RAIB
Rail Accident Investigation Branch

Rail Accident Report

Unauthorised train movement at High Street Kensington
29 April 2006

Department for Transport

Report 19/2007
June 2007

This investigation was carried out in accordance with:

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

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Contents

Introduction

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

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

3 Access was freely given by London Underground Ltd (LUL) to their staff, data and records in connection with the investigation.

4 Appendices at the rear of this report contain glossaries:

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

Summary of the report

Key facts about the incident

5 At 23:09 hrs on 29 April, District Line train 73 left Earls Court with approximately 150 passengers on board en route for High Street Kensington. On the approach to High Street Kensington the Train Operator realised that the wrong route had been set and stopped the train. A *wrong direction move* (WDM) was authorised to reverse the train a short distance so that the route could be reset. After considerable delay, when the train reversed it did not stop at the authorised limit; shortly after it was halted by the discharge of *traction current*. After several minutes the traction current was recharged; the train was then authorised by the Service Controller to travel to High Street Kensington where it terminated 67 minutes late.

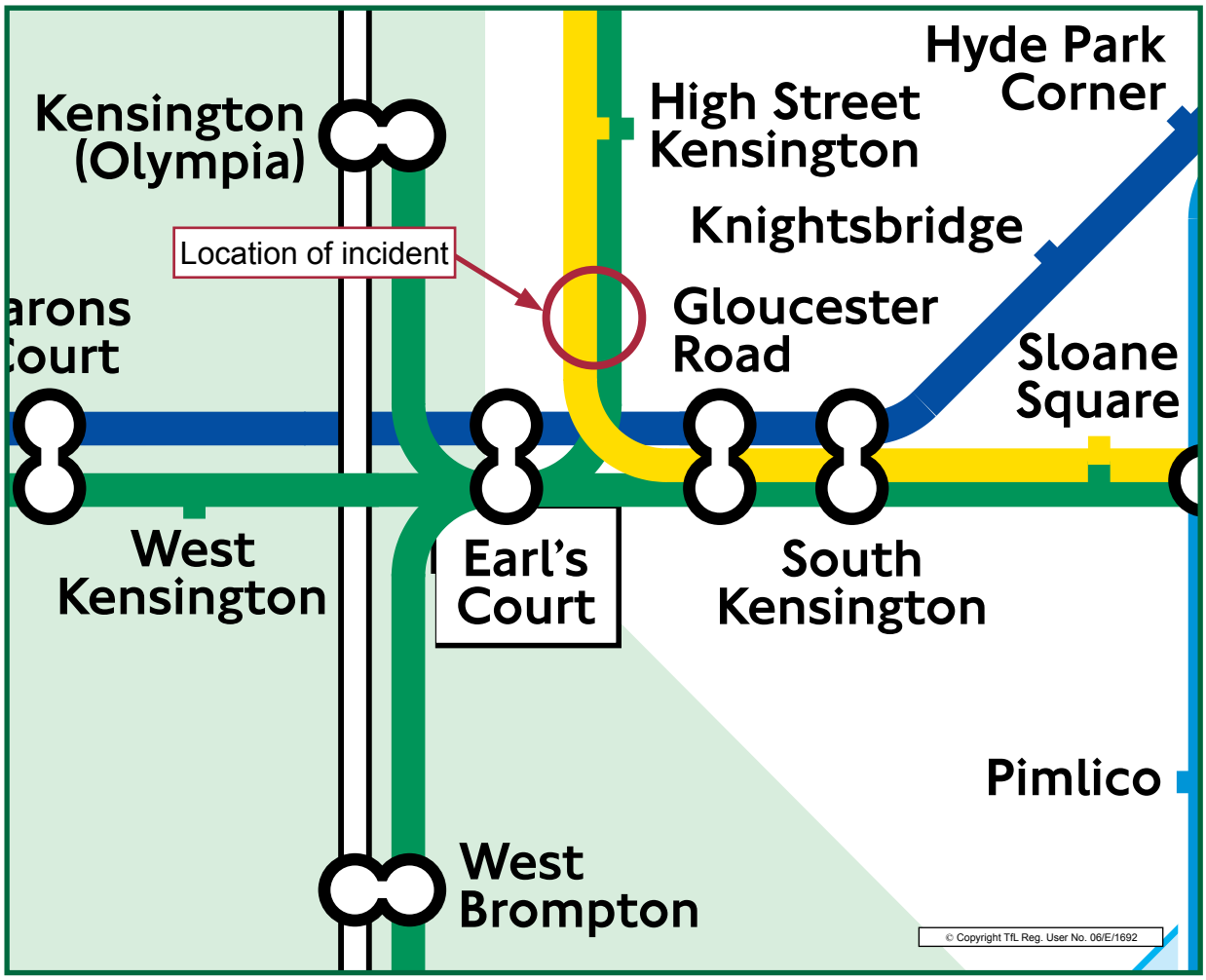

Figure 1: Extract from London Underground map showing location of incident

Immediate cause, causal and contributory factors, underlying causes

Immediate cause

6 The immediate cause of the incident was the failure to correctly locate and identify the position of ED171 signal during a WDM, with the consequence that train 73 did not stop at the authorised limit of the move. Under slightly different circumstances this could have resulted in a collision with another train travelling in the opposite direction. With the protective measures taken during the incident the risk of such a collision was exceedingly low.

Causal and contributory factors

7 Causal factors were:

- Lack of understanding over how the responsibilities of the person-in-charge of the WDM should be undertaken.
- Operating staff were inadequately trained and unfamiliar with the actions they were being asked to undertake. They did not make this lack of knowledge clearly known to others involved in the WDM.
- The poor performance of the train radio system.

8 Contributory factors were:

- The possible incorrect punching of the *programme machine roll*.
- The information obtained from the Train Operator appeared to be in conflict with that displayed on the signalling diagram in the Earls Court control room. With conflicting information, more detailed steps could have been taken to identify the position of train.
- Overall inadequate management of High Street Kensington station as demonstrated by uncharged torches and portable station radio, and inaccessible WDM forms.
- Poor communications protocols and discipline.
- All the correct forms and paperwork were not completed at the time of incident.
- The LUL *Working Reference Manual* has potentially misleading guidance on what actions are to be taken for a WDM.
- A WDM Protector was not appointed at Earls Court as required by the LUL Working Reference Manual.
- The working practices with the control room were poorly disciplined for both the authorisation of the route *release* and the WDM.

Underlying causes

9 Underlying causes were:

- Inadequate managerial supervision of operating practices within Earls Court Control Room and at High Street Kensington station.
- Inadequate managerial understanding of the essential knowledge necessary for staff to carry out their duties, specifically within the Earls Court – High Street Kensington operating area.

Severity of consequences

10 No passenger injuries or fatalities occurred.

11 No damage occurred to trains or infrastructure.

12 One member of staff sustained an injured knee and was absent from work for 8 days as a result of a fall when alighting from the cab of train 73 at the extremity of the WDM.

13 Approximately 150 passengers were subject to 67 minutes delay on train 73. The main saloon lights were lost for 14 minutes when the traction current was discharged. The emergency lights maintained minimum levels of illumination in the cars during this time; however some passenger anxiety was noticed by the LUL staff on board the train who followed procedures about keeping passengers informed. An unknown number of passengers on other trains were also delayed; some of whom also experienced the loss of main saloon lighting.

14 Emergency services attended at High Street Kensington in anticipation that some passengers might need medical attention. This is standard practice for LUL and the emergency services for trains delayed in tunnel sections. It is taken as a precaution against medical effects caused by temperature, humidity or anxiety-induced breathing and circulation difficulties. No medical attention was required.

Recommendations

15 Recommendations can be found in paragraph 168. They relate to the following areas:

- the knowledge base and understanding of operations staff;
- the correct application of the rules;
- a review of the rules to ensure that they are practical and unambiguous;
- undertaking safety critical communications in a suitable manner;
- rapid application of Connect Radio to the LUL Network.

16 Other recommendations, also to be found in paragraph 168, are not directly related to the train movement beyond the authorised limits. They do however focus upon the ability of LUL to operate the railway in a safe and efficient manner. They relate to the following areas:

- use of a person to protect a WDM (the WDM Protector);
- investigation of radio performance after radio related incidents;
- processes for maintaining emergency equipment;
- common methods for storing operational forms at stations.

The Incident

Summary of the incident

17 At 23:09 hrs on 29 April, District Line train 73 comprising six cars of *C stock* left Earls Court with approximately 150 passengers on board. Planned engineering work for that night required the train to terminate in one of the two terminal platforms at High Street Kensington rather than Edgware Road. Figures 2 and 3 show the layout of tracks and positions of platforms and signals. ED23 signal, protecting the diverging junction at High Street Kensington, was showing a green PROCEED aspect. When the train was close to the signal the train operator realised that an incorrect route had been set to the through platform (platform 2) rather than the terminating ones (platforms 3 or 4). The train passed the signal but stopped before the junction. After some difficulties due to poor radio communications, a WDM was authorised to bring the train back to the approach side of ED23. The train moved towards Earls Court but failed to stop at the authorised limit (ED171 signal). It finally stopped when the Service Controller discharged the traction current after the train had passed ED171 signal by approximately 140 m. After some further delay the train moved slowly *eastbound* to terminate, 67 minutes late, in platform 4 at High Street Kensington.

The parties involved

18 The train was operated by LUL. All staff directly involved with the incident were LUL employees.

19 Metronet SSL is contracted to LUL for the maintenance of the train and infrastructure excepting train radio systems.

20 Train radio systems are maintained by Thales under contract to LUL. Radio equipment that is fitted to trains is subject to simple functional tests undertaken by Metronet SSL; failed or suspect equipment is returned to Thales for attention.

21 The following LUL staff were involved in the incident:

- Train Operator – responsible for driving train 73 including door operation. All LUL trains are now operated solely by the Train Operator. No guard was present on the train.
- Service Operator – (elsewhere known as a signalman or signaller) responsible for the signalling and regulation of trains. There are a number of Service Operators, in the Earls Court Control Room, positioned at individual desks and responsible for a specific area of the District and Piccadilly Lines. Automatic programme machines located at the lineside control much of the routine operation of the signals and points. A Service Operator is only required to take direct control when special moves are required or the service is disrupted; at other times they monitor the progress of trains within their control area.
- Service Controller – (previously known as a Line Controller) responsible for controlling the immediate service on a line. There are two Service Controllers in the Earls Court control room; one is responsible for the Piccadilly Line and the other for the District Line. They provide service instructions to the Service Operators and manage calls over the train radio.

