RAIB

Rail Accident Investigation Branch

Rail Accident Report

Near-miss at Hanger Lane junction 27 March 2009

Department for Transport

Report 05/2010
March 2010

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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This report is published by the Rail Accident Investigation Branch, Department for Transport.

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Contents

Preface

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

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

Key Definitions

3 Trains on the Piccadilly and District lines of London Underground travelling through Hanger Lane Junction towards central London are referred to as travelling eastbound, or in the eastbound direction. Trains travelling towards Uxbridge or Ealing Broadway are referred to as travelling westbound, or in the westbound direction.

4 London Underground Limited (LUL) uses the job titles of 'service operator' and 'service controller' in everyday use, but they are defined in LUL's rule book as follows:

- signaller for service operator.
- *controller* for service controller.

This report uses the terms signaller and controller.

5 Appendices at the rear of this report contain the following:

- abbreviations, in appendix A; and
- technical terms (shown in *italics* the first time they appear in the report), in appendix B.

Summary of the Report

Key facts about the incident

6 At about 17:22 hrs on Friday 27 March 2009, eastbound District Line train 103 passed signal WM1 at danger at low speed. The train stopped with its leading end approximately five metres past the signal, and the train operator (driver of the train) reported the incident to the signaller by telephone. Signal WM1 is located between Ealing Broadway and Ealing Common in west London, and controls the approach to Hanger Lane junction where the Piccadilly and District lines converge.

7 At 17:26 hrs, the signaller gave the train operator authority to proceed across the junction. Shortly afterwards, and before train 103 had started to move, a westbound Piccadilly Line train crossed the junction in front of it creating the potential for a collision. The signaller had initially overlooked the presence of this train, and had then been unable to contact the train operator of train 103 once he became aware of the situation.

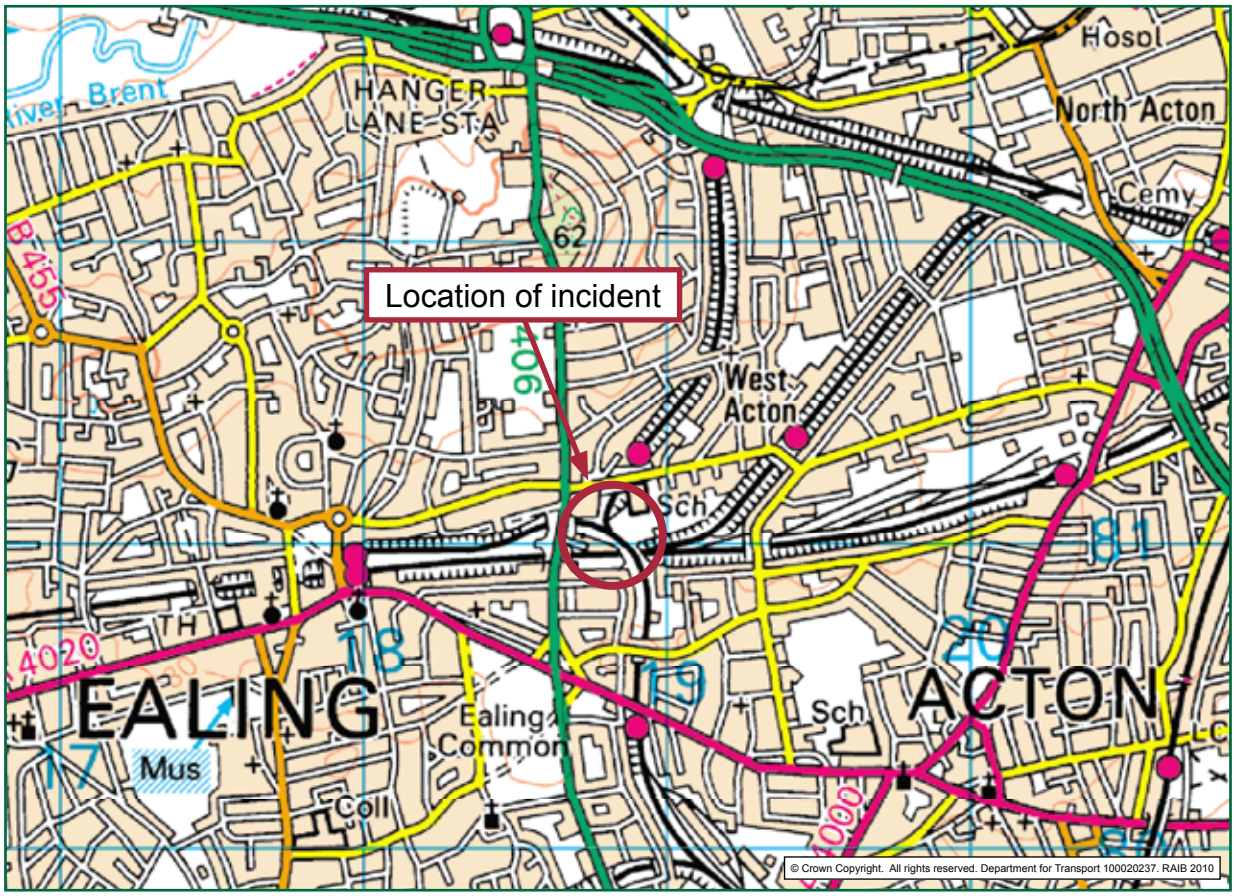


Figure 1: Extract from Ordnance Survey map showing location of incident

Immediate cause, causal and contributory factors, underlying causes

8 The immediate cause of the incident was the signaller giving train 103 the authority to proceed towards Hanger Lane junction before it was safe to do so.

9 Causal factors were:

a. the operator of train 103 passed signal WM1 at danger; and

b. the signaller did not bring all trains to a halt to protect the junction before giving train 103 authority to proceed.

10 The signaller was taking prescribed medication and it is possible that it affected his concentration and judgement. If this caused him to overlook the presence of train 316, the medication was also a causal factor.

11 Contributory factors were:

a. the signaller was under time pressure when dealing with the incident as it affected both the District and Piccadilly Line services and had the potential to cause extensive delays;

b. the signaller's workload, as he was operating two control desks during the incident; and

c. the communication arrangements in place between Earls Court and Baker Street control rooms at the time of the incident, which did not give the signaller's call adequate priority and prolonged the period during which trains 103 and 316 were at risk of collision.

12 Underlying factors were:

a. The design of points and *track circuits* at Hanger Lane junction;

b. LUL's rules and procedures for incidents involving trains which pass a *semi-automatic signal* at danger, which were fragmented and did not provide guidance on how a signaller was to meet the requirement to ensure that it was safe for a train to proceed; and

c. LUL's arrangements for maintaining the signaller's skills in managing degraded working, which were insufficient.

Severity of consequences

13 Although there were no immediate consequences of the incident, there was the potential for a collision to occur.

Recommendations

14 Recommendations can be found in paragraph 142. They relate to the following areas:

- guidance provided to assist signallers in dealing with incidents;
- use of simulation techniques during training;
- training of safety critical communication skills;
- issuing of medical advice to managers; and
- preparation of post-incident reports.

The Incident

Summary of the incident

15 At approximately 17:22 hrs on 27 March 2009, eastbound District Line train number 103 passed signal WM1 at danger within two minutes of starting its journey from Ealing Broadway to Upminster. The train was travelling at low speed and was stopped by the *train protection system* approximately five metres beyond the signal.

16 The train operator reported the incident by telephone to the signaller controlling the Hanger Lane junction area from a control room at Earls Court. The train operator subsequently received verbal authority to proceed across the junction from the signaller.

17 Before the train operator had moved his train, he observed a westbound Piccadilly Line service (train 316) passing over Hanger Lane junction ahead of him on a conflicting path. Although the trains were separated by a distance of at least 115 metres, there was the potential for a collision to occur as one train was proceeding on clear signals and the other had authority from the signaller to proceed.

The parties involved

18 LUL is the owner and maintainer of the infrastructure, and the employer of all the staff involved.

19 LUL freely co-operated with the investigation.

Location

20 Hanger Lane junction is located between Ealing Broadway, North Ealing and Ealing Common stations where the District and Piccadilly lines converge. Having converged, both eastbound lines share the same track (figure 2). The junction is above ground.

21 All *powered points* and signals at Hanger Lane junction are controlled from the Piccadilly Line control room at Earls Court.

External circumstances

22 The incident occurred during bright sunshine when the sun was low in the western sky.

Trains

23 District Line train 103 was formed of D78 tube stock introduced from 1980, and Piccadilly Line train 316 was formed of 1973 tube stock introduced from 1975. Neither train was equipped with forward facing CCTV equipment or an on-train data recorder (OTDR).

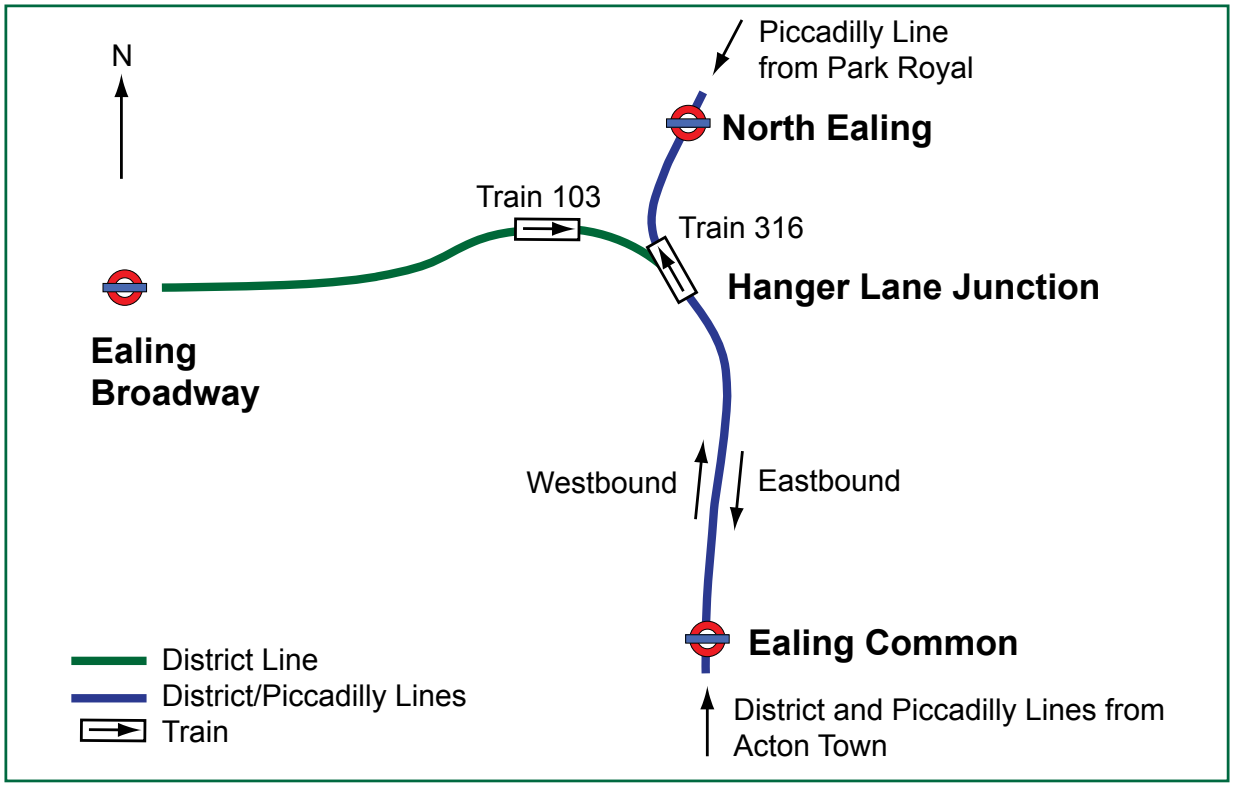


Figure 2: Simplified map of Hanger Lane junction showing position of trains during incident

24 Trains operating on the District and Piccadilly lines are fitted with *tripcock* equipment which works in conjunction with the signalling system. A *trainstop* is a device comprising a short arm which is raised when the signal is showing red (figure 3). If a train passes a signal at danger, the trainstop makes contact with the tripcock arm on the train which automatically applies the train's emergency brake. The tripcock equipment can be reset by the train operator following activation after the signaller has given authority to do so. After the tripcock has been reset, a timer limits the train to a maximum speed of 8 mph (13 km/h) for three minutes.

