor Rail Permit (CRP) in place. However, none include an explicit statement warning railway staff that conductor rail within a possession is live (see Table 4).

Document	Applicability	Safety clause		
		Treat conductor rail as live at all times	**No work to be carried out without a CRP in place**	**Conductor rail within a possession is live (unless a CRP is in place)**
DC Electrified Lines Instructions (RGS GO/RT3091)	Until 6 December 2006	Yes	Yes	No
DC Electrified Lines Working Instructions (Network Rail Company Standard NR/WI/ELP/3091)	From 2 December 2006	Yes	Yes	No
Module DC of the Rule Book (RGS GE/RT 8000)	From 2 December 2006	Yes	Yes	No
Module G2 of the Rule Book (RGS GE/RT 8000)		Yes	N/A	No
Personal Track Safety (PTS) Hand Book (RT3170)		Yes	N/A	No
Controller of Site Safety (COSS) Hand Book[2]		Yes	Yes	No

Table 4: Comparison of safety clauses contained in operational and training documentation

[2] The April 2005 COSS Handbook published by Rail Safety and Standards Board (RSSB) in conjunction with the Track Safety Strategy Group (TSSG).

74 It is the view of certain managers within EWS that a significant proportion of their drivers were unclear about the extent of conductor rail isolations within possessions. Nevertheless, EWS is of the view that all drivers always treated the conductor rail as being live, even when within a worksite in line with the message conveyed to drivers during *Personal Track Safety* (PTS) training. This view is consistent with RAIB's own view following interviews and discussions with EWS managers and drivers.

Issues associated with the driver of train 6Z25 attending his train in an area of DC electrification

Relevant rules and regulations

75 At the time of the accident the activities of train drivers were also covered by certain rules contained in the DC Electrified Lines Instructions (RGS GO/RT3091). Of particular relevance were rules concerned with personal safety when attending a train (clause 2.4) and when examining or carrying out repairs on a train (clauses 20.1 and 20.2). Clause 2.4 mandated that 'persons operating handbrakes, coupling or uncoupling vehicles, etc.' should:

'as far as practicable, work on the opposite side of the vehicle to the conductor rail'

76 Clause 20.1 stated:

'in any location, visual examination of trains or vehicles can be carried out without danger provided the live conductor rail or the overhead trolley wires are not touched'

77 Clause 20.2 mandated methods of protection to prevent any person coming into contact with the live equipment or the conductor rail when carrying out minor repairs.

78 On 2 December 2006 the above rules were transferred to a new module of the Rule Book, module DC. The requirements of clause 2.4 of the former DC Electrified Lines Instructions are now contained in clause 4.4 of module DC. In addition, this clause included the requirement to place an insulating trough over the conductor rail if it is not possible to work on the side of the train furthest from the conductor rail when coupling and uncoupling; as was previously mandated in clause 43.5(b) of the DC Electrified Lines Instructions.

79 The requirements of clauses 20.1 and 20.2 of the former DC Electrified Lines Instructions were broadly similar to those now contained in clauses 12.1 and 12.2 of module DC.

80 There are no rules that prohibit train drivers from passing between coupled vehicles in the train for which they are responsible. Nor are there any rules that prohibit (or advise against) drivers, or any other person, from stepping over a conductor rail when passing between coupled vehicles.

Background information concerning Driver B

81 Driver B had 20 years experience as a driver. For all this time he worked on DC electrified lines and he had 11 years of experience working freight trains. This has involved many turns of duty involving the operation of works trains within worksites and possessions. He had been based at Hoo Junction since October 1998.

82 Driver B has been described by his employer and his colleagues as enthusiastic, professional and highly knowledgeable about train driving and railway operations in general. This view was reflected in his staff record which also shows that he had a particular interest in operating trains in connection with engineering work.

83 His record shows that Driver B always performed well in the theory and practical assessments carried out as part of the EWS competence management system. At his last assessment carried out in March 2006 his assessor wrote:

'Driver B demonstrated a good underpinning knowledge based on Q&A and "what if" scenarios also by relating to actual experience'; and

'Driver B was able to demonstrate an in depth wealth of underpinning knowledge through Q&A and various scenarios experienced over the years'.

84 Driver B was an active union representative and was known to have a keen interest in safety matters; he had been active in Network Rail meetings to examine issues associated with the operation of engineering trains. These interests also led to his involvement in a working group to examine the feasibility of *driver only run-round operations.* This had involved a visit to Stewarts Lane stone terminal three days before the accident. During this visit there had been a discussion of the safety implications of drivers going between vehicles in order uncouple or couple a locomotive during a run-round operation.

85 Driver B's performance had been the subject of assessment over a period of eight years in accordance with a process defined within the EWS Operations Safety Management System (EWS/OS/001). This performance assessment system is designed to record and score all operating incidents involving the driver in order that the risk of future occurrences can be assessed. The forms associated with this process record no incidents against Driver B. His risk of involvement in a safety incident was therefore scored by EWS as 'Category D1; No Risk'.

86 Driver B was 40 years old. Eight months previous to the accident he had been subject to a company medical. He was passed as fit but concerns were raised about his weight. For this reason his fitness was subject to additional monitoring.

87 Driver B's working pattern over the previous 89 days has been analysed using the HSE *Fatigue Index* calculator. This gives a score of 23.6, well below the indicative value of 30 at which work induced fatigue is of concern.

88 In the week immediately before the accident Driver B had worked the following shift pattern:

Friday 28/07/06	12:09 hrs to 21:30 hrs (duration of 9 hours 21 minutes)
Thursday 27/07/06	Off
Wednesday 26/07/06	Meeting from 07:00 hrs to 15:00 hrs (duration of 8 hours)
Tuesday 25/07/06	11:54 hrs to 23:00 hrs (duration of 11 hours 6 minutes)
Monday 24/07/06	15:48 hrs to 23:30 hrs (duration of 7 hours 42 minutes)
Sunday 23/07/06	Off

89 The above work pattern is unlikely to generate abnormal levels of fatigue.

90 The RAIB is unaware of any additional factors that would have given rise to fatigue or abnormal levels of stress.

91 At the time of the accident Driver B was wearing a high visibility tabard, a short sleeved polo shirt and knee length shorts. The wearing of shorts was contrary to the EWS policy on approved workwear.

Operation of the train

92 Train 6Z25 was prepared by ground staff in the early hours of 29 July at Hoo Junction yard. The train was inspected to check that all handbrakes were released and a brake continuity test was performed by Driver A and a member of ground staff.

93 The member of ground staff observed the passage of the train (from the left hand side of the train in the direction of travel). He recalls that the tail lamp was in place and that there were no problems with the running of the train.

94 An analysis of the data obtained from the OTDR shows that the journey from Hoo Junction to Dover Priory (a distance of 91 miles) took 2 hours 43 minutes at an average speed of 33.5 mph (55.3 km/h). During this journey there were no long periods of sustained braking. Only three full service applications were made during the entire journey.

95 Given the manner that the train had been driven from Hoo to Dover Priory it is unlikely that the brake blocks of the wagons in the train would have become abnormally heated at any point of the journey unless the brakes were defective.

96 Driver B arrived at Hoo Junction at around 12:00 hrs. He signed a form to acknowledge receipt of his operating notices (including WON 18) and phoned the Trains Master at Hither Green to report on duty. The telephone conversation was short and the Trains Master did not recall anything unusual about what was said or Driver B's manner of speech.