- Duty Manager Trains – responsible for managing Train Operators and their working schedules. The Duty Manager Trains at Earls Court is located in a separate office remote from the control room.
- Station Supervisor - Days – directly responsible for the daytime operation of a station and, when required, for managing a number of operational procedures involving trains, including acting as WDM Person-in-Charge.
- Station Supervisor - Nights – as above, but covering night time operation of the station.
- Duty Station Manager – responsible for the immediate operation of a group of stations and, when required, for managing a number of operational procedures involving trains, including acting as WDM Person-in-Charge.
- Service Manager – in overall control of the service provided by each line. The Service Manager at Earls Court is located in an office some distance from the control room.

Location and infrastructure

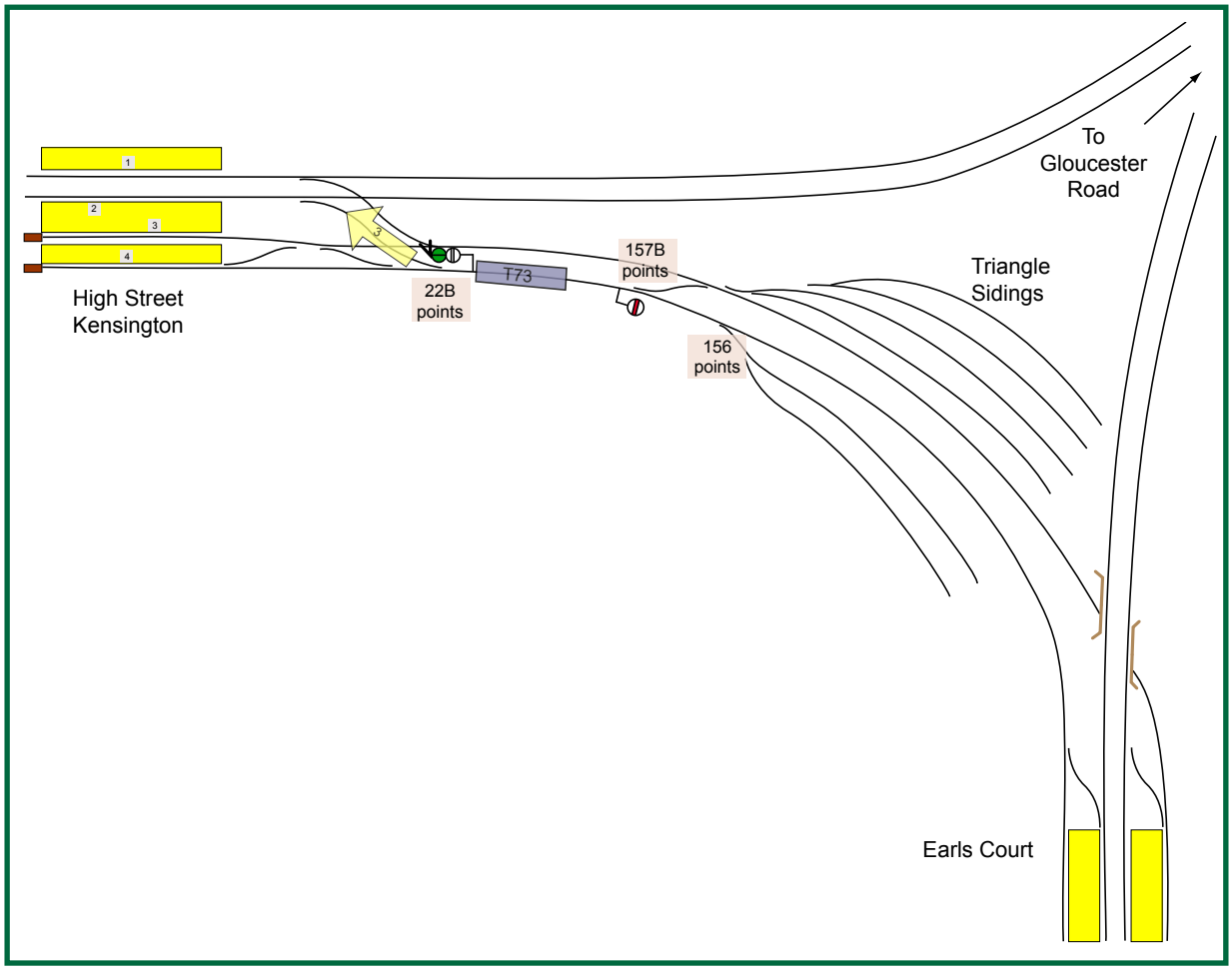

Figure 2: Track diagram of Earls Court to High Street Kensington

22 High Street Kensington, Earls Court and Gloucester Road Stations form the limits of a complex triangular junction between the District and Circle Lines (Figure 2). Stabling sidings, known as Triangle Sidings are provided on both sides of the west curve between Earls Court and High Street Kensington stations. A detailed diagram showing signal positions between Triangle Sidings and High Street Kensington is shown in Figure 3.

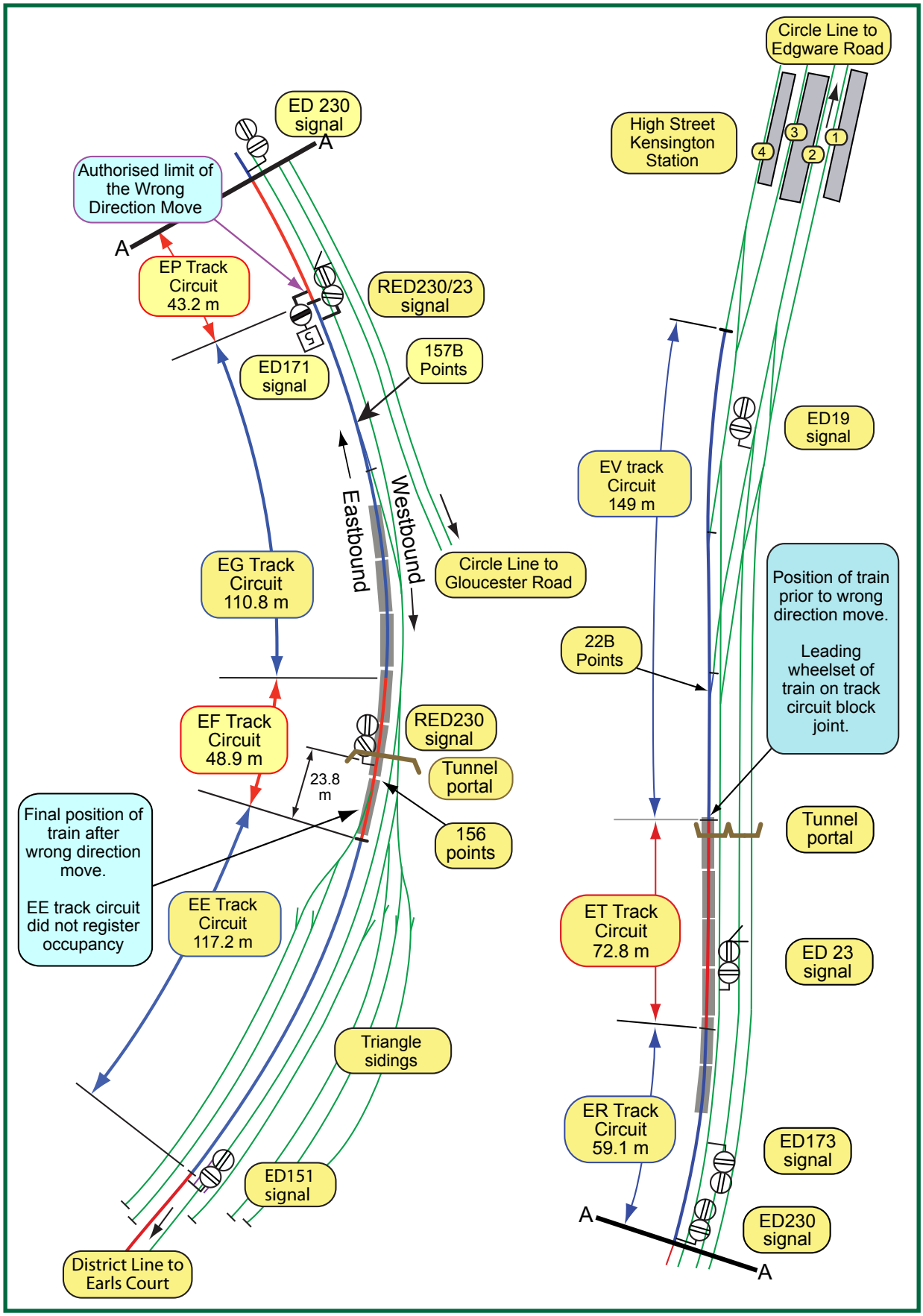

Figure 3: Detailed diagram of track and signal layout between Triangle Sidings and High Street Kensington

23 The train services operating through the triangular junction are complex. All are controlled or monitored by the Service Operator at the Earls Court desk. The trains using the west curve between Earls Court and High Street Kensington stations comprise the following District Line services:

- High Street Kensington to Olympia service via Earls Court;
- Putney Bridge or Wimbledon to Edgware Road; and
- Empty stock moves to and from Triangle Sidings.

Services on other parts of the triangle include:

- Circle Line through Gloucester Road and High Street Kensington (east curve);
- Richmond to Upminster (District Line) via Earls Court and Gloucester Road (south curve);
- Ealing Broadway to Tower Hill (District Line) via Earls Court and Gloucester Road (south curve); and
- Wimbledon to Upminster (District Line) via Earls Court and Gloucester Road (south curve).

24 The speed limit from Earls Court Junction to High Street Kensington is 20 mph (32 km/h), with a 15 mph (24 km/h) limit across the junction to and from High Street Kensington platforms 1 and 2.

The train

25 The Edgware Road to Wimbledon service is operated solely by C stock. On 29 April 2006 *Car* 5524 of train 73 was leading as it left Earls Court.