Figure 3: Trainstop in the raised (stop) position (photograph courtesy of LUL library)

Signalling equipment

25 The converging eastbound routes approaching the junction are protected by signals WM1 on the approach from Ealing Broadway, and WM2 at North Ealing station. These signals are referred to as 'semi-automatic' signals, because they can operate in *automatic mode* or can be controlled by the signaller if necessary.

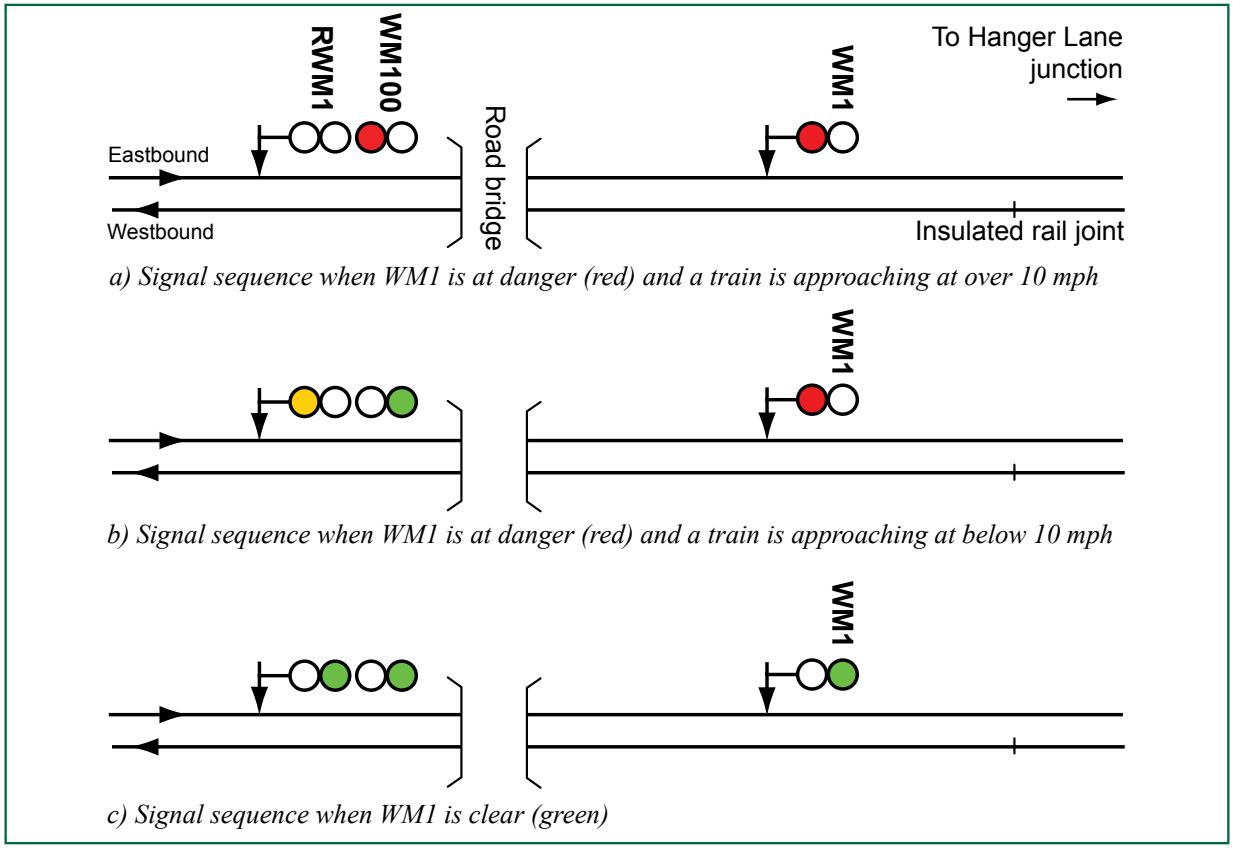


Figure 4: Signal sequence for an eastbound District Line train approaching Hanger Lane junction

26 Signal WM1 is preceded by signals WM100 and RWM1. Those two signals are located 74 metres before signal WM1 and mounted together (figures 4 and 5). They provide a train operator with information on the status of signal WM1:

a. Signal WM100, mounted at the top of the post, is provided to reduce the risk of a train passing signal WM1 at danger, and doing so at a speed which would make it unable to stop before reaching the junction. When signal WM1 is at danger, signal WM100 shows a red aspect to approaching trains travelling at more than 10 mph (16 km/h). A timing device, linked to track circuits which can detect a train's position, measures the speed of an approaching train. If signal WM1 remains at danger, signal WM100 will only clear to green once the signalling system has verified that the approaching train's speed is sufficiently low and that the trainstop at signal WM1 is raised.

b. Signal RWM1, mounted below signal WM100, is a *repeater signal* for signal WM1. This signal is designed to show a yellow aspect if signal WM100 is showing green but signal WM1 is at danger, or a green aspect if signal WM1 is green. It shows no aspect if signal WM100 is at danger. Signal RWM1 is provided to assist a train operator if the sighting of signal WM1 becomes obstructed when a train is approaching on the opposite line due to curvature of the track.

Figure 5: Signal WM100 mounted above signal RWM1. Signal WM1 is beyond the road bridge ahead

27 The *insulated rail joint* for signal WM1 is located 43.6 metres in advance of (ie beyond) it, as shown in figure 6. This separation is much greater than that found at more modern installations for historical reasons. If a train passed signal WM1 at danger, it would have to travel at least 43.6 metres in order to occupy the next track circuit before the infringement was detected by the signalling system and displayed to the signaller. It could then continue for a further 76 metres before reaching the junction (figure 7). If a train passed signal WM1 at danger but stopped within 43.6 metres, the overrun would not show on the track diagrams in the control room or affect other signals at the junction.