97 Driver B then joined a taxi that had been arranged to take him to the item 34 worksite at Buckland.

98 Whilst in transit Driver B used his mobile phone to confirm the location of train 6Z25 with Driver A. Driver A informed him that train 6Z25 was stabled behind train 6Z24, at Martin Mill. Driver B then asked the taxi driver to take him directly to Martin Mill. Consequently, Driver B did not go to the main site access point in Old Park Bridge and as a consequence received no site safety briefing.

99 The member of EWS ground staff who was on site to prepare the trains and inspect the loaded wagons recalls meeting Driver B on his arrival at Martin Mill by taxi. They had a conversation on various topics but at no point was mention made of the conductor rail isolation or its extent.

100 The member of EWS ground staff then inspected the train (this included a visual inspection of the rolling stock) and the loading of the wagons. All was found to be in good order.

101 Driver A remained in charge of train 6Z25 until the arrival of Driver B at Martin Mill.

102 None of the above persons recalled anything unusual about the manner or behaviour of Driver B.

103 At 14:13 hrs Driver B drove train 6Z25 a distance of around 300 metres up to the worksite marker boards. Here he was met by the ES who briefed him on the arrangements for leaving the worksite. He also received a briefing from the PICOP (via the ES's mobile phone). The PICOP instructed him to drive to signal EBZ41 and to seek the authority of the signaller before proceeding out of the possession and up to EBZ40.

104 At 14:30 hrs the marker boards were lifted and the train left the worksite bound for Deal.

105 Analysis of output from the OTDR shows that Driver B drove the train cautiously between Martin Mill and signal EBZ41 at Deal. It took 16 minutes 55 seconds to cover a distance of four miles and the speed of the train never exceeded 24 mph (39.6 km/h). The average speed was 14 mph (23.1 km/h). An average speed of 14 mph is typical of a safe operating speed within a possession.

106 To control the speed of the train to this extent, and given the steep down gradients between Martin Mill and Deal, Driver B had applied sustained and frequent braking during the journey. In total the brakes had been applied during 64 per cent of the journey. This degree of sustained braking is unusual and is certain to have resulted in the temperature of the brake blocks rising.

Actions of Driver B when stopped on approach to signal EBZ41

107 On arrival at signal EBZ41 the driver left his train to speak to the signalman. At this time the blockman was waiting nearby to lift and restore the protection on the down line after the departure of train 6Z25. It was the blockman who first noted white smoke.

108 On being told by the blockman that 'white' smoke was emanating from his train Driver B chose to investigate. As an experienced and knowledgeable driver he would have been aware that the brakes of the wagons would be hot following sustained braking but is likely to have wanted to check that he did not have a handbrake left on, dragging brakes or another mechanical problem.

109 In conjunction with the blockman he chose to investigate the source of smoke from the six-foot side of the train. This was logical given the fact that smoke had been observed on this side. Driver B would have known that he was at little risk from trains approaching on the up line since the blockman would have had to remove protection on that line to allow another train to approach.

110 On arrival at wagon DB 972563 (the 14th wagon on the train) the blockman drew Driver B's attention to the brake block on corner A1 of the wagon (Figure 6). It appeared to the blockman that this brake block was glowing red (Figure 9).

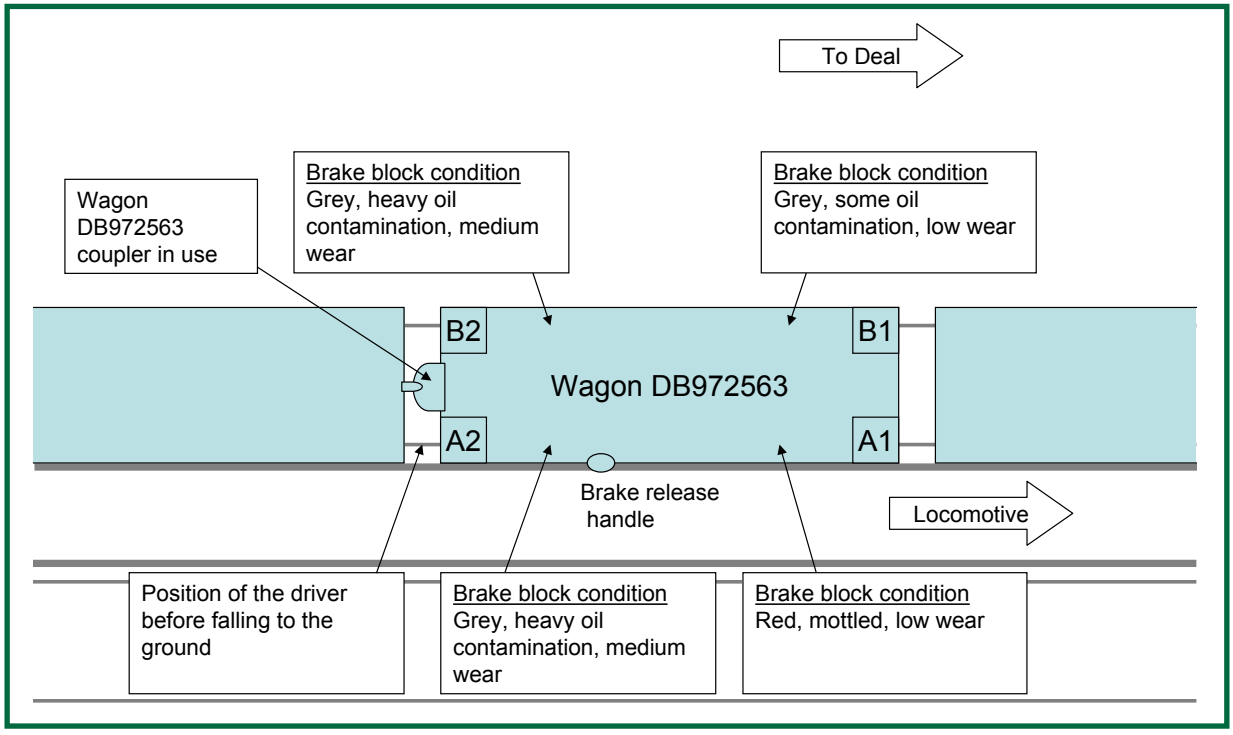

Figure 6: Sketch of wagon DB 972563

111 Driver B returned to the locomotive then released (and overcharged) the brakes. He applied the locomotive's straight air brake (which applies the brake on the locomotive only) to prevent the train from rolling and then returned in order to check that the brakes were released on wagon DB 972563.

112 Shortly after Driver B arrived in the cab the blockman observed the A1 brake block moving away from the tread of the wheel. At this moment the wagons rolled forward a few centimetres as the brakes released along the length of the train.

113 On his return from the locomotive the blockman thought that Driver B looked hot, sweaty and exhausted. Driver B kicked the brake rigging in order to confirm that the brake block was clear from the wheel. Having done this he stated to the blockman that he was going to the other side of the train to check that the blocks were released on the other side.

114 Without warning, Driver B ducked under the buffers of wagon DB 972563 and the wagon behind (i.e. between the 14th and 15th wagon). Whilst passing under the buffer and over the conductor rail the blockman observed Driver B convulse, reach out for the coupler chain and fall.

115 The investigation has sought to identify the most likely mechanism by which Driver B's body could have contacted the conductor rail and formed a path for the traction current. This also involved a reconstruction of Driver B's actions.

Reconstruction of Driver B's actions

116 With the co-operation of EWS, a reconstruction was arranged with two loaded ZBA wagons stabled on a siding with a length of de-energised third rail. The dimensions of the conductor rail and its relationship to the running rail and sleepers were similar as those measured on site at Deal.