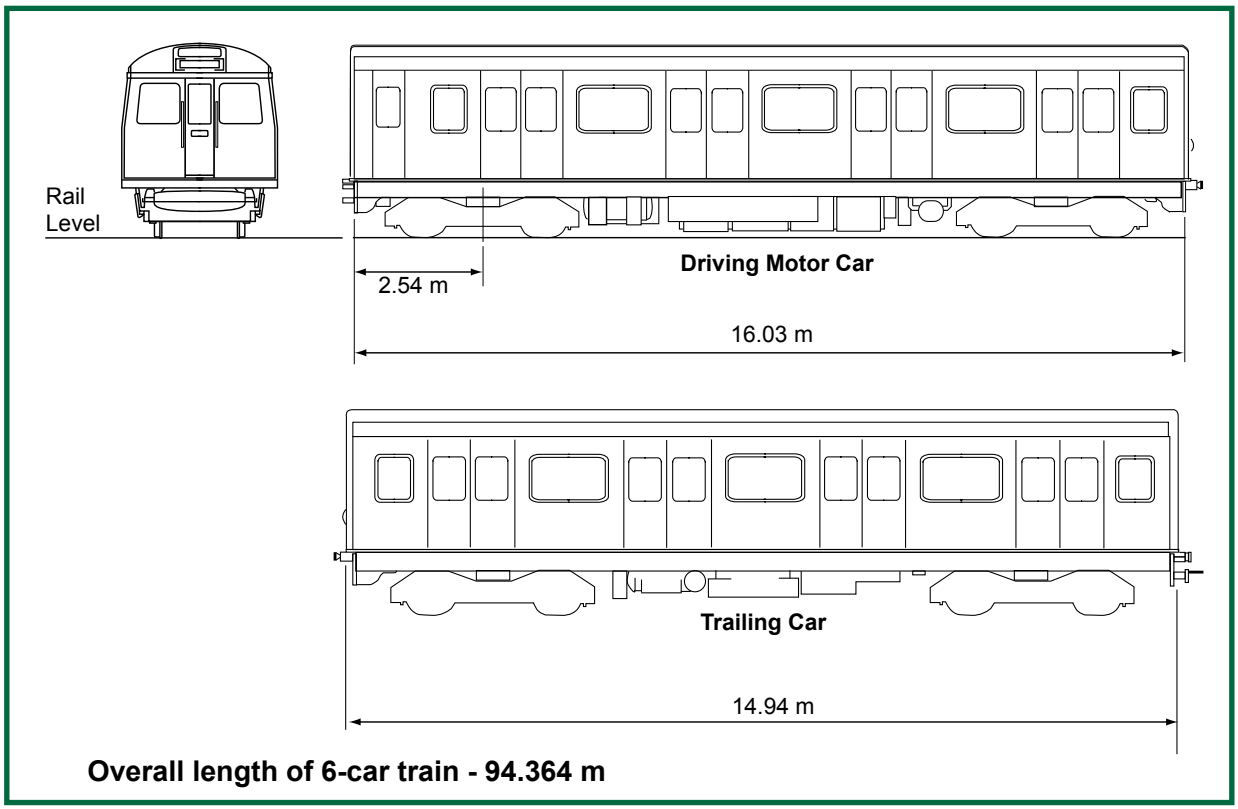

Figure 4: Diagram of C stock

26 The leading ends of all Circle and District Line trains are fitted with a tripcock. This will apply the emergency brake when the tripcock arm hits the raised arm of a trainstop. A trainstop is positioned near each signal that can display a (red) STOP aspect. The train stop arm is lowered when the signal displays a PROCEED (green or yellow) aspect.

Radio system

27 The train radio system was retrofitted to C stock from the late 1980's onwards when changes were made for one person operation. It provides an open system broadcast to all trains, with a 'closed' communication channel enabled when the transmit button is pressed in the train cab. All trains can thus hear broadcast messages from the control room but only the Service Controller can hear the response from a particular train when the 'closed' communication channel is being used.

28 The radio system does have a number of performance limitations in comparison with more modern systems; however, it normally operates in an adequate manner. Radio traffic has increased significantly in recent times; this has caused a reduction in the ability to communicate with trains without delay. A new system, known as Connect Radio, is being introduced on the District Line.

29 A number of poor reception areas are known to exist; however, the location where train 73 stopped is not known for this. Normally no trains would stop there and hence communication difficulties may have gone unnoticed.

30 The train radio unit is mounted on the left hand side of the drivers' cab between the sliding cab door and windscreen. It is fitted with a telephone style handset and an internal broadcast loudspeaker. The loudspeaker is muted when the handset is being used.

31 In the control room the radio system and its handset is located on the Service Controller's desk; it does not connect directly to the Service Operator's desk. The Service Controller is thus the only person in direct communication with Train Operator's train radio.

32 Train radio equipment receives a regular, but simple functional check in the train maintenance depot. This does not confirm that the radio is working to full specification but simply that it is functioning at the location and time of test. The LUL Working Reference Manual requires that the radio is able to receive and send messages prior to each train entering service. *Base stations* and communications links to the control room are subject to similar regular functional checks. These actions are adequate to confirm that the train radio system is working; however they do not confirm that communications are fully available over the whole network.

Telephones

33 A *signal post telephone* (SPT) is provided at most *controlled signals*. In tunnel sections they are sometimes positioned high up on the tunnel wall to avoid the Train Operator leaving the cab. The SPT for ED171 signal is mounted near ground level between the eastbound and westbound tracks. The SPT for ED23 is mounted at ground level behind the signal in a grey box (see Figure 9).

34 SPTs and the LUL *auto telephone* system connect to the Service Operator via a *telephone concentrator* located on the Service Operator's desk.

35 Train Operators are not prohibited from carrying personal mobile phones, although they are required to be switched off during their normal duties. During this incident the availability of the Train Operator's and Duty Station Manager's mobile phones provided an alternative means of communication when the radio system ceased to function adequately.

Earls Court Control Room

36 Earls Court Control Room is jointly occupied by District and Piccadilly Line operating staff. Each Service Operator controls train movements using button route setting controls dating from the 1960's. Illuminated signalling diagrams of the District and Piccadilly lines are provided on the curved wall in front of the eight Service Operators. Train numbers, which keep in sequence with train *berth* occupancy, are indicated on this diagram.

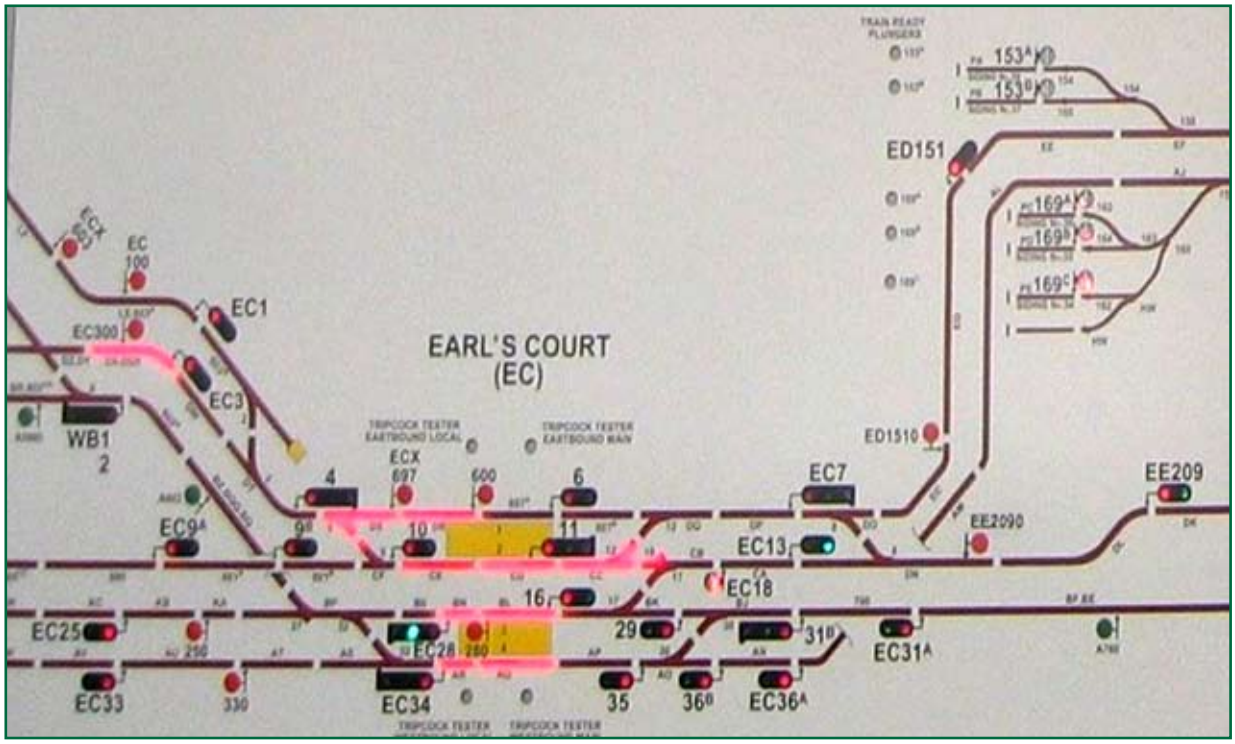

Figure 5: Part of Earls Court District Line illuminated signalling diagram

37 Each Service Operator has a specific length of line to manage. The Service Controller provides an oversight of operations on the line and instructs the Service Operator on specific actions to be taken.

38 A Service Operator only needs to intervene when service regulation, out of sequence running, turn-backs or other disruptions need to be managed. The Service Operator then takes over manual route setting of trains from automatic programme machines (see paragraph 42). Manual route setting is controlled by means of buttons on the Service Operator's desk.

39 The Earls Court – High Street Kensington – Gloucester Road triangular junction regularly requires manual control when service disruption occurs, eg due to trains arriving out of sequence, running late or requiring a change of destination.

40 Communication between the Service Controller and Service Operator is either by telephone (which is fitted with a voice recorder) or by speaking directly between the two desks (known as 'calling over' messages). The latter is not a formally authorised method but occurs regularly, especially at times of high activity. Such messages are not recorded, furthermore all staff in the room can overhear, which may cause distraction from, or confusion with their own duties.

41 Space in Earls Court control room is limited and staff work in conditions that would not meet current design standards. Monitoring of the passage of trains and route setting is more labour intensive than for later installations that have the benefit of computer based technology with enhanced capabilities over *programme machine* operation. Noise levels are relatively high. The room has been scheduled for rebuilding or re-equipping for several decades; however, concerns over disturbing asbestos insulation whilst maintaining operational capability have delayed building improvements.

Signalling

42 Route setting is normally undertaken by programme machines located in lineside signal equipment rooms. Unless overridden by the buttons on the Service Operator's desk, they provide the electrical commands to the *interlocking* (see paragraph 46). They operate using punched rolls of plastic 9 inches (228.6 mm) wide. Lines of punched holes are coded to describe the train number, destination, route, and if required, time due. Each programme machine roll (see Figure 6) carries the complete timetable for the day at the junction concerned. Contact fingers detect the holes and activate the appropriate control circuits in a similar way to the operation of a push button on the control desk. The plastic roll is unwound in steps by each train passing through the junction; at the end of the day it is rewound to the beginning.