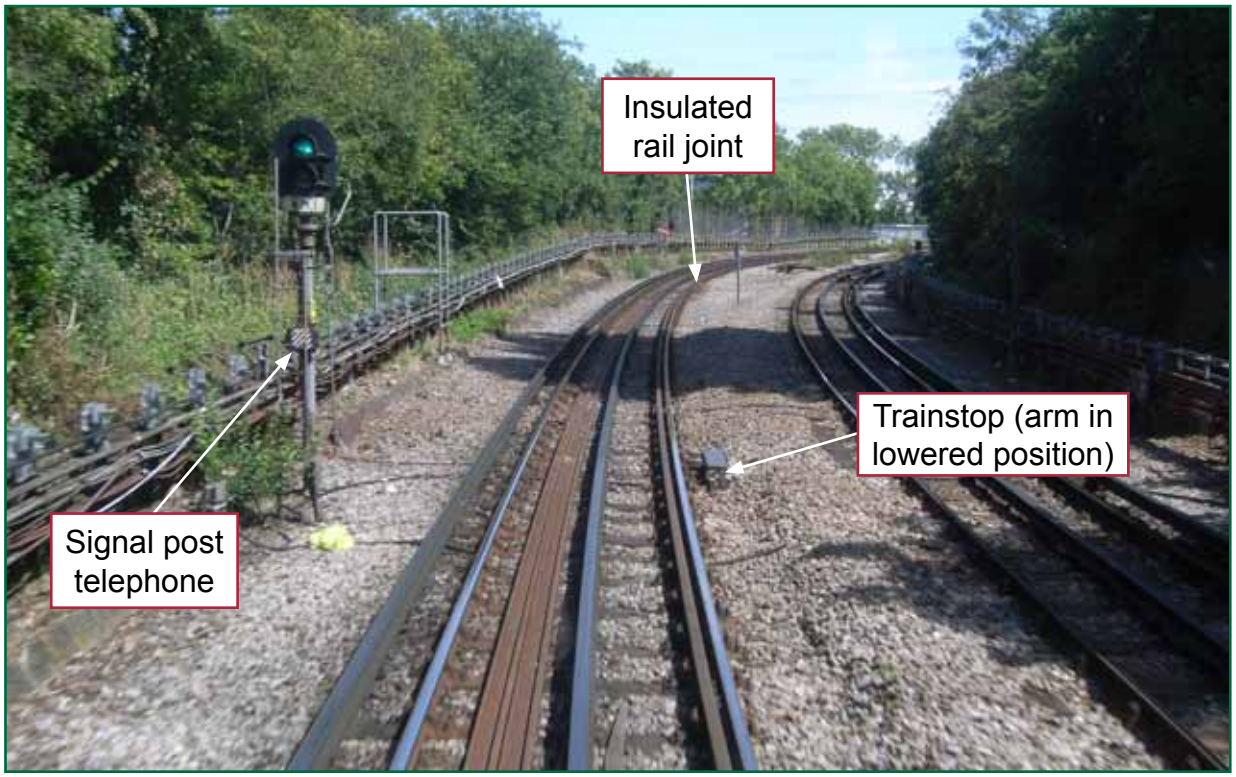


Figure 6: Signal WM1, with Hanger Lane junction in the distance

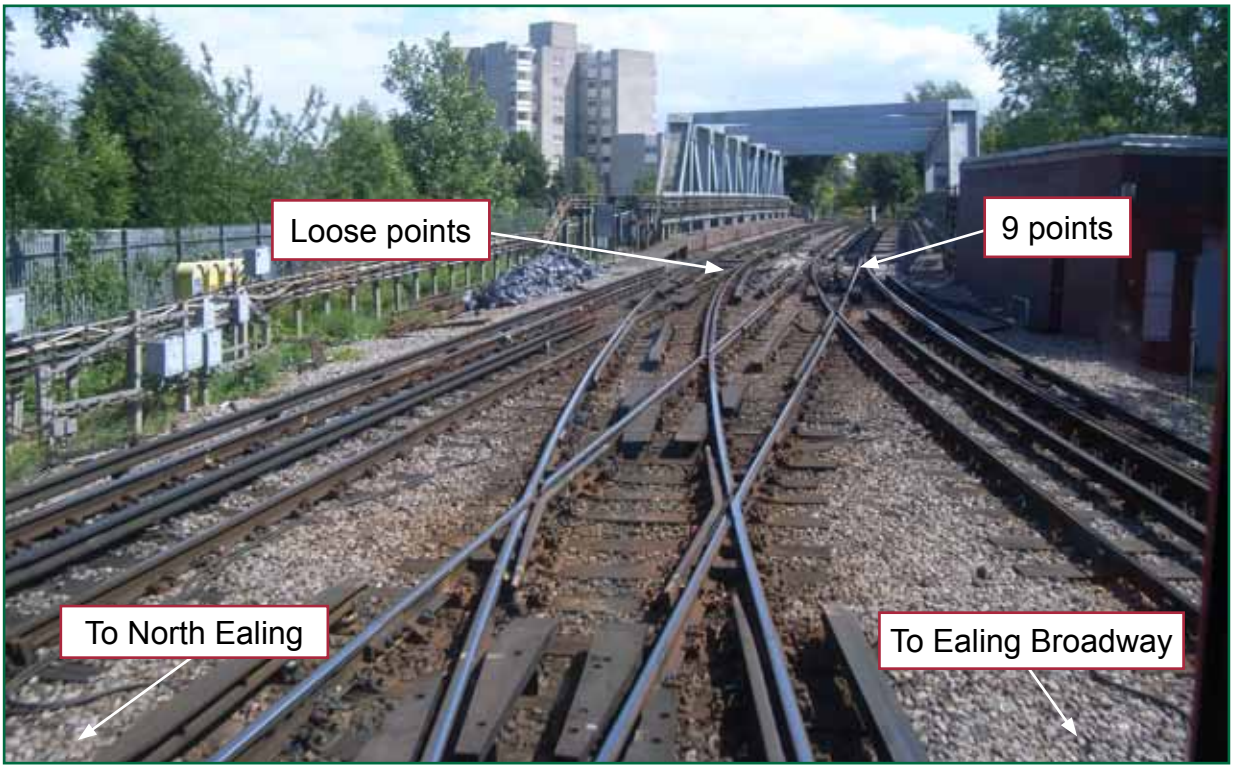


Figure 7: Hanger Lane junction viewed from eastbound District Line

28 The line speeds on the approach to the junction are 20 mph (32 km/h) over the eastbound District Line and 25 mph (40 km/h) westbound for both the Piccadilly and District Lines. The eastbound District Line, used by train 103, is on a rising gradient of 1:76 approaching the junction.

29 Trains approaching the junction in the westbound direction are controlled by semi-automatic signal WM22 at Ealing Common station (see figure 8). Semi-automatic signals WM20 and WM21 control the junction, the signal used depending on the route being taken. A Piccadilly Line train crossing the junction towards North Ealing would encounter signal WM22 and then WM21.

30 Hanger Lane junction is equipped with conventional powered points on the westbound line for facing direction moves from Ealing Common, and *loose points* on the eastbound. At the time of the incident, there were 14 sets of loose, or *spring toggle* points (which operate in a similar manner), on the London Underground network. These types of installation are only suitable for moves in the *trailing direction* and are gradually being phased out as junctions are renewed to improve operational flexibility.

31 The signalling system at Hanger Lane junction is not fitted with data logging equipment as it was designed and installed in the 1950s. Communication arrangements between the signaller, controller and train operator are discussed in paragraph 79.

Events preceding the incident

32 The signaller involved in the incident arrived at Earls Court at approximately 15:30 hrs on 27 March 2009, in preparation for a shift starting at 16:00 hrs covering meal-break relief duty. This involved the signaller covering each of the different control desks to allow the rostered signallers to have a meal break. He signed in with the Piccadilly Line *Service Manager* in charge of the control room.

33 The signaller's first control desk duty was to cover the Acton Town desk (controlling the Hanger Lane junction area) from 17:00 hrs. At the same time he also took over the adjacent Northfields desk controlling the Heathrow branch, and worked the two positions simultaneously. This allowed two signallers to take meal breaks. He identified that some trains coming from Heathrow did not accord with train numbers shown on the control room display and instigated an exercise to correct this numbering in liaison with a member of station staff at Acton Town.

34 The District Line train operator, who was to drive train 103, booked on duty at 12:25 hrs at Upminster depot. He had been rostered to work a 'spare' turn to cover any train operator absences. He was subsequently asked to cover duty 542 that involved preparing a set on Upminster depot, prior to working a passenger service from Upminster to Ealing Broadway and return.

35 The train operator left Upminster at 15:32 hrs and had an uneventful journey to Ealing Broadway. After arriving, the train operator took a short break before rejoining his train.

36 At 17:21 hrs, train 103 departed from Ealing Broadway. As the train approached Hanger Lane junction, the train operator observed signal WM100 displaying a red aspect, which indicated that signal WM1 was also at danger. He slowed the train to below 10 mph (16 km/h). This was detected by the signalling system which allowed signal WM100 to clear to a green aspect and signal RWM1 to yellow (figure 4).

Events during the incident

37 After observing signal WM100 clear to green, the train operator moved his control lever to apply power and keep the train moving. He then observed that the trainstop at signal WM1 was raised and moved the control lever to the emergency brake position. This action was too late to prevent the train passing signal WM1 at danger. The tripcock tripped and the train came to a stand approximately five metres beyond the signal at 17:23 hrs.

38 The train operator left the driving cab and used a *signal post telephone* (SPT) mounted on the post of signal WM1 to contact the signaller. He reported that he had passed signal WM1 at danger without authority. He did not use the phonetic alphabet, describing the signal as "WM1" rather than "whiskey mike one". The signaller asked the train operator to wait while he contacted the District Line controller, and made arrangements to move the train.

39 At 17:25 hrs, the signaller rang the controller located at Baker Street. The controller was involved with managing a concurrent but unrelated incident at Sloane Square, which required him to deal with a high volume of radio traffic. As a consequence, he was not able to answer the call from the signaller immediately.

40 The controller answered the call after 65 seconds, and the signaller informed him of the incident and that he intended to authorise train 103 to proceed. The controller sought confirmation that the signaller had spoken to the train operator, and agreed that the signaller could authorise the train forwards across the junction. The controller accepted that the points could be treated as spring toggle points and therefore did not need securing.

41 The District Line Service Manager, located with the controllers at Baker Street, overheard this call and contacted the Piccadilly Line Service Manager at Earls Court seeking clarification of the signaller's intentions. The Piccadilly Line Service Manager went into the control room and satisfied himself that the signaller, who was in the process of agreeing arrangements for moving train 103 forwards, was handling the incident appropriately.

42 The District Line Service Manager was unaware of the loose points and contacted the station supervisor at Ealing Broadway to start making arrangements for train 103 to be moved back to signal WM1 before restarting. This would involve the station supervisor having to walk down the track to the train in order to act as the '*wrong direction movement person in charge*' in accordance with the LUL rule book (refer to paragraph 90). This action was aborted when the Piccadilly Line Service Manager rang to confirm that train 103 could be moved forwards in this instance due to the presence of loose points.

43 The signaller put *programme machine* Hanger Lane S1, controlling eastbound traffic, into push-button (ie manual) mode. This action maintained signal WM2 at red at North Ealing station and ensured that eastbound Piccadilly Line train 340, which was approaching the station, did not proceed beyond North Ealing. He also arranged for a Piccadilly Line controller, located at Earls Court, to contact the train operator of train 340 by radio to inform him that he would be held at signal WM2. This radio message was broadcast at 17:27:25 hrs.

44 The signaller also put programme machine Ealing Common S2, controlling westbound traffic, into push-button mode in order to stop westbound Piccadilly Line train 326 at signal WM23A on the approach to Ealing Common station (figure 8).

45 The signaller did not prevent westbound Piccadilly Line train 316, then at Ealing Common station, from progressing towards Hanger Lane junction and North Ealing station without interruption.

46 The signaller resumed his telephone call to the operator of train 103, and proceeded to inform him of the protection arrangements that he had put in place. The signaller gave the train operator a series of verbal instructions, culminating with the phrase "carry out that procedure, OK?", which the train operator understood as giving him authority to proceed. The train operator accepted this instruction without repeating the message back as required by the LUL rule book, and the call was terminated at 17:27:35 hrs. During this conversation, the signaller had observed signal WM22 at Ealing Common clear for train 316 on the control room *signalling diagram*.

47 The train operator returned to the cab of train 103 and reset the train's tripcock apparatus before preparing to move his train.

48 At 17:27:40 hrs, the signaller instigated a second telephone call to the District Line controller to confirm the actions taken and conclude the incident. The controller was still busy with the Sloane Square incident and did not answer for 38 seconds (figure 9).