117 Before the reconstruction, care was taken to ensure that the configuration of the two wagons reflected as accurately as possible the layout encountered on the site of the accident.

118 A volunteer carried out the reconstruction. This person was selected because his physical characteristics were as close as possible to those of Driver B.

119 Once it was determined that the reconstructed conditions were as close as practicable to those at Deal on 29 July 2006, the blockman was asked to direct the subject in order to recreate the nature of Driver B's movements as he ducked under the buffer.

120 The reconstruction demonstrated that simultaneous contact was possible between the inside of the left leg on the conductor rail and the back of the upper left arm on the underside of the buffers. These points of contact are closely aligned with the marks observed on Driver B's body (see paragraph 154).

121 Figures 7a and 7b show the likely position of Driver B at the point he received an electric shock.

Figure 7a: Likely position of Driver B at the point he received an electric shock

Figure 7b: Likely position of Driver B at the point he received an electric shock

The electric shock

122 The simultaneous contact of the leg with the conductor rail and the arm with the buffer created the potential for electric current to be conducted into the metallic structure of the wagon, into the rail and thence to earth.

123 The following factors would have contributed to the severity of the electric shock:

- The points of contact were not covered by clothing (see paragraph 91). This is significant since certain fabrics are known to have a high resistance to electricity.
- The day was hot with little wind and Driver B had been exerting himself. As a consequence he was sweating heavily. This created a layer of saline fluid on the surface of the skin. This would have enhanced the conductivity of his skin.

124 A passage of an electric current through the torso is likely to result in electric current across the heart. This may cause the heart to stop or fibrillate and cease to pump blood.

125 The electrical protection devices in the substation did not trip as a consequence of the electric shock sustained by Driver B. This is not unexpected since the current involved was too low to be detected as an *earth fault*.

126 There was no flash or bang associated with the electric shock. This absence is consistent with literature on the topic. Flashes and bangs are normally associated with the breaking of an electric arc. This is unlikely if the current is low.

127 Early reports had suggested that the electric shock was sustained due to Driver B's foot being in contact with the conductor rail after he had fallen. However, this early hypothesis has been dismissed on the following grounds:

- There is no evidence of an electrical injury on the foot.
- The contact occurred on the sole of the boot. The plastic sole is intact and would therefore have served as an effective insulator.

EWS policy on the provision and use of insulating troughs

128 EWS do not provide *insulating troughs* on its locomotives and do not train drivers or ground staff on their use. EWS have stated that there is no room for such equipment in locomotives and that the use of insulating troughs by drivers is inappropriate since it may encourage them to work in proximity to live conductor rail.

129 EWS have explained a number of impediments to the provision of troughs. These include:

- lack of space for storage in locomotives;
- the need for regular inspection; and
- the need to provide special training to drivers.

130 Despite the above policy, a recent briefing paper (Traction Digest 139 dated August 2006) issued by the EWS Operations Standards department stated:

'If you are required to go between locomotive(s) and or vehicles you must enter over the running rail furthest from the conductor rail. If this is not practicable then an insulated troughing cover must be placed over the conductor rail first'.

131 No other train operators operating on Network Rail DC electrified lines in the southern part of England provide insulating troughs for use by train crew. The reasons given for the non-provision of insulating troughs are the same as those described by EWS.

132 At the time of the accident the provision of insulating troughs on trains and locomotives was not mandated by any Railway Group Standards.

Competence for working in areas of DC electrification

EWS arrangements

133 The EWS competence management system has four main components. These are as follows:

- initial driver training and associated assessments;
- training courses (training courses include a formal assessment) and briefings to cover new topics or areas of newly identified risk;
- a two year cycle of theoretical and practical assessments.

134 In addition, drivers are required to undergo a Personal Track Safety course every two years. This course is delivered by EWS Operations Managers.

135 It is not known the extent to which the initial training delivered to Driver B covered issues associated with DC electrification as no records are available. However, the PTS course covers the issue of safety when working in proximity to the conductor rail. This element of the PTS training covers module G2 of the Rule Book (see paragraph 52) and the short section in the PTS hand book that covers conductor rail safety.

136 Driver B was recertified as competent in PTS following a course in April 2006.

137 The list of standard questions used in relation to the two year assessment cycle includes a question about the need to treat the conductor rail as live at all times.

138 Driver B's last assessment cycle was completed on 31 March 2006 when he attended an assessment day. This included an assessment of his knowledge of rules and regulations.

139 There are no records to indicate that Driver B had ever received formal training or briefings on those parts of the DC Electrified Lines Instructions relevant to train drivers (e.g. clause 2.4, 'attending to vehicles').

Behaviour of the rolling stock

140 All of the wagons on train 6Z25 were of the ZBA type. These wagons are all fitted with a simple air brake system. This comprises a distributor feeding a single large cylinder. When air is fed into the cylinder from the distributor it drives a piston. Each brake block is connected to this piston by mechanical linkages.

141 The application of an even brake force at each wheel is dependant on the correct adjustment of the mechanical linkages. This adjustment is performed by moving pins along a series of holes in the *push rod* associated with each individual brake block (see Figure 8).

142 Typically the adjustment of the push rod will be performed when a new brake block is fitted. This is necessary if the new brake block is not to be forced too hard against the wheel tread.

Maintenance and inspection

143 Wagon DB 972563 was the focus of attention when Driver B was examining his train (see paragraph 108). This wagon had been the subject of planned preventative maintenance on the previous day at Hoo Junction. The relevant EWS standard (EWS/ES/0207) mandates that the brake blocks on ZBA wagons should be examined and adjusted where appropriate as part of the PPM process.

144 Maintenance records show that a single brake block was replaced on wagon DB 972563. This brake block was at corner A1 of the wagon. The new brake block had been stored in a damp environment for some time and had developed a thin layer of rust. This gave it a red appearance (see Figure 9).

145 All brake block connections showed evidence of lubrication carried out during the PPM. In the case of the brake blocks at corners B1, B2 and A2 there is evidence that oil applied during lubrication had contaminated surfaces of the brake blocks. This contamination is known to occur due to the liberal application of oil by use of a brush.