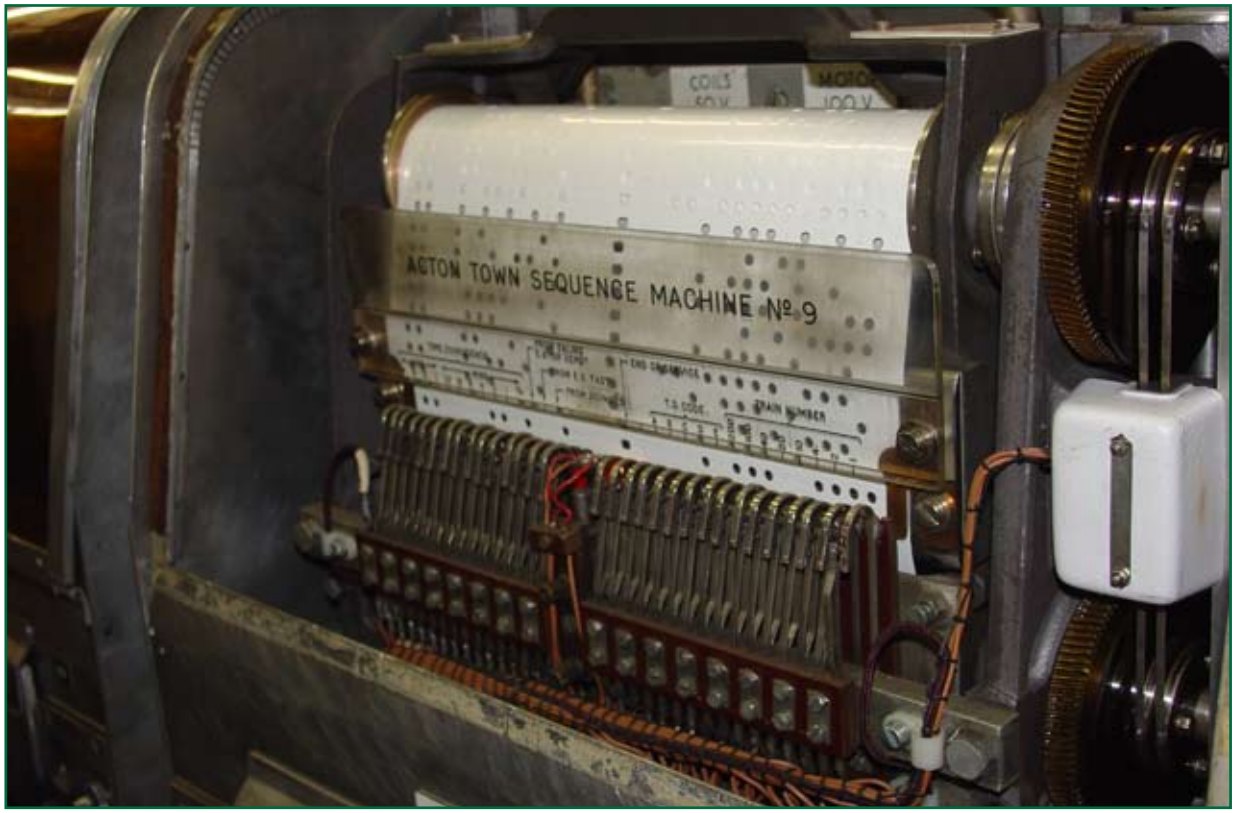

Figure 6: LUL Programme machine (This is a stock photograph of a similar machine at Acton Town)

43 Programme machines can operate in one of two modes; as 'sequence machines' when the setting of routes is dependant upon a prescribed sequence as each train arrives at a junction control or as a 'time machine' when the departure of trains is regulated on a time basis. This incident involves the High Street Kensington programme machine operating as sequence machine.

44 A *train describer* identifies the train number code (sometimes called the train description) which is then compared with the number code for the current step of the programme machine. If they agree, ie they are 'in *correspondence*', the required train routing actions are performed. If they do not agree, ie they are 'out of correspondence', then an alarm is raised on the Service Operator's control desk. If an out of correspondence alarm is raised the Service Operator may choose to allow the train description to set the route immediately, or allow the programme machine to determine the route, or require the route to be set manually.

45 Timetable changes can be implemented either by issuing instructions to the Service Operator to manually set the required route, or for longer lasting changes, by producing a new programme machine roll. Rolls are often changed to accommodate engineering works that repeat over a period of time. The machine has no automatic means to identify that the correct roll is being used; however the use of an incorrect roll will be detected by the Service Operator receiving a series of out of correspondence alarms as unexpected trains arrive.

46 The Westinghouse style V interlocking machines are located in Interlocking Machine Rooms (IMRs) placed strategically around the junction. Each has a unique identification assigned to them, eg 'ED' or EE'. 'ED' IMRs are located at the south end of High Street Kensington inner rail platform 1 and at the northeast side of Triangle Sidings. 'EE' IMR is located to the north west of Gloucester Road and 'EC' IMR at the west end of Earls Court. The naming of controlled signals directly relates to the IMR that controls them, eg ED171 is controlled from 'ED' IMR. The interlocking machines operate by compressed air in accordance with the standard practice of LUL. Fully automatic signals do not necessarily conform to this convention.

47 Traditional *ac capacitor fed single rail track circuits* with *insulated block joints* (IBJs) are used for train detection throughout the area. The *two-aspect colour light signals* use incandescent bulbs. (Figure 3 is a scale diagram showing the relationship of the signals, track circuits and track. It shows the position of train 73 prior to, and at the extremity of the wrong direction movement.)

Figure 7: Signal RED230

Figure 8: Signal RED230/23

Figure 9: Signal ED230

Figure 10: Signal ED23 showing route to Circle Line Platform 2

Figure 11: Signal ED23 showing route to terminal Platform 3

Figure 12: Signal ED171

48 For a train travelling from Earls Court towards High Street Kensington, the first *main signal* encountered is ED1510, mounted to the left side of the track. This is followed by ED151 mounted to the right.

49 The following signal is RED230 (yellow – green aspects) (see Figure 7) mounted to the left of the train on the tunnel headwall at the exit to Triangle Sidings. It is a repeater signal that gives advance warning of the aspect being displayed by ED230. It is not fitted with a *trainstop*.

50 The next signal is RED230/23 (yellow – green aspects) (see Figure 8) mounted to the right of the train near ground level. It is fitted with an *arbour lights* junction indicator that indicates the route set at High Street Kensington. Three horizontal white lights are displayed for the route to platform 2, three lights at 45º for the route to platform 3, and no lights illuminated for the route to platform 4 (see Figure 13 for the similar arbour lights route indicator fitted to ED23). This signal is a repeater for ED230 and ED23; it gives advance warning of the aspect being displayed by both these signals. It is not fitted with a trainstop.

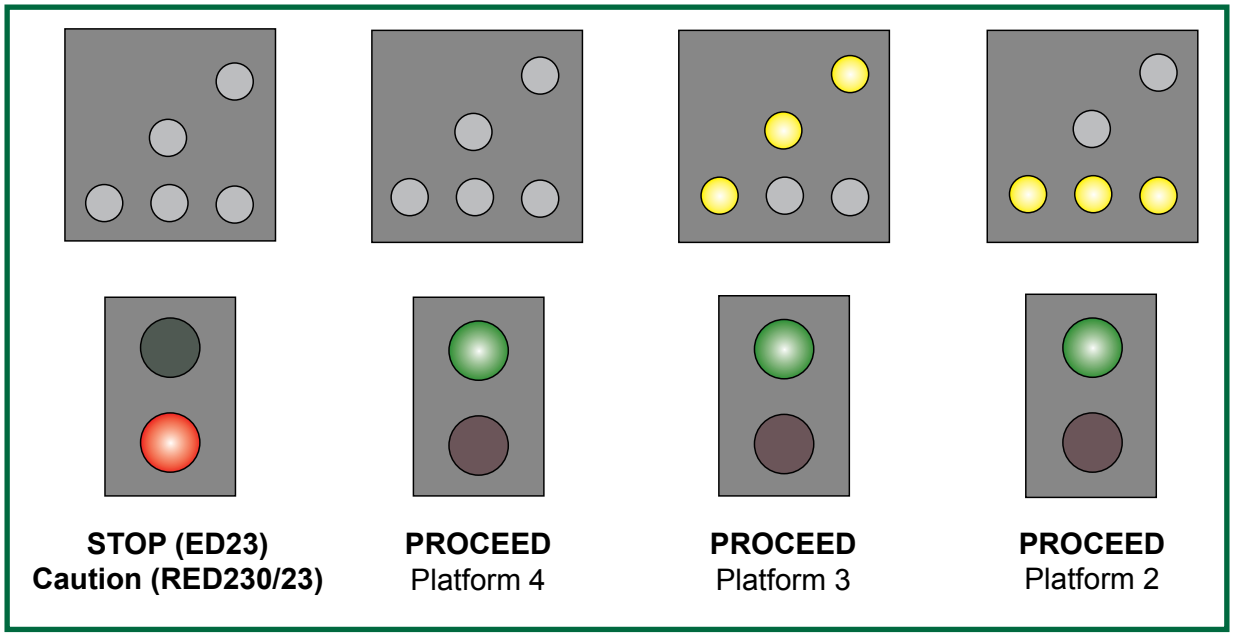

Figure 13: Routes applicable to the arbour lights junction indicators on signals ED23 and RED230/23 (Note: when at Caution, RED230/23 shows a yellow lower aspect)

51 ED230 is the first stop signal encountered after Triangle Sidings. It is followed by ED23 (Figures 10 and 11) which acts as the *outer home signal* for High Street Kensington station; it also protects the facing junction for the terminal or through platforms. It is mounted near ground level in the *6 foot* and is thus on the right hand side of the driving cab, it is fitted with an arbour lights junction indicator (see Figure 13) and has an associated train stop.

52 Facing in the opposite direction to the above three signals is ED171 (See Figure 11). This is a halogen lamp, fibre optic shunt signal. Unlike the main signals described above it does not show a red STOP, or green PROCEED aspect; instead it displays a horizontal red bar for STOP, and a 45º red inclined bar for PROCEED. The illumination projected from the face is brighter than other signals in the area. It controls movements from the eastbound track back into Triangle Sidings. It has a train stop fitted and is mounted near ground level next to the right hand side tunnel wall. It is therefore remote from the left hand driving position in the train cab.