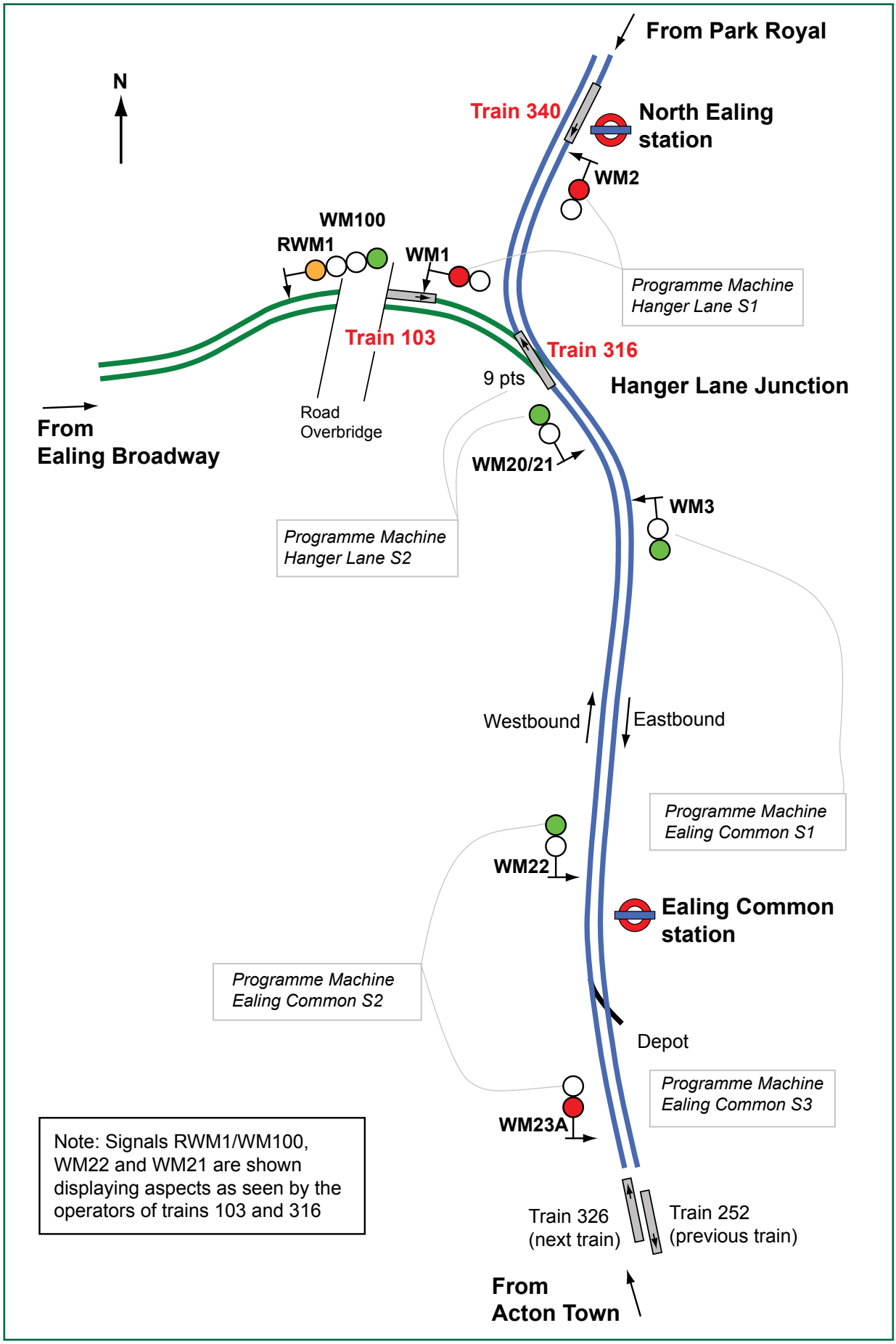
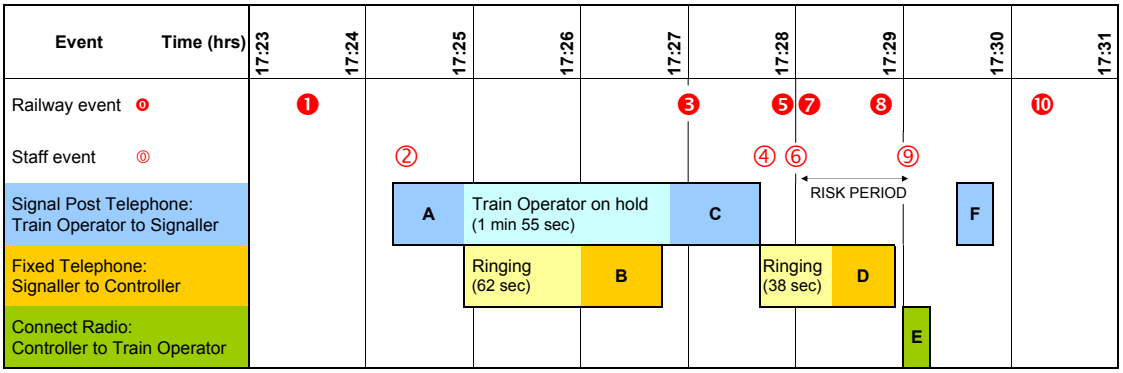


Figure 8: Schematic map showing layout of junction and location of trains at 17:28:34 hrs (during incident)

Timeline



Key

Events:	Time	Event
❶	17:23:40	Train 103 passes signal WM1 at danger (SPAD incident)
②	17:24:20	TRAIN OPERATOR reports SPAD incident to signaller from SPT* at signal WM1
❸	17:27:00	Signal WM22 clears to green, allowing train 316 to leave Ealing Common station
④	17:27:40	TRAIN OPERATOR returns to train 103 believing he has authority to move
❺	17:27:50	Train 316 passes signal WM22. 'Uxbridge' destination shown on signalling diagram
⑥	17:28:00	SIGNALLER becomes aware of risk of collision between trains 103 and 316
❼	17:28:10	Signal WM21 clears to green, allowing train 316 to cross Hanger Lane junction
❽	17:28:45	Train 316 crosses Hanger Lane junction ahead of train 103
⑨	17:29:05	TRAIN OPERATOR of train 103 instructed to return to SPT* and contact Signaller
❿	17:30:20	Train 103 starts to move towards Hanger Lane junction

Communications:	Start time	From / To	Summary of message
A	17:24:15	Train Op to Signaller	TRAIN OPERATOR reports SPAD to Signaller and is asked to hold
B	17:26:00	Signaller to Controller	SIGNALLER notifies Controller of SPAD and agrees course of action
C	17:26:45	(continuation of **A**)	SIGNALLER gives Train Operator authority to proceed
D	17:28:20	Signaller to Controller	SIGNALLER tells Controller to "Grab that 103"
E	17:29:00	Controller to Train Op	CONTROLLER instructs Train Operator to call Signaller using SPT*
F	17:29:25	Train Op to Signaller	SIGNALLER gives Train Operator authority to proceed

* Signal post telephone

Figure 9: Time-line diagram showing chronological relationship between key events

49 At 17:27:50 hrs, train 316 passed signal WM22. Its position was automatically updated on the large signalling diagram in front of the control desk (figure 10). The display panel above it also lit at the same time to show the train's destination as 'UX' for Uxbridge, both displays being visible to anyone within that part of the control room. An off-duty signaller who was seated close to the signaller observed this and drew the signaller's attention to train 316. The signaller, who had already been waiting for the controller to answer for 20 seconds, was startled by this. He was aware that there was the potential for a collision and his first action was to check the signalling diagram to see whether train 103 had moved.

50 Although there were other methods by which the signaller could stop trains, for example, by discharging the traction current, he anticipated that the controller would answer and maintained his original course of action. At 17:28:18 hrs, the controller answered the call. The signaller immediately told him to "Grab that 103, he's had permission to move", followed by "Call him now. Tell him he's got the authority to go over". The controller selected Hanger Lane junction on his *Trackernet* screen to confirm the position of train 103, but the close-up view meant that train 316 was off-screen and he was unaware that it was approaching the junction.

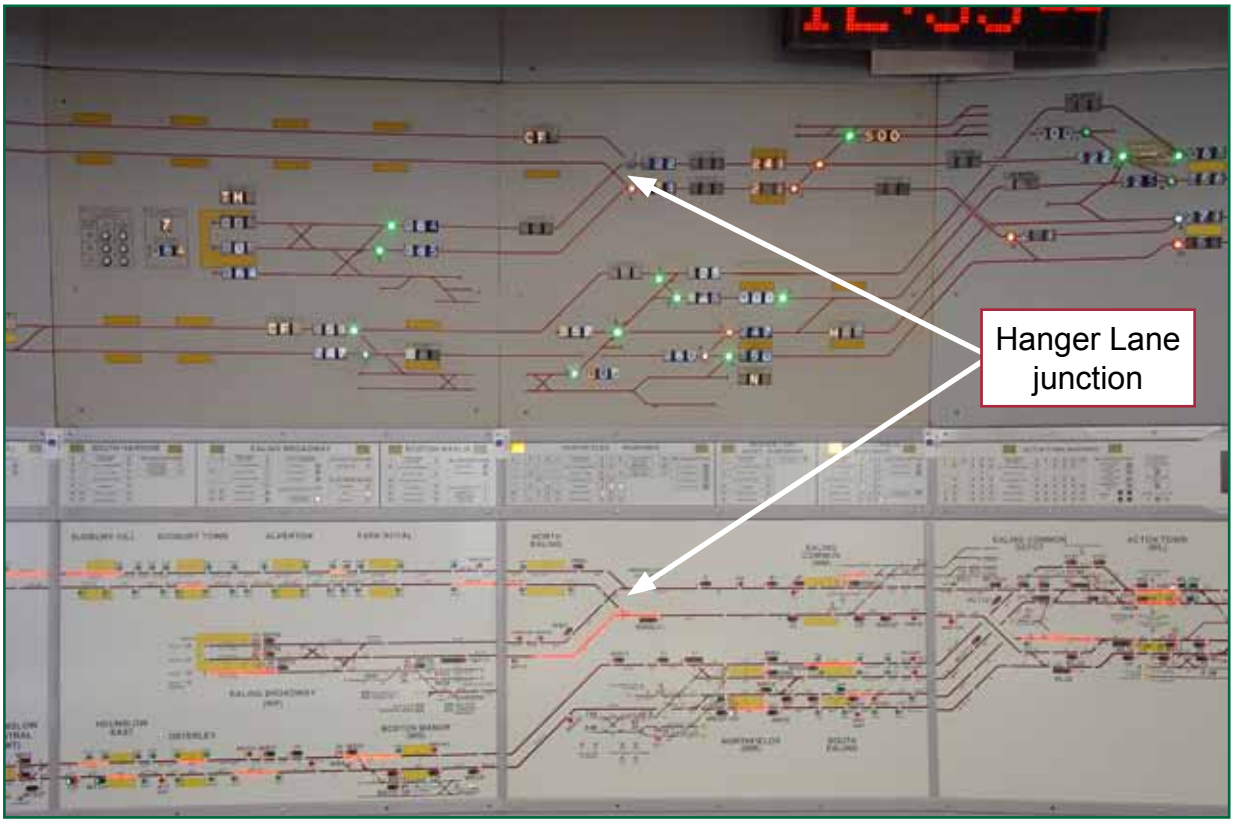


Figure 10: Display panel (top) and signalling diagram within the Earls Court control room

51 The controller queried this instruction, to which the signaller repeated "Yes I've told him. I want him to carry it out now, to get across there now". When the controller asked what he was to tell the train operator, the signaller responded "Ask him to ring me on the signal post telephone". This call concluded at 17:28:53 hrs.

52 At this time, the operator of train 103 was preparing to move his train forwards. As he looked ahead, he observed the rear section of a Piccadilly Line train crossing ahead of him which Trackernet records confirm as train 316. Believing that he had authority to cross the junction, he immediately initiated a radio call to the controller.

53 Almost simultaneously at 17:28:58 hrs, the controller initiated a radio call to the operator of train 103, approximately 58 seconds after the signaller first became aware of the potential for a collision. Once the radio call was connected, the train operator started to speak, but the controller, believing that he had initiated the call, interrupted the train operator and instructed him to contact the signaller again, using the signal post telephone.