Figure 8: Adjustment of the push rod on ZBA type wagons

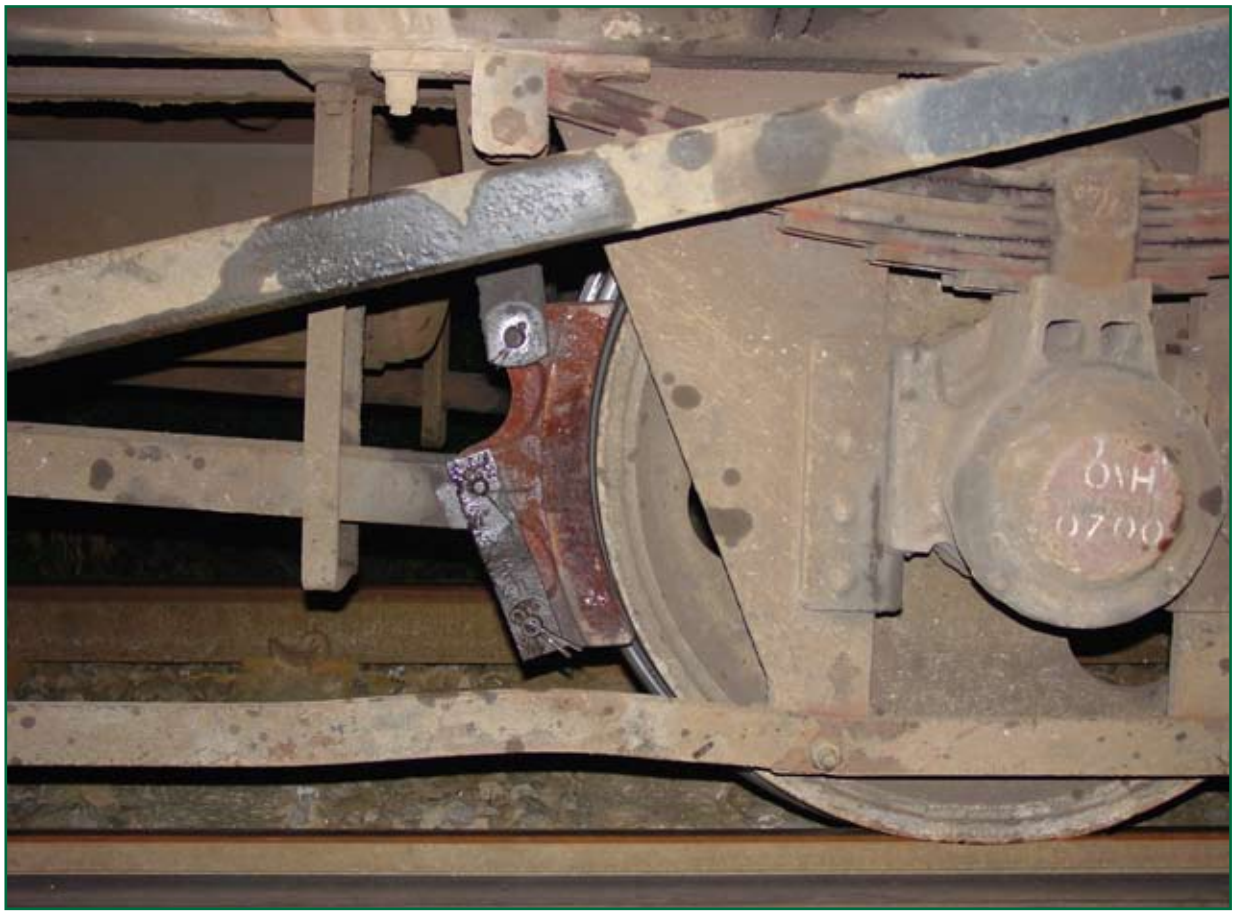

Figure 9: Brake rigging showing the brake block at corner A1

Condition of wagon DB 972563 on 29 July 2006

146 There is a range of evidence indicating that the brakes on wagon DB 972563 were operating correctly on 29 July 2006:

- No problems with the brakes were observed as train 6Z25 left Hoo Junction yard.
- Driver A encountered no problems during the journey between Hoo Junction and Dover Priory.
- All brake blocks moved away from the wheel tread when the brakes were released during brake testing following the accident.
- No problems with the brakes were observed as train 6Z25 was hauled back to Hoo Junction following the incident.
- The adjustment of the push rod associated with the brake block at corner A1 was inspected by EWS and found to be correct.
- No fault was found when the brakes were later subject to a full functional brake test in accordance with EWS standard EWS/ES/0097.

147 Given the above, it is probable that the 'white' smoke observed by the blockman was caused by oil contamination burning off the surface of one or more brake blocks. Oil is known to produce white smoke and is likely to combust at a temperature between 300 and 400 ºC. These temperatures are likely to have been generated during the long slow descent from Martin Mill.

148 The blockman recollected that the brake block at corner A1 appeared to be glowing red. Had this been the case the block would have reached a temperature in excess of 800ºC. At this temperature damage would have occurred to the brake block and the wheel tread. Furthermore, the lubrication around the split pins that secure the brake block in place would have burnt away had the block reached such a high temperature. As can be seen from Figure 9, this was not the case.

149 There is no doubt that the brake block at corner A1 had become very hot during the journey towards Deal. However, the exact temperature reached cannot be determined with any accuracy. It is possible that the red appearance of this brake block was influenced by the layer of rust on its surface (see Figure 9 and paragraph 144).

Dimensions of the conductor rail and its relationship to the running rail

150 The dimensions specified in the relevant Network Rail standard (NR/SP/TRK/0049) for the conductor rail and its relationship to the running rail and sleepers are shown in Figure 10. The following key dimensions are of particular note:

- the distance between the centre line of the conductor rail and the inside edge of the running rail is specified as 405 mm (with a tolerance of ± 10 mm);
- the difference between the height of the conductor rail and the adjacent running rail is specified as 76 mm (with a tolerance of +10 mm and -3 mm).

151 Following the accident the conductor rail in proximity to Driver B's final position was measured. The position of the conductor rail relative to the running rail and sleepers conformed to the standard.

152 The overall stepping distance over the conductor rail and the adjacent running rail was no greater than might be expected at any other location with DC electrification. The ballast under and around this section of conductor rail was compact and even.

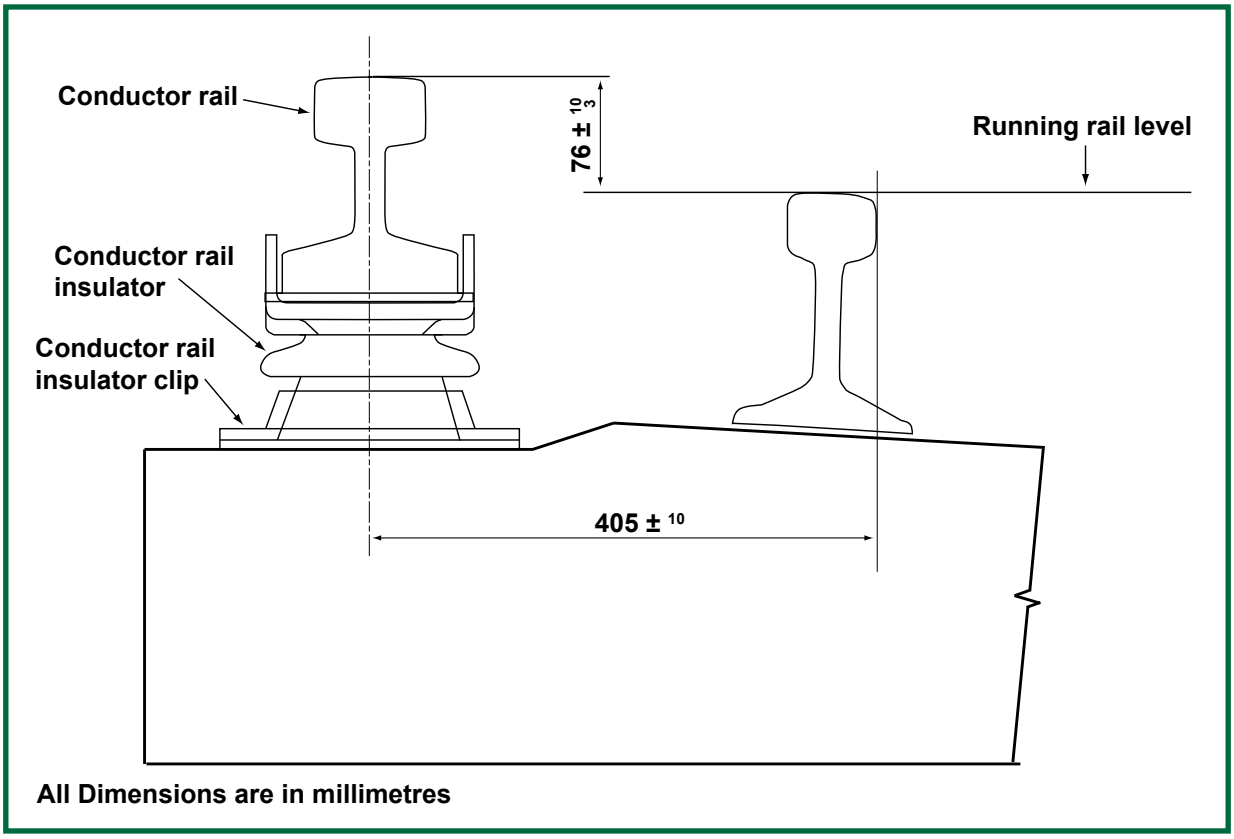

Figure 10: Dimensions of the conductor rail and its relationship to the running rail

Medical evidence

Pathology

Injuries sustained

153 Driver B sustained injuries that were consistent with electrical burns on his left arm and on the inner part of his lower left leg.