Events preceding the incident

53 The Train Operator for train 73 started his duty on 29 April 2006 at 16:46 hrs with a planned finish time of 01:07 hrs. The meal break was between 20:30 hrs and 21:30 hrs. The day before, 28 April, a similar duty between 16:03 hrs and 00:33 hrs was worked, with rest days for the two previous days.

54 Train 73 commenced its journey at Wimbledon. On the trip eastbound, three trespassers had run in front of the train near Putney Bridge; the Train Operator had subsequently spoken briefly to constables from the British Transport Police. The Train Operator was shaken by the incident and spoke to the Duty Manager Trains at Earls Court about being relieved. He declared himself fit to continue driving the train but with the understanding that he would review the situation when he reached High Street Kensington.

55 A programme machine roll change was required to accommodate the regular planned engineering works for Saturday nights. This change affected the whole passenger service to / from Edgware Road from Saturday 29 April 2006 to Monday 1 May 2006. The correct punched holes on the programme machine roll would have set up the route for train 73 to reverse at High Street Kensington. This did not happen. The roll in use on the day of the incident set up the route for train 73 to terminate at Edgware Road.

56 Prior to the incident the Service Operator had worked 15:00 hrs to 23:00 hrs 23 – 26 April, followed by two rest days. On the 29 April the Service Operator had booked on at the prescribed time at 23:00 hrs and received handover advice about the state of the service from the outgoing operator. He then became engaged in managing the train service. He set the High Street Kensington area to operate normally under programme machine control. Immediately before the incident he was engaged upon signalling activities elsewhere within his control area.

57 Immediately before the incident, the Service Controller was engaged upon a number of tasks, including radio communications with two other trains. There was considerable background noise level in the control room from a number of internal control room radio and telephone conversations.

External circumstances

58 The train service on the District Line was significantly disrupted just before the incident. There was late running, trains cancelled and *short working*. Station staff were also dealing with large crowds from a concert in the Earls Court area which resulted in a number of telephone calls to the control room regarding the disrupted train services. All control room staff concerned with the District line service were experiencing an intense level of work and concentration.

Events during the incident

59 At approximately 23:07 hrs, following some passenger enquiries to the Train Operator at Earls Court station, train 73 departed for High Street Kensington. It was routed past signals ED1510, ED151, RED230, RED230/23 and ED230 on the west curve. It obeyed the 20 mph (32 km/h) speed limit over this section of line. All signals showed a PROCEED aspect. The following signal, ED23, also showed a green PROCEED aspect with route 3, for platform 2, indicated on the arbour lights route indicator. The position indications for the route indicator are shown in Figures 10, 11 and 13. A tabulation of the subsequent event chain is listed in paragraph 160..

60 On the approach to ED23 the Train Operator did not immediately recognise that an incorrect route had been set to the through platform. The correct route would have directed the train along route 1 (platform 4) or route 2 (platform 3). Both these routes lead to terminal platforms.

61 No alarm was raised within the Earls Court control room to notify an incorrectly set route because the programme machine had set the route required by its timetable roll. It was nevertheless an incorrect route for train 73. The Service Operator did not notice the incorrect route on the diagram and thus had no reason to override the automatic route setting.

62 On passing ED23 the Train Operator applied service brake step 1 and brought the train to a stand approximately three to four car lengths (46 m to 62 m) beyond the signal. In this position the train was between 16 m and 32 m away from the switch blades of 22B points. The IBJ between ET and EV track circuits is situated at 52.4 m beyond ED23 (Figure 3).

63 The Train Operator then attempted to contact the Service Controller by train radio to report that the train had taken the wrong route but that it was clear of the junction points. He expected the Service Controller to instruct him to either continue to Edgware Road, or more likely, to undertake a rapid reversal in platform 2. He did not expect that the route would be reset into platform 3 or 4. The radio link did not function well; although the Service Controller was able to hear some of what the Train Operator was saying, the Train Operator was unable to hear the Service Controller. In spite of these difficulties, the Service Controller understood that the train had approached ED23 signal with the incorrect route set.

64 From the *signalling diagram* indications the Service Controller was aware that Circle Line train 204 was approaching High Street Kensington from Gloucester Road. This would need to be routed through platform 2. If a platform 2 reversal for train 73 was permitted, the Circle Line train would be held at ED20 signal until platform 2 was clear. This could take several minutes as it would involve all passengers being detrained, the Train Operator changing ends and then reversing the train clear of the platform and junction.

65 Initially the diagram showed that train 73 had not passed ED23. This indication reflected the condition of track circuits; EP, ER and ET that were occupied, whilst EV was clear (Figure 3). A decision was made in the control room that the Service Operator should take a release for the route currently set for train 73. After the mandatory time delay for the route release, train 73 would be able to enter one of the bay platforms and train 204 would be able to use platform 2. They would only experience the minimum of delay.

66 Taking the release involved the Service Operator operating a control that replaced all signals in the immediate area to a STOP (red) indication. Routes could not then be set or signals cleared until a fixed time of two minutes had elapsed; this ensured that all trains in the affected area had stopped moving. The time can not be overridden by the Service Operator or Service Controller.

67 Exactly how the decision for a route release was agreed is uncertain; there is conflicting evidence about this issue. The appropriate paperwork was not completed at the time of authorisation.

68 The signalling diagram indicated to those in the control room that train 73 had not passed ED23 signal thus permitting a route release to be taken. Neither the Service Operator nor the Service Controller knew that ET *track circuit* continued for approximately 52 m beyond the signal.

69 At approximately 23:10 hrs the Service Controller tried to advise the Train Operator that a release would be taken and that the train was to remain where it was; the correct route would be set after the release had timed out. This message was not received by the Train Operator. The Service Operator initiated the route release and, knowing that no routes could be set for two minutes, diverted his attention to signalling matters elsewhere within his control area.

70 Shortly after the release had been initiated, EV track circuit became occupied (Figure 3), changing the diagram indication. This led control room staff to believe that train 73 had moved and that a signal passed at danger (SPAD) event had occurred. Radio communications with the train remained at a very poor quality with no messages being received by the Train Operator (see paragraphs 27 – 32).

71 At approximately 23:15 hrs the Service Controller arranged for the Station Supervisor – Days at High Street Kensington to report to the Service Operator where train was located. The Station Supervisor – Days walked to the end of platforms 2 / 3 and located the leading car standing just clear of the tunnel mouth and fully clear of the junction. It was a significant distance from the *home signal* ED19 at the entry to platform 2 (Figure 3).

72 Shortly afterwards the Station Supervisor – Days reported the position of the train to the Service Controller using the station supervisor's office telephone. The Service Controller then asked the Station Supervisor – Days to assist in setting up a Wrong Direction Move (WDM) for train 73 in order to position it on the approach side of ED23 signal.

73 There is conflicting evidence on how the WDM was authorised, however the Service Operator and Service Controller did agree that it should occur. No records of this authorisation were made at the time.

74 Concurrent with the activities involving the Station Supervisor - Days, the Train Operator contacted the Duty Manager Trains at Earls Court to ask for instructions about what he should do. A communication link was then set up using the Train Operator's personal mobile telephone and the Service Controller's desk phone. The Train Operator affirmed that the train had not moved, that ED23 signal had showed a green PROCEED aspect, and that a SPAD had not occurred.

75 The Station Supervisor – Days then began to collect the equipment necessary for supervising a WDM; a lamp, a *station train radio*, a station radio and a portable phone. He also tried to find, without success, a WDM form. Before he had everything he received a further telephone call from the Service Controller asking him to stand down because a Duty Station Manager would be undertaking the management of the WDM.

76 After replacing the equipment the Station Supervisor – Days received a further call from the Service Controller advising him that no Duty Station Manager could be found and that he (the Station Supervisor - Days) was to supervise the WDM. After collecting the equipment and a further unsuccessful search for the WDM form, the Station Supervisor – Days walked along the track from the end of platform 4. Radio communication between the Station Supervisor – Days and the Service Controller was then lost.

77 After the Service Controller had advised the Station Supervisor – Days that no Duty Station Manager could be found, the Service Manager at Earls Court decided to despatch the Earls Court Duty Station Manager to High Street Kensington. The Duty Station Manager travelled to High Street Kensington by taxi arriving at about 23:25 hrs.

78 When the Station Supervisor – Days arrived at the train he spoke to the Train Operator who advised him that ED23 signal was not showing a red aspect when the train passed it and that he did not understand why a WDM was needed. The Station Supervisor – Days asked the Train Operator to talk to the Service Controller, but this was not possible because the train radio was still not functioning adequately.

79 The Station Supervisor – Days then tried to use the station train radio but this did not work because of flat batteries. The portable phone also did not work because the location of the train was too far away from the base station. The station radio was able to provide a poor communication link; but only to station staff. Eventually the Station Supervisor – Days spoke to the Service Controller using the Train Operator's personal mobile phone. The Service Controller asked the Station Supervisor – Days to contact the Service Operator regarding the instructions for completing the WDM form and to make contact using a SPT; one would be located on the tunnel wall near the front of the train. The Station Supervisor – Days had never used an SPT before, but agreed to follow this instruction.

80 The Station Supervisor – Days then walked back along the track between the tunnel wall and the train but was unable to find an SPT for ED23 signal. Unknown to the Station Supervisor – Days this telephone is mounted in the 6 foot behind ED23 signal. The Station Supervisor – Days eventually located an SPT on ED173 signal located near to the rear of the train.

81 ED173 is mounted to the left hand side of westbound tracks. Upon arrival at the signal the batteries in the Station Supervisor - Days' lamp failed. He was left with no means of communication and standing in the dark. The only illumination was provided by the lights of the train. The nearest rail was the positive conductor rail charged at 630 volts. Fortunately he managed to return to the train without mishap and advised the Train Operator what had happened.

82 The Station Supervisor – Days then received a call from the Station Supervisor – Nights confirming that the Station Supervisor – Nights was at High Street Kensington with the Duty Station Manager from Earls Court; the Duty Station Manager would walk to the train with a replacement lamp and radio equipment and then act as the WDM person-in-charge. Before the Duty Station Manager left the platform, the Duty Station Manager advised the Station Supervisor – Nights that he would not be involved in the WDM.

83 When Duty Station Manager arrived at train he initially spoke to the Train Operator and told him that a WDM was to be performed. The Train Operator stated that a SPAD had not occurred and that a WDM was not necessary. The Duty Station Manager and the Station Supervisor – Days then climbed into the cab and began to carry out the WDM procedures as instructed by the Service Controller. This included arranging for the *tripcock* to be *cut out* at both ends of the train (LUL Reference Manual Fe100 and Fe300d).