Events following the incident

54 The signaller informed the train operator again that the junction was clear and that he had authority to proceed. The signaller repeated the measures that he had put in place to protect the junction which the train operator queried, asking for repeated reassurance that the junction was clear. At 17:31 hrs, train 103 crossed the junction at low speed.

55 In response to the original signal passed at danger (SPAD) incident at signal WM1, the controller made arrangements for the operator of train 103 to be met on arrival at the next station, Ealing Common, to allow his fitness to continue to be assessed. However, this did not occur sufficiently quickly and the train operator continued to the following station, Acton Town. Here he was relieved of duty and asked to attend a post-incident interview at Earls Court. On arrival at Earls Court the train operator was told that, due to a separate incident at Edgware Road, no one was available to see him. He was instructed to travel to Barking, some 50 minutes away, where he was to be met and interviewed by a Duty Manager (Trains) in accordance with LUL's procedures.

56 Meanwhile, the Piccadilly Line Service Manager prepared a post-incident report on behalf of the signaller. This report gave a brief description of the SPAD incident and action subsequently taken. The signaller signed the report and it was faxed to the Duty Manager (Trains) at Barking.

57 At Barking, the Duty Manager (Trains) started to investigate the circumstances of the SPAD incident while waiting for the train operator to arrive. This was triggered by a telephone call from the train operator in which he expressed concern about how the SPAD incident had been handled, and involved comparing train movement information from Trackernet (figure 11) with the signaller's report.

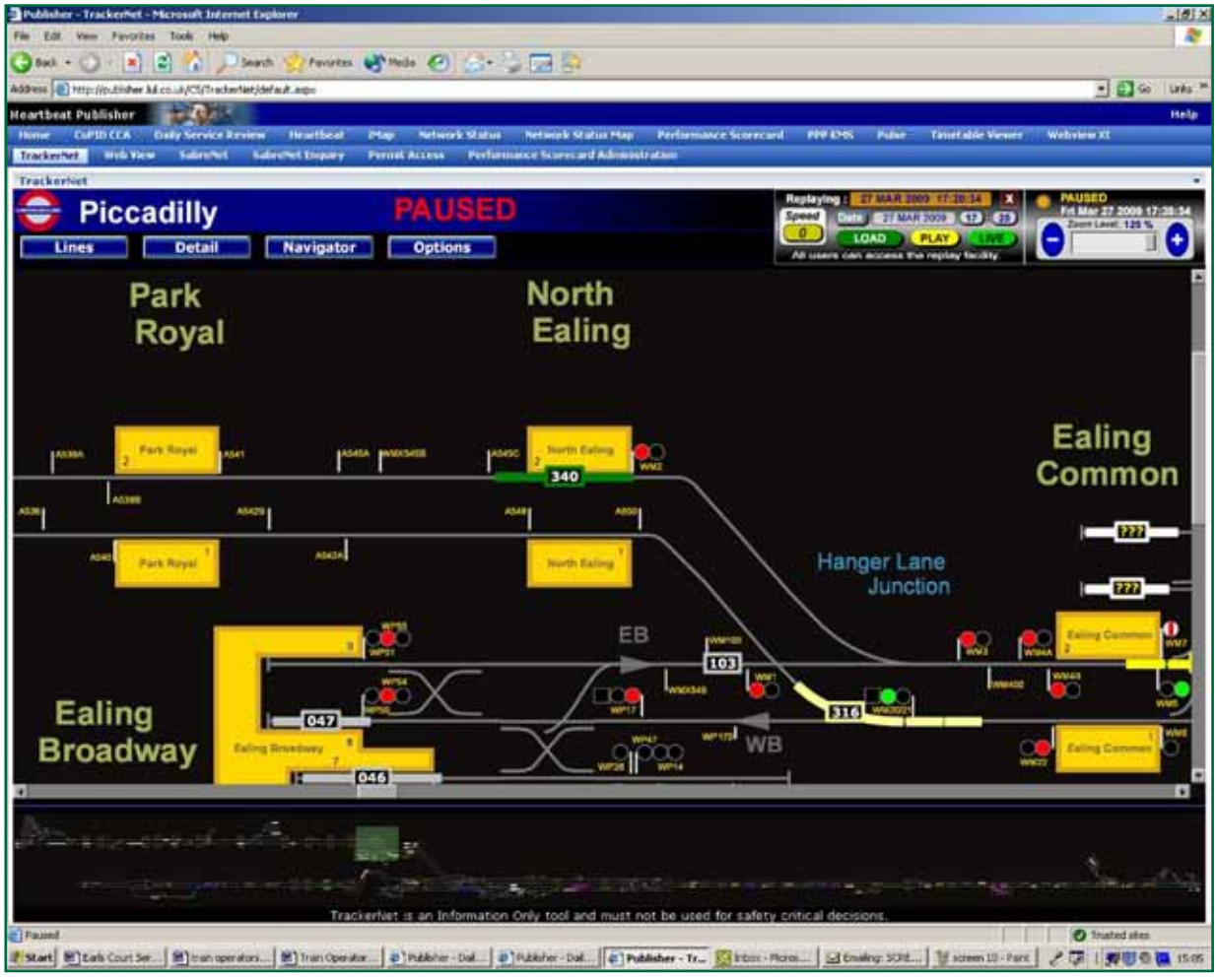


Figure 11: Trackernet screen image at 17:28:34 hrs showing train 316 crossing junction ahead of train 103

58 The Duty Manager (Trains) identified that a near-miss incident had occurred in the aftermath of the SPAD, and the subsequent interview with the train operator confirmed this. The train operator alleged that the SPAD had occurred due to sunlight on signal WM1 which had led him to believe that the signal had cleared to green, and that he was alerted to the signal being at danger by seeing the trainstop in a raised position by which time it was too late to stop.

59 Although the train operator was not subjected to drugs and alcohol testing following the incident, the Duty Manager (Trains) was in a position to assess his fitness for duty during this meeting which met the requirements of the LUL rule book.

60 The Duty Manager (Trains) observed that the signaller's report made no reference to the near-miss which followed the SPAD incident, as it stated that all trains were stationary before the incident train was authorised to pass signal WM1. The signaller's report also gave the wrong train number and had it travelling on the westbound, rather than eastbound line (see table 2, following paragraph 128).

61 The Duty Manager (Trains) commenced further enquiries involving the District Line Service Manager and other more senior on-call managers. This included a review of control room voice tapes by the District Line Service Manager, who formed a view that the signaller had been panicking. After consultation with the signaller's line manager, he contacted the Piccadilly Line Service Manager and advised him to relieve the signaller from duty. This occurred at approximately 21:00 hrs.

62 The signaller was immediately interviewed by the Piccadilly Line Service Manager and subject to drugs and alcohol screening, as laid down by LUL's procedures, the results of which were negative (ie clear). The signaller stated that his communication with the train operator had been interrupted when the cable of the telephone on the control desk pulled out of its socket, and that he had not intended to give train 103 authority to proceed at that time. Access to the telephone sockets was partly obstructed by a heavy bracket which had been installed recently in connection with London Underground's *Connect project*, designed to replace various legacy radio systems (refer to paragraph 104).

Consequences of the incident

63 There were no immediate consequences from this incident as the two trains were separated by at least 115 metres at all times. However, had train 103 moved promptly once given authority to proceed, there was the potential for a collision to occur.

The Investigation

64 The incident was reported to the RAIB at 07:25 hrs on 28 March 2009 (the morning after it had occurred), due to the full circumstances of the incident not being known immediately.

Sources of evidence

65 Evidence has included:

a. control room voice recordings;

b. data from LUL's train monitoring system, 'Trackernet';

c. witness statements;

d. medical reports; and

e. location maps and signalling diagrams.

Key Information

Train Operator

66 The train operator had over ten years' experience driving trains on the District Line. He was considered to have a good driving record, and had not been involved in any relevant incidents during the five years prior to this incident. Before that, he had passed signals at danger on two occasions, both of which were later attributed to his inattention. Neither event led to an accident.

67 The train operator had not had problems with sighting signal WM1 previously.

68 The RAIB has analysed the train operator's actual shift pattern against a *fatigue and risk index* published by the Health and Safety Executive (HSE). This indicates that his shift pattern should not have created a risk of fatigue.

Earls Court Control Room

69 The Earls Court control room supervises the operation of the west end of the Piccadilly and District lines. There are six control desks, staffed by signallers, who are able to monitor train movements via two long wall-mounted diagrams (figure 10). These are:

- a control room display showing train numbers and destination information; and
- a signalling diagram showing the actual position of trains and the status of all semi-automatic signals.

70 The destination information is not displayed continuously. For westbound trains approaching Hanger Lane junction, the destination is not shown until the approaching train has passed signal WM22, after departure from Ealing Common station.

71 The signalling system uses programme machines to control train movements. These can be operated in three modes:

a. programme (ie automatic), indicated by a green lamp on the control room display;

b. first-come first-served, indicated by a yellow lamp; and

c. push-button (ie manual), indicated by a red lamp

72 Hanger Lane junction is equipped with two programme machines: S1 controls eastbound train movements via signals WM1 and WM2, and S2 controls westbound movements via signals WM20/21 and 9 points. Ealing Common is equipped with three programme machines with S1 controlling eastbound movements via signal WM3, S2 westbound via signals WM22 and WM23A and S3 the adjacent depot (figure 8).

73 A roster of 42 signallers operates the six control desks on a 24 hour three-shift basis. The roster includes a meal-break relief signaller for each shift who is able to cover all the control desks. The roster rotates staff between 'early' (ie 06:50 hrs to 15:00 hrs), 'late' (ie 14:50 hrs to 23:00 hrs) and 'night' (ie 22:50 hrs to 07:00 hrs) shifts.

74 Hanger Lane junction comes under the control of the Acton Town control desk. This desk, together with the Earls Court desk, has the greatest level of activity within the control room.

75 If the control room is short-staffed, some desks can be left unattended to work automatically. The Piccadilly Line Service Manager is responsible for determining which desks are left unattended and the Kings Cross desk is normally de-staffed first as it is the least busy.

Baker Street Control Room

76 Before March 2008, controllers for the District and Piccadilly lines were both located within the Earls Court control room with the signallers. The District Line controllers were moved out to a new control room at Baker Street, partly to reduce overcrowding at Earls Court, and to put them closer to controllers for the Circle and Hammersmith & City lines. The move did not affect Piccadilly Line controllers who remained in a location at the rear of the control room at Earls Court.

77 To mitigate the effect of the separation between signallers and District Line controllers, direct telephone links were installed between the two control rooms. Although incoming calls went into a queuing system, the telephone equipment identified the caller and LUL required calls between the two control rooms to be treated as a priority. This arrangement was less effective during busy periods or if either control room was already dealing with an incident. However, the majority of calls between the control rooms were to relay information, and did not require high-priority status.