154 The above injuries aligned closely with the points of contact identified during the reconstruction of the actions of Driver B (see paragraph 120). The shape and alignment of the injuries match the shape of the component with which Driver B is likely to have come into contact. In particular it has been found that the direction and radius of the curved mark on Driver B's upper arm matches that of the wagon buffer.

Cause of death

155 The post-mortem examination identified no obvious natural cause of death.

Toxicology

156 The toxicology report indicates the presence of alcohol in the blood at a level of 74 mg per 100 ml of blood. This level is slightly below the prescribed limit for persons in charge of a motor vehicle (80 mg per 100 ml) but 2.5 times the limit of 30 mg per 100 ml of blood set by Railway Group Standard GE/RT8070.

157 This level of alcohol in the blood may be sufficient to affect performance[3]. Literature on the effects of alcohol at around 80 mg per 100 ml of blood points to a range of consequences. These can include:

- impaired motor coordination;
- impaired reasoning;
- reduced perception;
- decreased concentration;
- risk taking; and
- impaired ability to judge distances.

158 There is no direct evidence that the behaviour of Driver B was influenced by the presence of alcohol in his blood. No witness has indicated that they were aware that Driver B was under the influence of alcohol or that his behaviour gave them any reason for concern. The recorded conversation between Driver B and signaller that occurred some 11 minutes before the accident shows no obvious signs that Driver B was under the influence of alcohol. In this recording Driver B is lucid and cogent and is able to relay a telephone message and use the phonetic alphabet without difficulty.

[3] References include:

- Denney, RC (1986) Alcohol and accidents
- BMA Guide to Alcohol and Accidents
- Drink Drugs and Driving, 2nd Edn. 1985; Brownlie and Walls

Actions taken in response to the collapse of Driver B

Blockman

159 Immediately after the accident the blockman contacted the PICOP using his mobile phone. He asked if the power was off. The PICOP seemed uncertain but stated that he would check with the ECR.

160 The blockman checked Driver B's pulse and attempted heart massage despite the fact that the sole of Driver B's boot was touching, or very close to the conductor rail.

161 The blockman was then informed by the PICOP that the conductor rail had been live (contrary to the blockman's previous understanding) but was now isolated.

PICOP

162 When the PICOP was informed of the accident he was initially uncertain as to the status of the conductor rail at this location. Nevertheless, he was quick to recognise the need to inform the ECR.

163 The PICOP did not identify his call to the ECR as an emergency call as required by Module G.1 of the Rule Book. However, he relayed the information about the situation and its location quickly and effectively such that the ECO was able to carry out an emergency isolation (see paragraph 168).

164 The PICOP then informed the signaller and asked him to call the emergency services.

Signaller

165 The signaller called the emergency services at about 15:00 hrs. At the time he was unaware of the exact location of the incident and the best means of access. For this reason the police and ambulance initially logged the incident as being at the signal box in Albert Road, Deal.

166 On arrival at the signal box the emergency services were directed by the signaller to a suitable access point.

Electrical Control Room

167 On receiving the emergency call from the PICOP, the ECO was able to quickly and accurately identify the electrical section involved in the incident and operate the circuit breakers needed to carry out an emergency isolation.

Time taken to de-energise the conductor rail

168 In total the time elapsed from the collapse of Driver B to the de-energisation of the conductor rail is estimated to be around three minutes. However, the time taken to carry out this emergency isolation will not have affected Driver B's chance of survival since his exposure to the electrical current is almost certain to have ceased as he fell to the ground.

Response of the ambulance service

169 The total time taken for the ambulance crew to reach Driver B was around 15 minutes. This included time taken to first seek instruction, and assurance that the conductor rail was de-energised, from the signaller at the signal box in Albert Road.

Analysis

Immediate cause

170 The immediate cause of the accident was Driver B's leg coming into contact with a live conductor rail at the same time as his arm was in contact with the buffer thus causing an electric shock (see paragraphs 107 to 127 and 154).

Actions of Driver B

171 The accident occurred as a direct consequence of Driver B trying to duck under the buffers of the 14th and 15th wagon in order to reach the other side of the train. He did this with the intention of checking that the brake blocks on the other side of the train had released. By passing between the wagons he avoided the need to walk 200 metres around the front of his train (see paragraphs 107 to 114).

172 The investigation has sought to identify the reasons why Driver B elected to take this action. The following factors were considered:

a. Driver B appeared hot and tired on his return from the locomotive having released the brakes (see paragraph 113). This condition may have caused him to elect to pass between the wagons rather than walk another 200 metres.

b. There were no specific rules or instructions that prohibit drivers from passing between the vehicles of their own train (see paragraph 80). In fact, Driver B had recently been involved in discussions with managers about a method of operation that required drivers to enter between vehicles, as a matter of routine, when coupling and uncoupling (see paragraph 84).

c. There were no specific rules prohibiting railway staff from stepping over a conductor rail whilst passing between coupled vehicles (see paragraph 80).

d. There is no evidence that Driver B had received no formal training on the procedures to be adopted when attending a train in an area of DC electrification (see paragraph 139).

e. Driver B may have been mistaken or confused about the extent of conductor rail isolations in possessions. If this were the case it is possible that his perception of the risk he was taking was defective thus causing him to place himself in a dangerous situation (see paragraphs 71 and 74).

173 Although it is likely that items (a) to (d) influenced the actions taken by Driver B it is impossible to know with any degree of certainty the contribution of each. For this reason all are classified as possible causal or contributory factors.

174 Item (e) concerns the possibility that Driver B took these actions because he was mistaken or confused about the extent of the conductor rail isolation. This possibility is supported by the fact that a significant number of EWS drivers were unclear about the isolation arrangements in possessions (as was the blockman at Deal). It is also the case that a misunderstanding by Driver B would help explain why he elected to expose himself to the risk of coming into contact with the conductor rail.

175 On the other hand, Driver B had 20 years experience, a detailed knowledge of railway rules and a particular interest in train operations associated with engineering works. During his years as a freight train driver he had driven out of numerous worksites and would have had ample opportunity to observe the method of working.

176 Had Driver B been mistaken about the status of the conductor rail it is likely that he would have still have endeavoured not to come into contact with it. Such behaviour would been in line with the widely held view held by EWS drivers that the conductor rail should always be treated as live, even when located within a worksite or possession (see paragraph 74).

177 All operating documents that were applicable in July 2006[4] were clear about the need to treat the conductor rail as live at all times although none were explicit about the possibility of the conductor rail remaining energised inside possessions.

178 Given the above information it is not possible to know the extent to which Driver B's decision to duck under the buffers was influenced by a misunderstanding or confusion about the status of the conductor rail. For this reason the significance of this factor has not been determined.