84 The Duty Station Manager used his mobile phone to contact the Service Operator who confirmed the WDM details; these were to 'move back to ED171, to change ends and to accept ED23 clear'. The Duty Station Manager did not have any WDM forms and wrote the WDM instruction on the cover of the *Traffic Circular*: 'Train – 73 authorise to ED171 remain ED23 accept clear' (Figure 14). He gave this to the Train Operator with a verbal instruction to reverse the train such that the driving cab was behind ED171. The Duty Station Manager asked the Train Operator if he knew where ED171 signal was located and received an affirmative reply; however, none of the Train Operator, Duty Station Manager or Station Supervisor – Days really knew to which signal the number ED171 referred. The Duty Station Manager then contacted the Service Operator by mobile phone and confirmed that the train was moving.

85 The train then proceeded at slow speed towards Earls Court with the Train Operator, Duty Station Manager and Station Supervisor – Days in the leading end cab. The Service Operator noticed that the diagram showed that the section associated with EV track circuit (Figure 3) beyond ED23 had cleared, indicating movement of the train in the authorised direction.

86 The Train Operator continued to drive the train up to and past ED171 which was displaying a STOP aspect. The Train Operator did not advise the Duty Station Manager about the approach to this shunt signal. The train was not *tripped* at the signal because the tripcock had been cut out (see paragraph 113). There is conflicting information about what recognition those in the cab had of this signal. The Duty Station Manager, as the person-in-charge of the WDM, did not instruct the Train Operator to stop the train.

87 The Service Operator noticed that the signalling diagram showed that further sections of line had progressively cleared, indicating that the train was proceeding beyond the authorised limit of the WDM. The Service Operator made the Service Controller aware of this development who immediately discharged traction current.

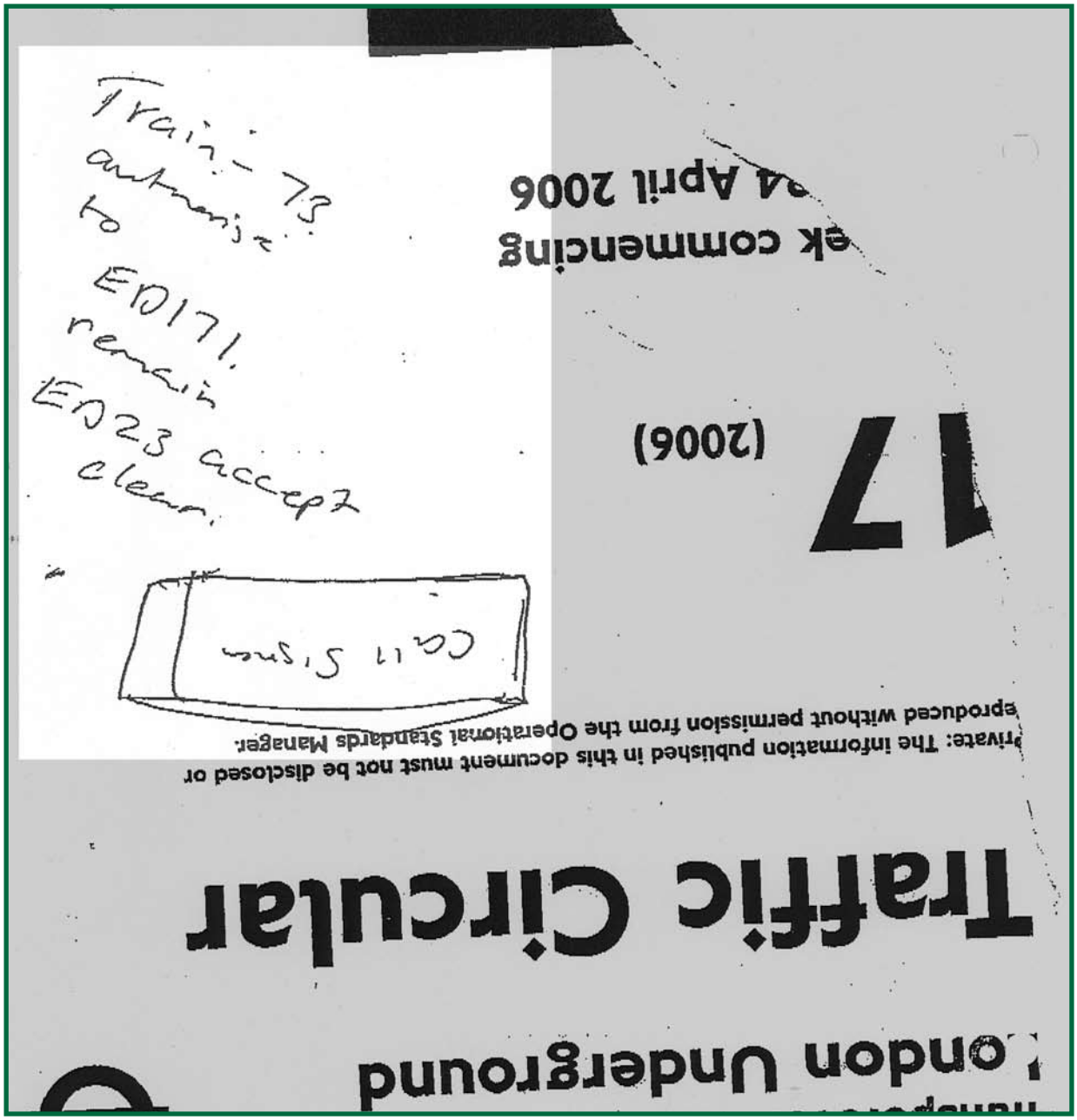

Figure 14: Front cover of traffic circular with instruction for WDM (highlighted)

88 Following the *discharge* of traction current the train came to a stand. During a telephone conversation between the Duty Station Manager and the Service Controller about where the train was located, the Duty Station Manager requested that the Station Supervisor – Days identify the signal that had just been passed. The Station Supervisor – Days climbed out of the cab but fell approximately 4 feet (1.2 m) to the ground, injuring his right knee in the process. He managed to walk the short distance and identified the signal as RED230. This information was relayed back to the Service Controller.

89 After a short period the traction current was recharged. The Duty Station Manager was authorised by the Service Controller to allow the train to move back to ED23. The Train Operator moved to the cab at the High Street Kensington end of the train, accompanied by the Duty Station Manager and Station Supervisor – Days. The Duty Station Manager advised the Service Controller that the train was ready to move and instructed the Train Operator to move up to ED23. The train started to move forward but then stopped. The Train Operator returned to the other cab and reset the rear tripcock after which movement towards ED23 was again attempted. Again the train was brought to a halt followed by a further tripcock reset at the rear of the train by the Train Operator. At the third attempt the train successfully drew up to ED23. The train remained at the signal for a short period after the signal changed to a green PROCEED aspect before it continued to platform 4 at High Street Kensington where passengers were detrained at 00:41 hrs.

Consequences of the incident

90 The most significant consequence of the incident was the knee injury sustained by the Station Supervisor – Days that resulted in 8 days off work

91 The only other consequence of the incident was the delay caused to passengers on train 73 and elsewhere.

92 Although ambulances were called to High Street Kensington, in compliance with LUL standard practices, no passengers required medical attention.

Events following the incident

93 The radio equipment fitted to train 73 and at the base station functioned correctly after the incident; they were not subject to special testing.

94 The functionality of the signalling equipment was checked and the signals and block joints inspected. No defects were found.

The Investigation

Investigation process

95 The RAIB received notification of the incident eleven hours after the incident had occurred. This was contrary to the Railways (Accident Investigation and Reporting) Regulations 2005 which require immediate notification of events that might, in slightly different circumstances, have resulted in a collision.

96 The RAIB undertook an examination of the block joint on EV track circuit and the signal sighting for RED230, RE230/23, ED230, ED23 and ED171 signals. Cab riding was undertaken on a number of trains between Earls Court and High Street Kensington in both directions.

97 LUL provided copies of the voice tapes for the period leading up to and during the incident. These voice tapes played the major part in establishing the events that happened during the incident.

98 The RAIB undertook interviews with key staff. Due to sickness and holiday absence some of these took place a considerable time after the incident.

99 LUL information was reviewed relating to:

- the signalling system and track layout;
- operation of the area from the Earls Court control room;
- train data;
- training processes; and
- information gathered by the LUL investigation.

Previous occurrences of a similar character

100 WDMs are a feature of LUL operations; however they are not common at any location. Mostly they occur on sections of line that do not involve complex junctions or multiple sidings. Many WDMs are carried out to reverse trains in tunnel sections of the LUL network and permit passenger unloading after a service blockage. It is very rare for any incident to occur from a WDM.

101 The RAIB has not been able to find evidence of a similar prior event in the Earls Court or High Street Kensington areas.

Analysis

Identification of the immediate cause

102 The immediate cause of the incident was the failure by the person-in-charge of the WDM to correctly locate and identify the position of ED171 signal and to stop the train at it, The Train Operator also failed to identify ED171 and proceeded past a signal displaying a STOP aspect. The consequence was that train 73 did not stop at the authorised limit of the move. Under slightly different circumstances this could have resulted in a collision with another train travelling in the opposite direction. With the protective measures taken during the incident the risk of such a collision was exceedingly low.

Identification of causal and contributory factors

Condition of the train

103 With the exception of the poor performance of the train radio system (see paragraph 63) there were no faults with the train that could have affected what happened. The condition and maintenance of the train are thus not considered to have contributed to the incident.

Operation of the train

104 The train was being driven correctly and in accordance with speed limits until the time that the train passed ED23.

105 The first junction indicator that the train passed is fitted to RED230/23 signal (Figure 8) a short distance inside the tunnel beyond Triangle Sidings. This displayed three horizontal lights indicating that the route was set for platform 2. Although the Train Operator knew that the train was booked to terminate at High Street Kensington a possible scenario why the route indication did not register with him was the train's normal destination being to Edgware Road and the green PROCEED aspect being displayed. The low line speed of 20 mph (32 km/h) on the approach to High Street Kensington meant that there would be adequate time to brake for ED23 when it was first sighted. There is also a slight possibility that the indicator could have been mistaken for the three lights inclined at 45º indicating the correct route for platform 3. Similar route indications would have been received on ED23 signal. No firm evidence exists why the Train Operator failed to respond to these incorrect route indications.