78 District Line controllers use the Trackernet display screen-based system to monitor the position and identity of trains. Their role is to monitor the railway to ensure it runs to timetable and deal with any incidents that arise. Trackernet is an information-only tool and, at the time of the incident, could take up to 30 seconds to update. It is not used for making safety-critical decisions, and the screens do not show the programme machine mode or destination of trains. For this investigation, other evidence has been used to corroborate Trackernet timings.

Methods of communication

79 At the time of the incident, phase 1 of the Connect project's radio system (*Connect Radio*) had been implemented on the London Underground network, and this allowed controllers and train operators to communicate. The signallers at Earls Court control room were excluded from this arrangement pending the implementation of phase 2 of the project, scheduled for mid-2009. During the interim, the following communication methods were available for controlling District Line services:

a. secure two-way radio between the controller at Baker Street and each train, with both the train operator and controller being able to initiate radio calls;

b. signal post telephone between semi-automatic signals and the signaller, which were unrecorded and could only be initiated from the signal (ie by the train operator); and

c. telephone between the signaller and controller: the recipient was able to identify the caller by means of a screen display before answering and was required to give incoming calls from the other control room priority.

Signaller

Experience and training

80 The signaller had over ten years' experience working within the Earls Court control room and also acted as an instructor for new signallers. He was a local union health and safety representative, and as a consequence, typically 25% of his working time was spent on union duties rather than operating a control desk.

81 The signaller sat and passed an annual reassessment in August 2008 as part of LUL's competency development programme. This assessment involved written tests to demonstrate knowledge under the headings 'Communicate using LU protocols' and 'Operate signalling equipment under degraded conditions'. During his time at Earls Court, he had assisted with, but not undertaken a practical safety critical communications course.

Health, medication and hours worked

82 The signaller had experienced deterioration in his health towards the end of 2008. His GP prescribed medication to treat his symptoms and advised him not to drive. The signaller was still taking this medication at the time of the incident.

83 Following a short period of absence, the signaller returned to work and requested a referral to LUL's occupational health department. After discussion, the signaller's manager agreed to his request. This was despite written guidance provided by the occupational health department not imposing a restriction on 'signalling duties' for the medication in question despite restricting those 'making decisions which can impact on safety'. This guidance, titled 'Helping managers decide on employee's fitness for work', was issued in January 2005.

84 The signaller attended an appointment with a doctor from the occupational health medical advisory team in January 2009. The doctor reported that while the signaller's condition was improving, he continued to experience symptoms that could affect his concentration. The doctor advised that while the signaller could continue to perform signaller duties at the desk, these were to be limited to five hours per day, and that he could undertake duties that did not require significant levels of concentration for the remainder of his shift. He also recommended that the signaller did not work night shifts pending a further review after five weeks.

85 In February 2009, the signaller attended a second appointment with the same doctor. On this occasion, the doctor reported that the signaller's symptoms were largely unchanged, but that the signaller was keen to increase his hours to a full shift. The doctor advised that this should be done gradually and with the oversight of a manager to ensure that he was able to cope with the increase in his hours. However, he was still to be restricted to working late shifts due to the possible 'hangover-effect' of his medication. The signaller was to attend a workshop to address his underlying medical condition, and the doctor specified that the shift restrictions were to remain until the workshop had commenced and 'things had improved significantly'. The restriction on working hours did not specify whether the signaller could work on days when he was rostered to take rest (ie rest days).

86 The signaller's manager adjusted the signaller's roster pattern to accommodate the restrictions imposed by the medical advisory team, and the signaller continued to work shortened 'late' shifts. During the 21 days preceding the incident, LUL's records show that the signaller worked in the control room on six days, undertook union duties on three days and had annual leave on four days. The remaining eight days were shown on the roster as rest days, but the signaller worked in the control room on five of those occasions.

87 On 27 March 2009, the signaller was rostered to take a rest day. On this occasion he worked because he had been asked to cover the late shift as the meal break relief operator and defer his rest day until the following week.

Rule Book

88 The LUL rule book is published in individual volumes. Volume 1 (rule book 1) contains the rules relating to communications. Volumes 5 and 7 (rule books 5 and 7) contain the rules to be observed when a train has passed a signal at danger.

Rule book 1 'Communications'

89 Rule book 1, section 2 'Giving and receiving messages', states that a person receiving a message 'must repeat back all safety-related information or actions to be carried out', and that when using communication equipment, 'you must use the phonetic alphabet'.

Rule book 5 'Movement of trains due to exceptional circumstances'

90 Rule book 5, section 2 'Working in the wrong direction', addresses the arrangements for authorising the movement of trains in the wrong direction, for example, to allow a signal to be cleared. The procedure states that this may be by secure radio, or by the appointment of a 'wrong direction movement person in charge' to authorise the movement. At the time of the incident, the secure radio option was not available pending full introduction of the Connect Radio system.

91 Rule book 5, section 8 'Passing a semi-automatic signal at danger (manually driven lines)', describes how a signaller gives authority to a train operator to pass a semi-automatic signal at danger, including information to be conveyed and agreeing protection arrangements if points need to secured. It goes on to inform the signaller: 'when it is safe to do so, you must give authority to pass the signal at danger. If you cannot communicate directly with the train operator, you must give this authority through the controller, station supervisor or the duty manager.'

92 Rule book 5, section 10 'Securing and unsecuring points' describes the process for securing points, but states that 'spring toggle points do not need to be secured for movements in the normal direction of travel'. LUL has confirmed that this rule also applies to loose points as they behave in a similar manner, but this is not specified.

Rule book 7 'Train incidents and safety equipment'

93 Rule book 7, section 4 'Signals passed at danger (without authority)' provides instruction for the train operator and states that the controller, signaller or station supervisor must be informed. Paragraph 4.3 gives more detailed instructions regarding the actions of the various parties for signals passed at danger without authority and states for semi-automatic signals that:

- 'You[1] must not move your train until you have received authority to do so';
- 'You[2] must tell the signaller and station supervisor if points need to be secured and in what position'; and
- 'You[3] must give authority for the train to proceed only by using a signal post telephone, a handsignal, secure radio (if authorised); or by asking a station supervisor or duty manager to do it in person.'

94 Rule book 7, section 4.4 'Controller's action in all cases' states: 'You must arrange for a duty manager or station supervisor at the next staffed station to assess the train operator's fitness to continue.' Section 4.5 requires a station supervisor or duty manager to try to find out whether a train operator involved in a SPAD incident has contravened LUL's drug and alcohol policy and whether he/she is fit to continue.

Options available to the controller

95 The controller was responsible for deciding what action to take. Although the rule book is not specific on this matter, the options available were either to allow the signaller to authorise train 103 forwards, having protected the junction and secured the points (if necessary), or to require train 103 to make a wrong direction move to put it back behind signal WM1 before clearing the signal. The controller accepted the signaller's proposal to move the train forwards on the basis that it could be done safely, that the points did not need securing, and that this would be the least disruptive option.

[1] ie the train operator

[2] ie the controller

[3] ie the signaller

Previous occurrences of a similar character

96 Signal WM1 has been passed at danger on two previous occasions during the five years prior to this incident. Details of these incidents are given below:

a. On 26 September 2007, signal WM1 was passed at danger when a recently qualified train operator failed to react correctly to the signal after becoming distracted. Following this incident, LUL's internal investigation proposed an action plan for the train operator which included his being accompanied over this section of line by a driver manager, receiving further training and being subjected to unannounced monitoring.

b. On 7 October 2006, signal WM1 was passed at danger when a train operator read the previous signal RWM1 as signal WM1. LUL's internal investigation found that the train operator, who had just returned from a protracted period of absence, observed signal RWM1 change to green. However this could not occur unless signal WM1 also changed to green, so it is possible that the train operator had actually observed signal WM100 and that the LUL investigator and/or train operator were unaware of the signal configuration in this area. Following this incident, an action plan was developed for the train operator, for which no details are available.

97 There has been no other recorded case of conflicting moves on the London Underground network being authorised over the last five years.

Analysis

Identification of the immediate cause[4]

98 The immediate cause of the incident was the signaller giving the operator of train 103 authority to proceed before it was safe to do so.

Identification of causal[5] and contributory[6] factors

Actions of the train operator on train 103

99 When the train operator of train 103 approached signal WM100, it was showing danger and as a consequence, he reduced speed to below 10 mph (16 km/h) which allowed this signal to clear to green. At the same time, signal RWM1, mounted on the same post, showed a yellow aspect indicating that signal WM1 remained at danger.

100 The train operator moved his controller to draw power, but this may have been necessary to keep the train moving as it was running on a curve and climbing a 1:76 uphill gradient. Therefore, this action does not, of itself, indicate that he had misread signal RWM1 or signal WM1.

101 The train operator alleged that he misread signal WM1 due to bright sunlight making it appear to show a green aspect. It is possible for signal WM1 to clear to green after a train has passed signal WM100. The signal head faces due west and the sun would have been low in the sky at this time of day in late March. However, the RAIB considers that it is unlikely that the train operator could have been misled by the aspect shown on signal WM1 for the following reasons:

a. The train operator was able to observe the preceding signals (RWM1 and WM100), exposed to similar lighting conditions, correctly.

b. An inspection by a London Underground supervisor travelling in the cab of a train at the same time of day and in bright sunlight within a week of the incident found that the signal was shaded and that the lit aspect was fully visible.

c. No previous allegations have been made regarding the sighting of this signal in bright sunlight.

d. The signal head is designed to minimise the risk of a false aspect being shown by having no reflective parts.

e. The red aspect was lit. If a train operator observes a signal which appears to be showing a dual aspect (ie both red and green in the case of signal WM1, as it would have been if the sunlight had made the green aspect appear to be lit), he is required by rule book 6, section 3, to treat this as a danger signal and stop his train.

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

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

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

102 It is therefore probable that the train operator either mis-read the signal sequence or was distracted. He observed the raised trainstop, but did not identify that signal WM1 remained at danger until he was too close to it to stop, and he subsequently passed the signal at danger. Not identifying that signal WM1 was at danger was a causal factor in the subsequent near-miss incident.

Actions of the signaller

Accidental disconnection of the signaller's telephone cable

103 The signaller, after obtaining the controller's permission to move train 103 forwards, then proceeded to instruct the train operator about the movement of train 103 (paragraph 46). It is possible that the signaller intended to hold the operator of train 103 on the telephone and that the train operator either concluded the call prematurely or was cut-off. This conversation was partially recorded in the background of another call, but it is not possible to establish what the signaller instructed the train operator to do. The signaller has alleged that the telephone cable came out of its socket on the control desk, and that the train operator inferred that he had authority to proceed earlier than the signaller had intended as a consequence.

104 The telephone cable is straight and it is possible to pull out the cable. However, this scenario is not supported by the following evidence:

a. the telephone cable is sufficiently long to make it difficult for an operator to pull out the cable while remaining seated at the control desk;

b. no witnesses in the control room observed this event;

c. the signaller did not report the occurrence to the controller, manager or any other member of staff at the time;

d. the signaller, in his subsequent telephone call to the controller, twice confirmed that he had given the operator of train 103 authority to move across the junction (paragraph 50); and

e. the train operator, despite omitting to repeat the message back to the signaller, believed that the call had concluded and that he had been given authority to proceed.