179 Evidence derived from the reconstruction of Driver B's actions has confirmed that his movements as he ducked under the buffer placed his leg into close proximity to the conductor rail. A slight misjudgement, loss of balance or slip during this movement would have been sufficient to cause his leg to have dropped into contact with the conductor rail (see paragraph 116 to 121).

180 It is not possible to know with any certainty the extent to which the presence of alcohol in Driver B's blood influenced his decisions or the execution of his actions. However, at the level of alcohol measured in the blood some significant degradation of performance is possible. This factor is therefore assessed to be a possible causal factor (see paragraphs 156 to 158).

181 It is recognised that low to moderate levels of intoxication can be very difficult to detect by conventional means (e.g actions of the individual and smell). Nevertheless, EWS and the railway industry in general have established a positive strategy to manage the issues associated with alcohol (Ref. RGS GE/RT8070 and Rule Book Module G1) and to promote the understanding and cooperation of staff.

182 The existing regime for detecting intoxication includes the following methods:

- monitoring of staff behaviour by line managers and supervisors;
- random and unannounced testing; and
- testing following accidents and incidents or if suspicion is raised.

183 It is not considered that this accident alone provides sufficient justification of an extension of the above arrangements. For this reason there are no recommendations related to the drugs and alcohol issue although it is stressed that railway companies should review their own performance, and the adequacy of management systems, on a regular basis.

184 Other factors affecting Driver B's behaviour could include general impairment arising from his apparent physical exhaustion. Driver B's weight and the hot weather are likely to have exacerbated any physical discomfort (see paragraphs 86 and 113).

185 EWS were aware that Driver B's Body Mass Index (BMI) was a matter for concern and had put a management plan into place to deal with the problem. For this reason there are no recommendations related to this issue (see paragraph 86).

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[4] - Rule Book modules G2 and DC;
- DC Electrified Lines Instructions; and
- PTS handbook.

186 Driver B would have been protected to some extent if he had been wearing long trousers. However, the benefit of this limited protection would have been lessened had the lower part of the trouser leg become damp with perspiration (see paragraph 123).

187 The safety benefit of requiring all railway staff in areas of DC electrification to wear long trousers is dependant on the electrical properties of the fabric used. There is therefore a need for additional research on this topic. Any benefit derived from the wearing of long trousers is likely to minimal at locations where the conductor rail is fitted with *guard boarding* since the likelihood of the side of the leg brushing against the conductor rail is greatly reduced.

Insulating troughs (see paragraphs 128 to 132)

188 EWS do not provide insulating troughs on its locomotives that operate in areas of DC electrification. Despite this EWS issued a 'Traction Digest' briefing that required the use of insulating troughs when going between locomotives and/or vehicles if it is not practicable to enter over the running rail furthest from the conductor rail (see paragraph 130). This briefing therefore recommended the use of an item of equipment that is not provided and which drivers are not trained to use. This is of concern since the briefing does not lay down the procedure to be adopted if an insulating trough is not available.

189 Given the above, there is a need for the EWS policy and briefing on the provision and use of insulating troughs, and the general procedures for attending trains in areas of DC electrification, to be clarified and disseminated.

Extent of isolation (see paragraphs 65 to 67)

190 The conductor rail at the site of the accident had not been isolated in connection with the engineering works. This was consistent with normal isolation planning arrangements applied by Network Rail in areas of DC electrification.

191 The DC Electrified Lines Instructions (current at the time of the accident) specify that the extent of an isolation should be sufficient to protect the worksite. There is no requirement that this be extended to include other areas within the limits of the possession.

192 The RAIB, in conjunction with the HMRI, has reviewed the advantages and disadvantages of the existing approach to planned isolations within possessions and compared these with an alternative approach based on the de-energisation of all conductor rails between the worksite and the possession limits.

193 This review, summarised at Appendix C, concluded that the alternative approaches generated the potential for additional risk. For this reason it is not considered that the isolation strategy adopted by Network Rail is a causal or contributory factor.

194 However, it is observed that modern technology creates the potential for simplification of the existing switching and isolation arrangements. The introduction of additional remote switching and remotely operated short circuit devices would reduce the need for strapmen and manual switch operators thereby facilitating longer isolations. Such solutions should be considered for adoption as part of future power upgrades and new areas of DC electrification.

Condition of the train

195 Driver B examined his train following a report of smoke emerging from one of the wagons. This smoke was likely to have been generated by the burning of excessive oil contamination on the surface of the brake blocks on wagon DB 972563. It is probable that this contamination occurred when the brake rigging was being lubricated during maintenance on the previous day (see paragraph 145).

196 The combustion of oil contamination occurred when the brake blocks became hot as the train descended the down gradient between Martin Mill and Deal (see paragraph 147).

197 There was no evidence of either a brake defect or a handbrake being inadvertently left on (see paragraph 146).

198 Freight train drivers will generally be familiar with the examination of their trains and should be able to do this without exposure to undue risk. Thus the accident was not caused by the heating of the brake blocks and the subsequent production of smoke. Nevertheless, these are precursor events that contributed to the final outcome.

199 Given the above, the contamination of the brake blocks by oil during the lubrication of the brake rigging can be classed as a contributory factor.

Other safety issues

200 In the course of the investigation a number of issues have been identified that are not causal or contributory to the accident but nevertheless give rise to safety concerns. These are described in the following paragraphs.

Staff briefings (see paragraphs 69 and 98)

201 It is of concern that Driver B did not receive a safety briefing on arrival at the worksite. This omission arose due to the fact that the driver chose to go straight to his train that was standing three miles from the main access point where the safety briefings were being conducted.

202 The physical separation of engineering trains from areas of main work activity is a common feature of possessions. For this reason it is often the case that drivers will not access worksites by the designated main access points and may therefore bypass any safety briefing process. In these circumstances it is the responsibility of the ES (within the worksite) or the PICOP (outside the worksite) to ensure that the driver is properly briefed.

Procedures for attending a train (see paragraphs 75 to 80)

203 Although not directly causal to the accident it is noted that Driver B elected to examine his train from the side nearest the conductor rail. It is probable that this decision was driven by the following factors:

- the smoke was observed emerging on this side of the train; and
- it was easier to walk along the up line or six-foot than in the cess (the cess formed a rough walking surface).

204 The DC Electrified Lines Instructions did not provide clarity on the steps to be taken when examining a train in an area of DC electrification. Clause 2.4 instructs railway staff to 'attend' a train on the side furthest from the conductor rail whenever practicable. However, the definition of 'persons attending a train' is limited to:

'persons operating handbrakes, coupling or uncoupling vehicles, etc.'

205 Driver B was not carrying out these actions and therefore may not have been covered by clause 2.4.

206 The definition of 'attending a train' contained in the DC Electrified Lines Instructions (and the subsequent module DC of the Rule Book) should be expanded to include any activity requiring the driver to make physical contact with the train (e.g. releasing brakes or operating changeover levers).

207 The current module DC of the Rule Book (in force from 6 December 2006) has introduced the requirement to use an insulating trough when working on the side nearest the conductor rail during coupling and uncoupling. Since no train operators provide this equipment on their trains it is not clear how this rule can be applied by drivers, shunters and guards when coupling or uncoupling trains at locations where it is not possible to work on the side furthest from the conductor rail (e.g. adjacent to a station platform or a running line).

Staff awareness of conductor rail status (see paragraphs 71 to 74)

208 There is a lack of consistent understanding amongst track workers and train operating staff that the conductor rail inside possessions is often energised. This lack of understanding is likely to arise for the following reasons:

- potentially misleading wording in the WON; and
- the lack of explicit statements in the Rule Book and other operating documents to explain that conductor rail inside possessions is often left energised.