106 There is no evidence that the Train Operator was distracted or disturbed by earlier events at Putney Bridge on the original approach to ED23 signal. It was only when the train was very close to ED23 signal, and the junction, that the Train Operator recognised and reacted to the incorrectly set route.

107 No evidence has come to light that shift patterns, fatigue, health issues or personal circumstances had any bearing on this incident (see paragraphs 53 and 56).

Condition of the track

108 No defects were found with any part of the track that could have had a bearing on the incident.

109 No defect was found with the IBJ between EV and ET track circuits. An electrical connection across the joint would cause the signalling system and the signalling diagram to register that the track sections were occupied.

Condition of signalling and control equipment

110 The *route setting controls* in the control room were being operated correctly in accordance with the rules and instructions issued by LUL. There were no faults with the signalling controls that could have affected what happened. The condition and maintenance of this equipment are not considered to have contributed to the incident.

111 The signalling system operated correctly before, during and after the incident. ED23, its repeater signals and ED171 all had good sighting from the driving cab of an approaching train. No allegation has been made that the sighting of signals was inadequate given the low line speed of 20 mph (32 km/h). The illumination from ED171 was clearly visible (Figure 12) and brighter than other signals in the area. Signal identification plates were adequately visible (see paragraph 126).

112 The change of occupancy of EV track circuit (Figure 3) can only be explained by train 73 having stopped with its first wheelset over the IBJ. Initially EV track circuit did not register the presence of the train, however a slight movement of the train or track by just a few millimetres was sufficient to cause EV to register that the section was occupied. There is no evidence to indicate that the train was deliberately moved by the Train Operator at this time. Because no defect was found with the track circuit or IBJ, no other plausible explanation has been found for this occurrence. The position of the train reported by the Train Operator, Station Supervisor – Days and Duty Station Manager validates the likelihood of the first wheel resting on top of the IBJ.

113 Normal moves into Triangle Sidings are controlled by ED171 signal. For normal signalled moves, the automatic operation of the train's tripcock by the lineside trainstop would apply the brakes and bring the train to a stand if it attempted to pass a signal displaying a STOP aspect. Train 73 was not stopped at ED171 which was displaying a red STOP aspect because:

a) Its movement authority was obtained by verbal instructions from the control room and not through obeying the aspects of signals. As a result the leading tripcock had correctly been cut out by the Train Operator in accordance with LUL Reference Manual instructions (Fe300d). The duties of the second person in the cab included looking out for signals and ensuring that the Train Operator obeyed them, thus mitigating the risk, at least in part, for the absence of the tripcock protection.

b) The trainstop for ED171 was controlled to the lowered position, ie it would not activate the train's tripcock, when 157B points were set *normal* for moves straight along the eastbound line. This is to avoid normal service trains being *back-tripped*.

114 No evidence of poor signal sighting was found, nor was any allegation made about this.

Training and local area familiarisation

115 The process of training, familiarisation and gaining *local knowledge* by LUL operating staff is arranged in a variety of ways. Some training is provided centrally; feedback from staff indicates that this has no obvious deficiencies. Station specific training and area familiarisation is delegated to individual station groups within the line structure. The area familiarisation provided for Duty Station Managers and Station Supervisors is one of the topics that is arranged by local managers.

116 Duty Station Managers and Station Supervisors are primarily concerned with the operation of stations, including crowd control and the despatch of trains. Undertaking incident train control functions, such as a WDM, is an activity that is less commonly encountered and thus may require additional refresher training. LUL did not have:

- a uniform approach to how this type of knowledge is provided;
- a definition of how comprehensive it should be; nor,
- a structured approach of how checks are made that a correct understanding has been obtained and retained.

117 The lack of a robust structured approach for imparting local knowledge is a causal factor for the incident.

Knowledge of the High Street Kensington area

118 From time to time, Duty Station Managers are called upon to cover duties in areas other than their own. When special train moves such as a WDM are required, the lack of local knowledge is a serious limitation on their ability to manage the situation. To undertake those duties properly the knowledge gap needs to be supplemented, eg either by the use of information from the control room, or from documented guidance available at a station. The lack of local knowledge was not advised to the control room, nor were suitable documents obtained from Earls Court or High Street Kensington stations. Through the LUL intranet, signalling and track diagrams are available for local printing that would have assisted in managing the WDM. These diagrams are not subject to formal checking and issue control.

119 Neither of the Duty Station Manager or Station Supervisor involved in the WDM had undertaken a track walk in the area. Whilst they were generally aware of the track layout they had no detailed knowledge of where signals and SPTs were located. This significantly limited their ability to manage the WDM adequately and is a causal factor for the incident (**Recommendations 1 and 2**).

Stopping at the authorised limit of the move

120 The Train Operator had a good knowledge of the track layout and positions of signals on the routes over which he was passed to operate. This knowledge is a formal part of LUL processes for passing out a Train Operator for driving a train over a section of route. However, it was unlikely that any Train Operator could remember the number of each signal on those routes. Although the Train Operator confirmed to the Duty Station Manager that he knew the position of ED171, it was the duty of the person-in-charge of the WDM (the Duty Station Manager) to identify where to stop. The LUL Working Reference Manual (section Fe302e) states in the information section of Step 1 for the WDM Person in Charge 'If you are in any doubt over the wrong direction movement ask the Line Controller to explain' (Since publication of this section in 2002 the Line Controller has been renamed the Service Controller). In fact the Train Operator relied upon the Duty Station Manager and the Duty Station Manager relied upon the Train Operator for the knowledge about ED171.

121 It is possible that some confusion existed in the mind of the Train Operator between ED171 signal and ED151 signal, the latter being the signal on the eastbound line closest to Earls Court. This has not been proven.

122 Under normal circumstances the Train Operator is in full charge of controlling the train in compliance with signal aspects. After a WDM has been authorised, that command changes to the WDM person in charge. The Train Operator is then required to obey instructions from that person.

123 Before the train was halted by the discharge of traction current the Duty Station Manager was concerned that the train may have gone too far. That doubt should have been the trigger to order the Train Operator to stop the train immediately and to confirm with the Service Controller that the move was still proceeding correctly. That action was not taken.

124 The LUL Working Reference Manual Section Fe302e Clause 18.2 requires the person in charge of the WDM to 'apply the emergency brake if necessary'. This was not done after the Duty Station Manager became concerned that the train was moving beyond the WDM limit.

125 The lack of instruction to the Train Operator indicates that a clear understanding of who was in charge of the train's movement did not exist and was a causal factor for the incident (**Recommendation 3**).

126 Signal ED171 (see Figure 12) is brightly illuminated. The identification plate showing the signal number is clear, although the digits '171' are less readable than the 'ED' prefix. The signal is well sighted and its identification plate can be read reasonably well as a train approaches it at slow speed (less than 10 mph (16 km/h)), as would be necessary for any shunting move to Triangle Sidings, or under WDM authority.

127 No clear reason has been identified why the Train Operator, or others in the cab, did not notice ED171 signal. A possible explanation is that of distraction by others in the cab, although there was no reported unnecessary conversation during the move. The possibility of distraction, however, has not been disproven.

Identification of the train position

128 When the incident first began to unfold, and subsequently, there was considerable confusion in the control room over the exact position of the train. Actions were taken to identify the exact position of the train, including a check of the signalling diagram and sending the Station Supervisor – Days to report where the train was. After suspecting that a SPAD had occurred, although denied by the Train Operator (see paragraph 74), the subsequent change of state on the diagram led the control room staff to the erroneous conclusion that the train had been driven forwards past signal ED23. Their confidence in the information supplied by the Train Operator was fairly low. Further actions could however have been taken to clearly establish the position of the train beyond those taken. In particular the Station Supervisor – Days should have been asked to obtain a clear statement from the Train Operator on the first occasion that the Station Supervisor - Days was asked to report on the train's position. This is a contributory factor (**Recommendation 4**).

Station duties

129 The failure of the batteries on both the station train radio and the lamp brought from High Street Kensington by the Station Supervisor – Days station hampered the ability to manage the incident properly. It exposed the Station Supervisor – Days to a significant and unnecessary risk of electric shock. Although there are general instructions throughout LUL that station equipment needs to be maintained in an operational state, each line and each station has its own means of doing so. The practices for implementing this vary over the LUL network; there is some evidence that maintenance and inspection procedures were not fully documented, a feature that common procedures would rectify. This is a contributory factor (**Recommendation 5**).

130 A list of emergency equipment for High Street Kensington does exist, albeit with some omissions, eg station train radio. This list of equipment needs to be verified by LUL as complete. This is a contributory factor (**Recommendation 5**).

131 The attempt to use various items of emergency equipment outside of the station environment was an attempt by the Station Supervisor – Days to ensure that problems in using the train radio were overcome. This action did however highlight the lack of knowledge about where emergency communications equipment could reasonably be expected to operate (**Recommendation 6**).

132 The inability to locate a WDM form at High Street Kensington hampered the ability to manage the incident within the shortest possible time. There are no common procedures at stations for the storage of safety critical forms and similar paperwork. The provision of list identifying the location of these forms and/or the clear identification of the location itself would assist staff at times when they were under pressure to manage an incident in a timely manner. If extended to a common facility across all stations this would also assist staff if they needed to cover duties at other than their regular base. This is a contributory factor (**Recommendation 7**).

Communications protocols

133 Analysis of the voice tapes from the control room indicated poor discipline in using both telephone and radio communications. At one time during the incident the Service Controller was involved in talking to three Train Operators concurrently, with the intended recipient not always clearly identified. Telephone conversations with the Service Operator were likewise of an unstructured nature. The new LUL Rule Book clearly defines the discipline and protocols necessary for safety critical communications. The form of communications used at the time of the incident was a contributory factor (**Recommendation 8**).

134 Within the control room some verbal communications were by direct speech between the Service Operator and Service Controller. Some staff have commented that at times this practice can cause distraction; it also precludes the full recording of messages. There is no evidence that the background noise in the control room (see paragraph 57) had any bearing on the incident. The partial coverage of the voice recordings is a factor in the uncertainty over how the signal release and WDM were authorised.

Instructions about the limit of the moves

135 The LUL Working Reference Manual applicable to the Train Operator (Section Fe302d Clause 19.1) states that the Train Operator will ‘be told to stop at the end of the WDM and wait for instructions from the WDM person in charge’.

136 The LUL Working Reference Manual (Section Fe302e Clause 18.1) requires the person in charge of the WDM to tell the Train Operator ‘to stop at the WDM limit’. The Duty Station Manager gave these instructions before train 73 began to move.