The RAIB does not consider that the alleged disconnection of the telephone cable was a factor in this incident.

Signaller's working conditions

105 The signaller was working under time pressure during the incident as blocking the junction area for an extended period would affect services on the District and Piccadilly lines in both directions. This made the option of authorising train 103 forwards attractive (paragraph 95). The need to resolve the situation quickly in order to minimise disruption was a contributory factor.

106 The signaller's training dictated that he should protect the junction by stopping all train movements before permitting the incident train to move. LUL provide desk-specific training documents detailing the configuration of the signal areas controlled by each desk, but this information did not provide guidance on how to protect specific sections of track.

107 Once the signaller had obtained authority from the controller to move train 103 forwards across the junction rather than setting it back behind the signal, he took action to stop trains 340 and 326 from approaching the junction. Train 316 was closest to the junction, and he had the option of either stopping it at signal WM21 before the junction, or letting it run (ensuring that it had cleared the junction before giving authority for train 103 to proceed). He was aware of this train and observed signal WM22 clearing to green on the signalling diagram, allowing it to leave Ealing Common station, while he was talking to the train operator of train 103 (paragraph 46).

108 The signaller, who has responsibility for all train movements, took no action to prevent train 316 from continuing its journey. Despite there being no destination shown on the display panel, the train's number, prefixed with a 3, indicated that it was a Piccadilly Line service. It would therefore have to cross the junction to reach its next stop at North Ealing station. Had the signaller implemented the correct process, by bringing all trains to a halt to protect the junction before giving train 103 authority to proceed, this incident would have been avoided. This forms part of a signaller's basic training, and not doing so was a causal factor.

109 The signaller appeared to have forgotten about train 316 until his off-duty colleague intervened, 20 seconds after the end of his conversation with the operator of train 103. This may have been due to lack of attention or distraction arising from looking after two desks at once (paragraph 33). The signaller's workload during the incident was a contributory factor.

110 Other possible reasons for this oversight include the signaller's underlying health issues and the prescribed medication he was taking at the time of the incident. In order to determine the likely effects of the signaller's medication on his performance, LUL's occupational health department sought the opinion of a medical specialist with expertise in this area. In parallel, the RAIB commissioned independent advice from an occupational health consultant. Both opinions conclude that the medication being taken by the signaller is 'unlikely' to have caused the overlooking of the position of train 316 when giving train 103 authority to proceed. However, this type of medication can lead to impaired performance[7], with side effects including confusion and impaired concentration, either of which would have impacted on the signaller's performance if they occurred. For this reason, the impact of the medication cannot be ruled out; it is possible that the taking of prescribed medication may have affected the signaller's concentration and judgement. If this did cause him to overlook the presence of train 316, the medication was a causal factor in the incident.

111 The RAIB has analysed the signaller's actual shift pattern against the fatigue and risk index published by the HSE. There is no evidence that the signaller's actual working pattern (paragraph 86) created a risk of fatigue, although this assessment does not evaluate the effects of underlying health issues.

[7] Reference: British National Formulary.

Signaller's communication arrangements

112 At the time of the incident, signallers were reliant on controllers to contact a train operator via radio if they needed to communicate with them. The only alternative was if a train operator initiated a call to the signaller using a signal post telephone (paragraph 79). These arrangements had been in place since the introduction of train radios in the 1980s, and were originally facilitated by the co-location of signallers and controllers as a signaller could attract a controller's attention immediately in an emergency. The controllers were also able to view the signalling diagram.

113 The removal of District Line controllers to Baker Street took place in February 2008, 15 months before Connect Radio equipment was brought into use in Earls Court control room. During the interim period, if a signaller needed to contact a District Line train operator, he first had to telephone the District Line controller with the attendant risk of delay if the controller did not respond promptly. This arrangement did not contribute to the signaller's decision to authorise train 103 to proceed, but it meant that once he had realised his error, it took almost a minute for the message to reach the train operator via the controller who was distracted by a separate incident on a different part of the network.

114 The communication arrangements in place between Earls Court and Baker Street control rooms at the time of the incident did not give the signaller's call adequate priority. This prolonged the period during which the trains 103 and 316 were at risk of collision and was therefore a contributory factor.

Identification of underlying factors[8]

The arrangements for moving train 103 after the SPAD incident

115 Hanger Lane junction was equipped with a signalling system which was designed and installed during the 1950s. This included loose points on the eastbound line, used by trains in the trailing direction.

116 The loose points had a direct influence on the way in which the incident was handled, and in particular the options available to the controller and signaller. Their presence meant that the normal choice between working the train in the wrong direction to move it back behind the signal or securing the points ahead of the train did not apply. Although both options required a station supervisor or duty manager to attend site and would have been time-consuming, either would have secured the safety of the movement.

117 The loose points allowed the signaller to move the train forwards with the only protection provided being the manual stopping of all trains approaching the junction.

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

118 The signaller theoretically had the option of setting signal WM1 to green before authorising the operator of train 103 to re-start his train after the SPAD. This action would have protected the junction as the *interlocking* within the signalling system would have required all other signals approaching the junction to be at red and 9 points set to direct approaching westbound trains towards Ealing Broadway before signal WM1 could be cleared. However, the signaller did not do this for the following reasons:

a. The signaller's training had led him to believe that signals at the junction could 'lock' if a SPAD occurred at either signal WM1 or WM2. This would prevent any trains crossing the junction and cause further delay; and

b. He was aware of a proposed procedure which would allow the signal to be cleared following a SPAD, but which was subject to ongoing discussions between LUL and the trades unions which had not yet been agreed.

119 The relatively long distance (43.6 metres) between the signal and the insulated rail joint also meant that the signalling system did not detect that train 103 had passed signal WM1 at danger. In a modern signalling layout, where the insulated rail joint would be much closer to the signal, the wheels of train 103 may have crossed onto the next track circuit. This would have caused signal WM20/21 to remain at red, and in doing so, would have stopped train 316 on its approach to the junction.

120 The design of the junction and its signalling system allowed the signaller to give train 103 authority to proceed with minimum delay. However, the presence of loose points and the location of train 103 in relation to the position of the rail joint meant that the safety of train 103's movement after the SPAD relied totally on the actions of the signaller (paragraph 91). The design of points and track circuits at this junction was an underlying factor.

LUL Rule Book

121 Rule books 5 and 7 need to be read in conjunction to determine the arrangements for managing a train which has passed a semi-automatic signal at danger. As detailed in table 1, these documents specify the actions for which each party is responsible, but the information is presented in separate sections and there is a lack of cross-referencing to aid the user.

122 Neither rule book addresses the options available to a controller or signaller following a SPAD at a junction signal (paragraph 95), or prompts the need to consider conflicting train movements in the vicinity of junctions. The fragmentation of the rules, and the absence of guidance on how a signaller is to meet the requirement to ensure that it is safe for a train to proceed, were together an underlying factor.

Rule book 5, section 8: 'Passing a semi-automatic signal at danger (manually driven lines') • This section states that 'when it is safe to do so, you must give authority to pass the signal at danger' (paragraph 91), but is vague on how this is to be achieved. It does not otherwise deal with trains which have passed a signal at danger without authority.
Rule book 5, section 10: 'Securing and unsecuring points' • This section refers to spring toggle points and states that they do not need to be secured for movements in the normal direction of travel. However, there is no reference to loose points despite the fact that they are treated in the same way (paragraph 92).
Rule book 7, section 4: 'Signals passed at danger (without authority)' • This section contains a cross-reference to rule book 5 for instructions for passing an automatic signal at danger. The related cross-reference for semi-automatic signals is omitted. • This section does not detail the actions to be taken by the signaller prior to giving a train operator authority to proceed. A cross-reference to rule book 5, section 8 where this information is given is omitted. • A cross-reference to rule book 5, section 2 'working in the wrong direction', required if an incident train is to be returned to the correct side of a signal is omitted. • A cross-reference to rule book 5, section 10 'Securing and unsecuring points', required if an incident train is close to a junction, is omitted.

Table 2: Summary of rule book issues relating to semi-automatic signals passed at danger

Training and assessment of signallers

123 Signallers are subject to annual reassessment to ensure that they are capable of performing their duties. This is done using LUL's competence management system, 'Competence Standards & Guidance for service control', issued in April 2008. Section 3.2 of this document addresses the operation of signalling equipment under degraded conditions and describes the method of assessment as involving 'observation and simulation/desk top carried out away from the workplace mainly during Continuous Development Programme'. However, the course attended by the signaller in August 2008 did not involve simulation or desktop exercises for either degraded working or safety critical communications (paragraph 81).

124 A simulator is used for the training of new staff entering Earls Court control room, but this has not been routinely used for developing or enhancing the skills of existing signallers. The lack of such training denies signallers the opportunity to develop their practical skills except through live incidents. In this instance, an error was made which might have been prevented with enhanced training and the lack of such training is therefore considered to be an underlying factor.

Other factors for consideration

Safety critical communications protocol

125 The train operator used the signal post telephone to communicate with the signaller. Although forming a part of a train operator's annual re-training, he had only occasionally had to use safety critical communications protocol outside of the classroom. This is likely to be the reason why he did not use the phonetic alphabet or repeat the signaller's message back to him to ensure that a clear understanding had been reached. The signaller did not lead the conversation or request that the train operator repeat the message. The RAIB has previously made a recommendation concerning this issue (paragraph 129).

Signaller's post-incident report

126 The signaller's post-incident report was prepared on his behalf by the Piccadilly Line Service Manager. This was for reasons of expediency, as the Service Manager believed that the signaller would be unable to provide this report in a timely manner, and to avoid the signaller having to leave the control desk. At Earls Court, it was normal practice for a signaller to continue working while completing an incident report.

127 The signaller had not reported the near-miss incident to the Service Manager, possibly because he believed that the incident had been averted as train 103 had not moved. As a consequence, the Piccadilly Line Service Manager prepared the post-incident report without having a full understanding of the events, and the report stated that all trains were at a stand before the incident train was given authority to proceed. This was factually incorrect.

128 The situation was compounded by further errors within the post-incident report which are described in table 2. As a consequence, the report was of no practical value in determining what had occurred.