209 The safety impact of the above lack of understanding has been mitigated by the near universal attitude of treating the conductor rail as live at all times (in line with rules and guidance).

Emergency response

210 The time to reach the scene (15 minutes) only slightly exceeds the current target of 14 minutes for 90 per cent of ambulance calls in urban areas. This response time was reasonable given the need for the ambulance service to gain access to the railway and confirm that the conductor rail was de-energised (see paragraph 169).

211 The decision of the signaller to report the accident location as being the signal box in Albert Road was sound since it gave him time to identify the best access arrangements and to confirm that the conductor rail had been de-energised. On the arrival of the emergency services at the signal box he was able to advise them of the access location and to confirm that the conductor rail was de-energised (see paragraph 165).

Conclusions

Immediate cause

212 The immediate cause of the accident was Driver B's leg coming into contact with a live conductor rail at the same time as his arm was in contact with the buffer thus causing an electric shock (see paragraph 170).

Identification of causal factors

213 The following factors are considered to be causal:

- the decision of Driver B to pass between two wagons to avoid the walk around the train thus causing his leg and arm to come into close proximity to a live conductor rail (see paragraphs 171 and 178 and Recommendation 1); and
- a subsequent misjudgement, loss of balance, or slip causing Driver B's leg to drop into contact with the conductor rail (see paragraph 178 and Recommendation 4).

214 It is possible that the following factors were also causal:

- the absence of specific rules prohibiting railway staff from stepping over a conductor rail whilst passing between coupled vehicles (see paragraph 172 and Recommendation 1); and
- the absence of specific training on the procedures to be adopted when attending a train in an area of DC electrification (see paragraph 172 and Recommendation 2).

Identification of contributory factors

215 The following factor is considered to be contributory:

- combustion of oil contamination on hot brake blocks during the descent of the steep gradient between Martin Mill and Deal (see paragraph 195 and Recommendation 3).

Factors that may have influenced the behaviour of Driver B

216 As discussed in paragraphs 172 to 184 the reason that Driver B elected to duck under the buffers with the intention of passing between the vehicles, rather than walking round his train, has not been identified. However, the investigation has identified a number of factors that may be relevant. These are as follows:

- Driver B's judgement may have been impaired due to physical tiredness (see paragraph 184) or due to the influence of alcohol (see paragraph 180);
- there is a lack of explicit statements in the Rule Book and other operating documents to explain that conductor rail inside possessions is often left energised (see paragraph 208 and Recommendation 5);

- at no point did Driver B receive a briefing to expect the conductor rail to be live at all locations within the possession (see paragraph 69, 201, 202 and Recommendation 7); and
- the wording in the WON as it relates to DC isolations is potentially misleading (see paragraph 208 and Recommendation 6).

217 Given the above factors, it is possible that Driver B did not fully appreciate that the conductor rail inside possession was energised (see paragraph 208 and Recommendations 5, 6 and 7).

Other factors for consideration

218 The following factors related to safety have been identified during the investigation:

- There is a need for improved clarity in the rules related to attending a train, and the use of insulating troughs, in areas of DC electrification (see paragraphs 203 to 207 and Recommendation 8).
- Driver B did not attend the safety briefing on arrival at his train (see paragraphs 201 to 202).
- Modern technology creates the potential for new installations and upgrades to include facilities such as additional remote switching and remotely operated short circuit devices. In time such provisions could simplify the process of taking isolations thereby enabling their extension to include more of the engineering possessions (see paragraph 194 and Recommendation 9).

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

219 EWS have issued a Traction Digest briefing to all its drivers and ground staff team members to remind them of the risks associated with the conductor rail and the requirements of the relevant rules. The briefing is explicit about the possibility that conductor rail inside possession will be live.

Recommendations

220 The following safety recommendations are made[5]:

Recommendations to address causal and contributory factors

1 RSSB, in consultation with affected parties, should review the Rule Book module DC with a view to incorporating a specific provision prohibiting railway staff from stepping over a live conductor rail whilst passing between coupled vehicles (see paragraphs 213 and 214).

2 Freight Operators in areas of DC electrification should provide specific training to all drivers and ground staff with the objective of ensuring that they are fully aware of safe working practices when attending trains on lines with conductor rails. This training should also reinforce the message that the conductor rail should always be treated as live within possessions (see paragraph 214).

3 EWS should take steps to control oil contamination of brake blocks during lubrication of the brake rigging so far as is reasonably practicable (see paragraph 215).

4 RSSB should develop a Railway Group Standard provision to prohibit the wearing of shorts by persons who may require to step over or walk close to live conductor rail that is not fitted with guard boarding as part of their duties. The specification for any long trousers that may be mandated should allow for comfort in hot weather and enhanced electrical resistance (see paragraphs 187 and 213).

Recommendations to address staff behaviour in proximity to the conductor rail within possessions

5 RSSB, in consultation with affected parties, should review the Rule Book modules DC and G2 with a view to incorporating an explicit statement that staff should always consider the conductor rail inside possessions to be live unless they have been briefed by a person holding a valid conductor rail permit. This should be incorporated into the PTS hand book and the requirements for PTS training courses (see paragraph 216).

6 Network Rail should review the reference to isolation limits in the WONs with a view to modifying its wording such that railway staff are not misled or confused as to its meaning (see paragraph 216).

7 Network Rail and Freight Operators, should jointly establish a regime for ensuring that all train crew working to and from engineering possessions are given a suitable safety briefing. In areas of DC electrification this should always include a reminder that the conductor rail inside the possession should be treated as live at all times (see paragraph 216).

continued

[5] 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

Recommendations to address other matters observed during the investigation

8 RSSB, in consultation with affected parties, should review the Rule Book module DC with a view to clarifying the instructions to staff when attending a train in the absence of an insulating trough (see paragraph 218).

9 Network Rail, in consultation with affected parties, should carry out a review of standards and specifications related to new and upgraded DC electrification systems with the objective of simplifying the arrangements for the taking of isolations, minimising the requirement for trackside staff, and permitting the extension of isolations to include a greater proportion of the associated engineering possessions (e.g. additional remote switching and remotely operated short circuit devices) (see paragraph 218).

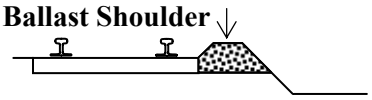
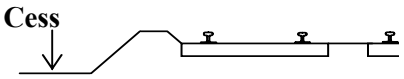
Appendices

Glossary of abbreviations and acronyms — Appendix A

AC	Alternating Current
BBRIS	Balfour Beatty Rail Infrastructure Services
COSS	Controller of Site Safety
CRP	Conductor Rail Permit
DC	Direct Current
ECO	Electrical Control Operator
ECR	Electrical Control Room
ES	Engineering Supervisor
EWS	English Welsh and Scottish Railway
GSTM	Ground staff team member
HSE	Health & Safety Executive
OTDR	On Train Data Recorder
PICOP	Person in Charge of Possession
PTS	Personal Track Safety
WON	Weekly Operating Notice