Information within signaller's report	Correct information (underlined)
Westbound train 107 advised that he had passed signal WM1 at danger.	The incident involved eastbound train 103.
I held the station starting signal at North Ealing westbound platform.	This should refer to North Ealing eastbound platform [affecting train 320].
I held train 321 outside of Ealing Common on the eastbound at WM23a.	The signaller held train 326 on the westbound at WM23a.
When all was stationary I authorised train 107 past signal WM1	Train 316 was not stationary when train 103 was authorised past signal WM1

Table 1: Schedule of errors within signaller's post-incident report

Recommendations made within RAIB's report into an incident at High Street Kensington

129 The RAIB has previously published a report[9] into an unauthorised train movement incident which occurred at High Street Kensington on 29 April 2006. Of the recommendations made, the following are relevant to this investigation:

- Recommendation 8, which referred to training in safety critical communications: 'LUL should ensure the instructions necessary for undertaking safety critical communications detailed within the new Rule Book are supported by training, familiarisation and a system of regular monitoring to confirm compliance with the instructions.'

  In response to this recommendation, LUL proposed that this matter be addressed by an ongoing programme to improve safety critical communications, including training and familiarisation. This was to be subject to regular monitoring by line managers, and by LUL's established safety and technical audit programme.

  The Office of Rail Regulation (ORR) accepted this action, and has checked and verified progress through their own sample monitoring. The ORR closed the recommendation in January 2009.

- Recommendation 11, which referred to the breakdown of safety critical communications. 'LUL should ensure that all operational staff are re-briefed about actions to be taken when a breakdown of safety critical communications occurs.'

  In response, LUL proposed that this recommendation could be closed by the implementation of rule book 1 'communications', which establishes safety critical communications protocols. Staff are required to repeat messages to ensure that the message has been understood, and not to carry out an action until that happens. If the communication link is lost for any reason (eg asset failure), alternative means of communication and operational rules are in place to cover such eventualities.

  The ORR accepted this action, and closed the recommendation in March 2008.

[9] All RAIB reports are available at www.raib.gov.uk

Conclusions

Immediate cause

130 The immediate cause of the incident was the signaller giving train 103 the authority to proceed towards Hanger Lane junction before it was safe to do so.

Causal factors

131 Causal factors were:

a. the operator of train 103 passed signal WM1 at danger (paragraph 102); and

b. the signaller did not bring all trains to a halt to protect the junction before giving train 103 authority to proceed (paragraph 108).

132 The signaller was taking prescribed medication and it is possible that it affected his concentration and judgement. If this caused him to overlook the presence of train 316, the medication was also a causal factor (paragraph 110).

Contributory factors

133 Contributory factors were:

a. the signaller was under time pressure when dealing with the incident as it affected both the District and Piccadilly Line services and had the potential to cause extensive delays (paragraph 105);

b. the signaller's workload, as he was operating two control desks during the incident (paragraph 109); and

c. the communication arrangements in place between Earls Court and Baker Street control rooms at the time of the incident, which did not give the signaller's call adequate priority and prolonged the period during which trains 103 and 316 were at risk of collision (paragraph 114. Refer also to paragraph 141).

Underlying factors

134 Underlying factors were:

a. The design of points and track circuits at Hanger Lane junction (paragraph 120);

b. LUL's rules and procedures for incidents involving trains which pass a semi-automatic signal at danger, which were fragmented and did not provide guidance on how a signaller was to meet the requirement to ensure that it was safe for a train to proceed (paragraph 122 and table 1, **recommendation 1**); and

c. LUL's arrangements for maintaining the signaller's skills in managing degraded working, which were insufficient (paragraph 124, **recommendation 2**).

Additional observations[10]

135 LUL's arrangements for developing and maintaining the safety critical communication skills of their staff were insufficient despite action taken in response to an earlier RAIB recommendation (paragraphs 125 and 129, **recommendation 3**).

136 Written guidance on the effects of medication, issued by LUL's occupational health department to assist managers in determining an employee's fitness to work, did not include signalling duties in the list of occupations affected by the medication prescribed to the signaller. This is a clear omission given that staff, whose duties include 'making decisions which can impact on safety', are listed as an affected group (paragraph 83, **recommendation 4**).

137 LUL's medical advisory guidance, in the case of the signaller, did not consider whether it was desirable for a person working restricted hours to be regularly working on rostered rest days (paragraph 85, **recommendation 5**).

138 The existing arrangements for preparing and issuing a signaller's post-incident report did not operate as intended. This was due to the Piccadilly Line Service Manager being unaware of the potential near-miss, as it had not been reported to him, and his confusion over the numbers and directions of the trains involved (paragraph 128 and table 2, **recommendation 6**).

[10] An element discovered as part of the investigation that did not have a direct or indirect effect on the outcome of the incident but does deserve scrutiny.

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

139 LUL has issued staff at Earls Court control room with a briefing note giving generic advice on the actions a signaller should take in the event of a train passing a semi-automatic signal at danger in their area of control (dated 14 May 2009). This includes a reminder to put the appropriate programme machines into push-button (manual) mode, and to ensure that all trains in the area are stopped and will remain so until given permission to move by the signaller. Any unauthorised or unsafe actions are to be reported to the controller or service manager immediately.

140 LUL has also:

a. revised the management of staffing levels within Earls Court and the way in which desks and duties are covered to reduce the likelihood of error inducing conditions;

b. reviewed the use of simulators in training control room staff in incident scenarios;

c. revised the content of the safety critical communications course in light of the lessons learnt from this incident about structuring conversations and the sequencing of instructions;

d. repositioned the insulated rail joint so that it is now 3.5 metres from signal WM1, this work being completed in July 2009; and

e. continued work to finalise a new SPAD procedure, which will allow a signal which has been passed at danger to be cleared before authorising a train to proceed, for implementation from mid-2010 (paragraph 118b).

Actions reported which address causal or contributory factors

141 The Connect Radio system has been fully implemented since this incident, allowing signallers to communicate directly with train operators and to initiate calls. In the light of this action addressing the factor identified in paragraph 133c, the RAIB has decided not to issue a further recommendation.

Recommendations

142 The following safety recommendations are made[11]:

Recommendations to address causal, contributory and underlying factors

1 LUL should formalise guidelines, or other safeguards, to assist signallers when a train passes a signal protecting a junction at danger (paragraph 134b).

The purpose of this recommendation is to provide additional support to signallers after a train has passed a signal at danger and when the signalling system is unable to provide the normal level of protection to trains.

2 LUL should make use of simulation techniques (including simulators) to enable signallers to practise their response in degraded working conditions, including communication with train operators (paragraph 134c).

The purpose of this recommendation is to enhance the ability of staff to deal with out-of-course events.

Recommendations to address other matters observed during the investigation

3 LUL should improve the arrangements for training, rehearsing and auditing the use of safety critical communication skills to reinforce compliance, particularly among occasional users (paragraph 135). This should establish the principle of a defined person having lead responsibility in all safety critical communications.

The purpose of this recommendation is to embed the use of safety critical communications.

continued

[11] Those identified in the recommendations, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail Regulation to enable them to carry out their duties under regulation 12(2) to:

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

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

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

4 LUL's medical advisory service should reissue its guidance to managers to clarify the categories of staff to whom working restrictions apply for specific types of medication (paragraph 136).

The purpose of this recommendation is to improve guidance issued to managers.

5 LUL's medical advisory service, when providing guidance to managers, should consider whether staff subject to medical working time restrictions should be permitted to work anything other than the standard roster for that individual (paragraph 137).

The purpose of this recommendation is to improve the management of staff who are under the supervision of a doctor.

6 LUL should re-brief staff on their procedures to require a post-incident report to be prepared by the person(s) directly involved, and provide staff with the opportunity to do this (paragraph 138).

The purpose of this recommendation is to improve the reporting of basic factual information following an incident.

Appendices

Appendix A - Glossary of abbreviations and acronyms

HSE	Health and Safety Executive
LUL	London Underground Limited
ORR	Office of Rail Regulation
SPAD	Signal passed at danger

Appendix B - Glossary of terms

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

Automatic mode	A colour light signal that changes its aspect automatically based on occupation and clearance of certain track circuits beyond it without intervention by a signaller.*
Connect Radio	A secure radio system (see Connect project)
Connect project	A project to provide a secure radio, voice, data and video system for the London Underground network. At the time of the incident, this project was ongoing and the system was partially implemented.
Controller	Person in overall control of the train service on a line, normally acting from the line's control room.
Fatigue and risk index	An index developed for the Health and Safety Executive. The fatigue element enables the assessment of the cumulative effects of hours worked on an individual's propensity to fatigue. The Risk element represents the relative risk of the occurrence of an incident on a particular shift in comparison with a roster pattern of two day shifts, two night shifts and four days off.
Insulated rail joint (IRJ)	A rail joint, in which one rail is electrically insulated from the abutting rail, which enables the signalling system to detect the position of a train.
Interlocking	On London Underground, an electro-pneumatic machine that provides the controls between points (switches) and signals that prevents conflicting routes from being set.*
Loose points	Points which rely on the wheels of each train to push the point blades into the correct position for the required route. They remain set in that position until a following train moves them if required, and do not provide the signalling system with an indication as to which route is set. A variation in this design is a spring toggle point, which is also operated by the wheels of trains, but with the point blades sprung to one position or the other rather than being allowed to sit at any position between the two.
Powered points	Points powered by a point machine and interlocked with the signalling system.
Programme machine	An electrically operated machine that controls the setting of routes and signals according to a predetermined sequence, timing or trigger conditions based on the timetable.*
Repeater signal	A signal provided on the approach to a main signal to provide an advance warning of the aspect being displayed by the main signal. Usually provided where the reading time of the main signal is sub standard.*

Semi-automatic signal	Running signals (including shunt signals) controlled by a signaller.
Service Manager	Shift manager responsible for signallers or controllers.
Signal post telephone	A telephone located on or near a signal that allows a train operator or other member of staff to communicate only with the controlling signal box.*
Signalling diagram	Electronic diagram indicating the position of trains and status of semi-automatic signals.
Spring toggle	Points that are held in the normal or reverse position by means of a spring and moved between positions by the movement of a train in the trailing direction.
Track circuit	An electrical or electronic device used to detect the absence of a train on a defined section of track using the running rails in an electric circuit.*
Trackernet	A computerised train-tracking system in use on London Underground for train control. This is separate from the signalling system.
Trailing direction	A train movement made through a crossover or turnout moving from crossing to switch toe.*
Train protection system	Protection comprising trackside trainstops and train borne tripcocks. When a signal is at danger and its appropriate trainstop is in the “on” position, the tripcock is mechanically operated which activates the train emergency brake.
Trainstop	A device that ensures compliance with a signal displaying a stop aspect by automatically applying the brakes should the train operator attempt to pass the relevant signal.*
Tripcock	A brake valve mounted on the outside of a vehicle bogie close to track level. The valve has a protruding arm that can be activated by the raised arm of a mechanical trainstop. This trainstop is raised when the associated signal is showing a stop aspect, so that if the train operator attempts to incorrectly pass the signal the brakes will be automatically applied.*
Wrong direction movement person in charge	Person appointed to supervise a wrong direction (ie reverse) movement of a train.

Appendix C - Key standards current at the time

London Underground rule book	Issue 1

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