Glossary of terms — Appendix B

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

Ballast shoulder	The ballast placed at the ends of the sleepers, timbers or bearers to give lateral stability to the track.* 
Blockman	The term used to describe a person located at the limits of the possession to lift detonators and the possession limit boards when so requested by the PICOP.
Brake rigging	Mechanical linkages connecting the brake blocks to the cylinder
Cess	The part of the track bed outside the ballast shoulder that is deliberately maintained lower than the sleeper bottom to aid drainage.* 
Chain	A unit of length, being 66 feet or 22 yards (approximately 20117mm). There are 80 chains in one standard mile.*
Conductor rail ('third rail')	An additional rail, generally of a unique section (such as 150 pounds per yard), used to convey and enable collection of electrical traction current at track level. *
Conductor Rail Permit (CRP)	A form of authority signed and issued by an Authorised Person to a person in charge of a group working on, or near to, conductor rail equipment. The purpose of the form is to make known to the person in charge exactly which equipment has been made electrically safe to allow work to commence.
Continuity brake test	A test to confirm that the train brakes are functional and connected throughout the length of the train.
Continuous airbrake	Airbrake system that extends throughout the length of the train.
Controller of Site	A person holding a safety critical qualification demonstrating the holder's competency Safety (COSS) to arrange a safe system of work.*
DC electrification system/ DC electrified line	A line fitted with conductor rails supplying traction current of the Direct Current (DC) form.*
Driver only run-round operations	Operation involving uncoupling the engine from one end of a train and coupling it to the other without the involvement of any staff other than the driver. The driver will carry out coupling and uncoupling activities.
Down line (between Buckland Junction and Deal)	The line that normally conveys trains in the direction of Deal

Earth fault	A fault condition in which electricity is conducted to earth
Electrical Control Operator	The person having control over supply to, switching of and isolation of an electrification system in a geographical area.*
Fatigue Index (FI)	The Fatigue Index (FI) was developed by the Centre for Human Sciences at the Defence Evaluation and Research Agency (now known as QinetiQ) in a research project commissioned by the HSE. This was to provide a means to assess the short-term, daily fatigue and cumulative fatigue risks associated with shift work.
Form B2	The form used to record the switching arrangements associated with an isolation in an area of DC electrification.
Guard boarding	Protective boards placed on one or both sides of a conductor rail at certain locations (e.g. depots and yards) to prevent accidental contact with the conductor rail.*
Hook switch	A manually operated switch on the track side that is operated using a hook on a wooden pole
Insulating trough	Insulated cover used to shield the conductor rail.
On-Train Data Recorder (OTDR)	Equipment for monitoring and recording data generated by rolling stock systems (e.g. speed, activation of brakes etc.)
Overcharge (of train braking system)	Applying additional pressure through the air braking system to facilitate the release of all brakes.
Personal Track Safety	Training and certification scheme to verify that a person is competent to work on or near the railway.
Person in Charge of Possession (PICOP)	The competent person nominated to manage the following: • Safe and correct establishment of the protection for the possession, complete with banners, detonators, point clips, Possession Limit Boards (PLB) and signals keyed to danger as required; • Managing access to the possession area by Engineering Supervisors (ES); • Managing the establishment of engineering worksites within the Possession; • Liaising with the signaller regarding the passage of the train into and out of the possession; • Controlling the movement of the train between the protection and worksites.*
Possession (engineering possession)	A period of time during which one or more tracks are blocked to trains to permit work to be safely carried out on or near the line.*
Possession limit board	A miniature version of the stop sign used on the roads, denoting the end of a possession.*

Push rod	A rod that pushes the brake blocks against the wheel tread.
Railway Group Standard (RGS)	A document mandating the technical or operating standards required of a particular system, process or procedure to ensure that it interfaces correctly with other systems, process and procedures. Network Rail (NR) produces Network Rail Company Standards (NRCS) that detail how the requirements of the Railway Group Standards are to be achieved on its system.*
Rudd	A 21 ton capacity wagon used for the transport of materials.*
Short circuiting strap	A piece of equipment used specifically for connecting the conductor rail and traction return rail together to prevent the conductor rail becoming energised within a worksite.
Six-foot	A term for the space between two adjacent tracks.*
Straight air brake	A brake system which acts only on the locomotive wheels and not on the rest of the train at all.
Strapman (men)	Term used to describe the staff responsible for applying the short circuiting strap.
Testers (of conductor rail)	Staff responsible for testing if the conductor rail is live using an authorised testing device.
Testing device (conductor rail)	A device used to test if the conductor rail is live.
Third rail electrification	A general term used to cover the type of electrification that involves the supply of DC current to trains by means of a conductor rail laid along one side of the track (the 'third rail').
Traction return rail	The rail of a track used as the return side of the traction current circuit on an electrified railway.*
Up line (between Deal and Buckland Junction)	The line that normally conveys trains in the direction of Buckland Junction.
Weekly Operating Notice	A document providing information about engineering work, speed restrictions, alterations to the network and other relevant information to train drivers and other operating and engineering staff.*
Worksite	The area within a possession that is managed by an Engineering Supervisor (ES).*
Worksite limits	The limits of the area controlled by an Engineering Supervisor. A worksite is delimited by marker boards when engineering trains are present.*
Worksite marker board	A board marking the limits of the worksite.

#	OPTION	SAFETY ADVANTAGES	SAFETY DISADVANTAGES
1	Limit the length of the possession to that required to protect the work activity (current rules)	• Isolation limits are distinct from possession limits thereby emphasising the need for staff to check that they are working under the authority of a valid CRP • Limits the number of staff needed on site to perform local protection functions[1, 2] • Minimises the extent and complexity of ECR switching schedules	• The conductor rail remains live outside of the area of work activity

2	Extend the length of the isolation to encompass the entire possession (with extension of local protection arrangements)	• The number of staff working in proximity to live conductor rail is reduced	• Overall levels of risk are likely to be increased due to the requirement for additional staff to carry out the local protection functions:
			  ○ operating manual/local switches in sub-stations and TP huts[1]
			  ○ application of additional short circuiting straps[2]
			  ○ operation of additional manual track-side switches (e.g. hook switches)
			• There is potential for confusion about the status of conductor rail within the possession
			• There may be a temptation for staff to carry out activities in proximity to the conductor rail within possessions without the authority of a CRP (i.e. they will come to expect that power is off)
			• Some electrical sections inside the possession may require to remain energised for traffic purposes. However, staff are likely to have an expectation that the conductor rail is isolated throughout the possession
			• The ECR switching schedules will become more extensive and complex. This complexity may give rise to human error

3	Open remote circuit breakers to de-energise sections of conductor rail outside the worksite where practicable (with local protection arrangements limited to those electrical sections within the worksite covered by the CRP)	• The number of staff working in proximity to live conductor rail is reduced without the need for additional staff to carry out local protection • There is no requirement for additional staff on site to perform local protection functions [1, 2]	• There is potential for confusion about the status of conductor rail within the possession • There may be a temptation for staff to carry out activities in proximity to the conductor rail within possessions without the authority of a CRP (i.e. they will come to expect that power is off) • Some electrical sections inside the possession may require to remain energised for traffic purposes. However, staff are likely to have an expectation that the power is off throughout the possession • The ECR switching schedules will become more extensive and complex. This complexity may give rise to human error

[1] The Health and Safety Laboratory carried out an analysis that showed that the individual risk to a 'nominated persons' visiting a sub-station or TP hut to operate and secure circuit breakers may exceed tolerable levels (Ref HSL report RAS/04/06). Any extension of isolations to mitigate the risk to maintenance workers is therefore likely to expose more 'nominated persons' to high levels of risk.

[2] The Health and Safety Laboratory carried out an analysis that showed that the application of short circuiting straps is a high risk activity that may generate levels of individual risk that are intolerable (Ref HSL report RAS/04/06). Any extension of isolations to mitigate the risk to maintenance workers is therefore likely to expose more 'strapmen' to high levels of risk.

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