137 The instruction given from the control room to the Duty Station Manager and thence to the Train Operator was potentially ambiguous. The intent was that the train should be driven to ED171 signal so that the cab at the Earls Court end was at ED171. Because ED171 signal controls the move back into Triangle Sidings, it faces the opposite direction to all other signals on the eastbound line to High Street Kensington, ie it faces in the direction of travel for the WDM. The instruction given did not clearly identify which cab should be positioned close to ED171. One member of staff thought that the instruction meant that the train should be positioned 'behind' ED171 signal. This could be interpreted as the train being between ED171 and Earls Court. Conflicting evidence about what instructions were given shows that there was some potential for error and is a contributory factor for the incident.

Use of the WDM form

138 Although a WDM authorisation form (Fz004 issue 02) was not used the information given to the Train Operator by writing on the Traffic Circular did contain the essential information that the form would have contained. The inability to use the correct form was thus not a factor in the incident.

139 The form authorising the WDM (see Figure 15) is a development of a form that dates back nearly a century. It provides some basic information about who is giving the authority, and when. However, the only useful operational information is the limit of the move. The form could usefully contain text to assist those undertaking the WDM (see paragraph 152).

LONDON UNDERGROUND LIMITED

WRONG DIRECTION MOVEMENT

TO BE COMPLETED BY THE WDM PERSON IN CHARGE

To:- Train Operator of train number .....

I authorise you to proceed in the wrong direction as far as .....

The section is protected and any points involved have been secured for the move.

This form must be returned to the WDM Person In Charge on completion of the move.

Date ..... Grade .....

Name & Employee No. ..... (Please Print)

Signed ..... Time form issued .....

TO BE COMPLETED BY THE TRAIN OPERATOR

Name & Employee No ..... (Please Print)

Depot ..... Signed .....

Time form returned ..... on completion of move

Figure 15: WDM form

Changes to the timetable

140 The incorrect punching of the programme machine roll could explain the wrong routing of train 73. Due to the time elapsed between the incident and this possibility emerging, no conclusive evidence has been discovered that this happened. However, no other likely cause for the incorrect routing has been found. Such events have occurred previously; it is one that existing operating procedures are well able to manage.

Train radio

141 The precursor event for this incident was the failure of the train radio communications channel. This inability to provide an adequate communication channel was the feature that caused a relatively minor event to escalate towards one that was potentially hazardous. Despite the problems caused by this poor communication channel, existing operational procedures are able to manage the movement of trains in a safe manner, albeit to a more extended time scale. The failure of the train radio communication was a contributory factor (**Recommendation 10**).

142 The mode of failure of the communications channel that was experienced was more typical of a poor reception area, rather than one of system capacity. Although there are known areas of poor reception between High Street Kensington and Gloucester Road, problems on the line from Earls Court have not been reported. It has not been possible to reproduce any similar failure in the vicinity of the block joint between EV and ET track circuits (Figure 3), albeit during daytime hours, using other trains.

143 The train radio system has become more inadequate in recent years when radio traffic has increased. At the time of the incident, radio traffic was at a high level. Elimination of the limitations of system performance is being addressed by the Connect Radio project; pilot installations are currently being introduced on the east end of the District Line.

144 Train radio equipment receives a regular functional check at the train maintenance depots, and prior to any train entering service. Failures are addressed through equipment replacement followed by return to Thales. There is no evidence that different depot procedures would have influenced the incident.

Identification of underlying causes

145 There are two underlying causes of the incident both of which played an equal role in the incident.

146 The first cause stems from LUL's lack of a standardised approach to ensure that operating staff are provided with the correct training, knowledge, familiarisation and experience necessary for them to do their jobs correctly. During the investigation a number of substantial differences in approach and thoroughness for local track familiarisation were discovered. Various good practices were evident in each location visited by this investigation; however, their application is not consistent over the network, or indeed between adjacent locations on the same line. The source of this less than robust approach lies with the senior management of both the line and network.

147 The second cause is the discipline necessary for the safe and efficient operation of the railway. In the control room, communications, and the complete concise logging of decisions and actions were not of the highest standards. Whilst that used was acceptable for matters that were not of a safety critical nature, their shortcomings became evident when unusual conditions appeared. Communication protocols and administrative practices used by station staff displayed the same shortcomings. The lack of communication discipline and the lack of good control room and station practices clearly lies with senior line management.

Other factors for consideration

Movement over facing points

148 The LUL Working Reference Manual is clear about the responsibilities of the Train Operator with regard to facing points:

a) The Standard, Section Fe100 clause 3 states that 'If during the move the train will need to go over catch or spring toggle points a Station Supervisor must be told as soon as possible. He will then arrange the movement and secure the points by scotch and clip.'.

b) The Procedure, Section Fe302d Clause 18, which is subservient to the standard, requires that the train 'stop the train short of any points and check that they are secured in the correct position for your move'. This was not done for movement over 157B and 156 points.

149 The LUL Working Reference Manual (section Fe302 clause 18.1) only instructs the WDM Person in Charge to tell the Train operator to 'stop at the end of the wrong direction movement and wait for further instructions'

150 The differences in wording, and apparent intent could lead to confusion. Fe100 clause 3 (paragraph 148a) only applies to catch or spring toggle points which must be secured in the correct position. Fe302d Clause 18 (paragraph 148b), applies to all points and requires that the train stops so that a check can be made that they are secured. The third, Fe302 clause 18.1 (paragraph 149) only mentions the end of the WDM (**Recommendation 9**).

151 The Train Operator obeyed section Fe100, but not Fe302d when he continued to drive over the facing points 157B and 156. Both points are regularly used in a facing direction by shunt moves into Triangle sidings, a move with which the Train Operator was familiar. Even though the points are not used for a signalled move towards Earls Court, they were *track locked* by the presence of the train and would not move during its passage over them. (Had there been a possibility that the points could move, then they would need to be secured by scotch and clip). There was thus a negligible risk of derailment.

152 The LUL Working Reference Manual places a requirement on the person in charge of the WDM to arrange for points to be secured and to confirm this to the Service Controller. There is no requirement to tell the Train Operator verbally that points have been secured, however the WDM form that should have been given to the Train Operator does include the statement 'The section is protected and any points involved have been secured for the move'. The form does not require an overt action on behalf of the person issuing it to confirm either part of the statement, other than to sign the form. There is no requirement to delete the reference to points if none are involved. The use of a form that included overt statements, perhaps by tick boxes would better control the information being given to the Train Operator and thus eliminate any uncertainty. Furthermore, on the WDM Form, it may be useful to include an instruction to stop before all facing points and to obey all signals encountered in the direction of movement. It could also provide space to list signals that could legitimately be passed at STOP; this information could be given to the person in charge of the WDM by the Service Operator.

Appointment of a WDM Protector

153 The LUL Working Reference Manual (section Fe302) is clear about the actions to be taken when a WDM is authorised. Section Fe302e Clause 7 requires that a *WDM Protector* be appointed by the person in charge of the WDM. This person must be positioned at the station in rear of the WDM area and must stop any train attempting to enter the area. Despite these instructions a WDM Protector was not appointed. It has not been confirmed whether staff were fully aware of the mandatory nature of this requirement (**Recommendation 12**).

154 Given the location of the WDM and the actions taken by the Service Operator in *collaring* the route setting buttons, it is unlikely that a WDM Protector could have enhanced the safety of the situation.

Train radio

155 Following the incident neither the radio system on the train, nor the base station for High Street Kensington were given a thorough check by Thales. The train merely received the normal depot and pre-entry to service checks. In the days following the incident the radio on the units 5524 operated as it was expected to do. The likelihood of a fault with the equipment is thus unlikely. Similarly, no abnormal difficulties were experienced with the base station and its use in providing a communication link with many District Line trains. The failure of the radio communication link has thus been considered a singular event.

156 LUL did not initiate any special action by Thales to investigate the failure of the radio communication channel (**Recommendation 13**).

157 Connect Radio will provide an enhanced capability for communications between the control room and trains. Had it been available at the time of the incident then a location-specific communications breakdown would have been very unlikely. LUL should ensure that the system is made available over the whole network in the shortest practical time (**Recommendation 10**).

Familiarisation in the use of SPTs by station staff

158 There was evidence about the lack of knowledge by the Station Supervisor – Days with both the location of the SPTs in the area, and how they should be used. This delayed the response for moving train 73 to High Street Kensington station (**Recommendation 2**).

Working practices in the control room

159 The working practices in the control room were not highly disciplined. This was displayed by the lack of structure to the communications protocols being used and also the lack of clarity over how the route release and the WDM were authorised. There was evidence that time pressure required staff to concentrate upon managing the service. The preparation of formal records only occurred when time became available. This method of working does not always permit appropriate thinking time to be available to ensure that the correct actions are being taken. Completion of forms and records at the time does however ensure that time is available for a check on proposed actions (**Recommendation 14**).

Summary of the event chain

160 The basic event chain is shown below:

1. Incorrect route is set by programme machine.
2. Train Operator does not notice the junction indicator on RED230/23.
3. Train Operator does not react to the junction indicator in time to stop before reaching ED23.
4. Train 73 passes ED23 at green (PROCEED) and stops with first wheels on the IBJ between ET and EV track circuits.
5. The control centre signalling diagram shows EV track circuit is clear indicating that train 73 has not passed ED23.
6. Train Operator tries to contact Service Controller but poor radio communications hampers details of situation being conveyed.
7. Service Controller understands that Train Operator has taken wrong route, but Train Operator cannot hear Service Controller's instructions to wait for the route release.
8. Service Operator takes a route release.
9. The control centre signalling diagram changes to show EV track circuit is occupied leading Service Operator and Service Controller to conclude that train has moved and a SPAD had occurred at ED23.
10. Station Supervisor – Days identifies position of train 73 with leading cab just outside tunnel portal.
11. Service Controller and Service Operator agree that a WDM is required to position train 73 on the approach side of ED23.
12. Station Supervisor – Days prepares to manage a WDM, and is then stood down.
13. Station Supervisor – Days is reactivated for the WDM and walks to train with emergency equipment.
14. Duty Station Manager walks to train on instructions from Service Manager.
15. Duty Station Manager instructs Train Operator to undertake a WDM to ED171 and writes instructions on cover of Traffic Circular.
16. Train 73 moves towards ED171 and then continues past it.
17. Service Operator notices that the signalling diagram indicates that train 73 has exceeded the limit of the WDM and informs the Service Controller.

18. Service Controller immediately discharges traction current.
19. Station Supervisor – Days leaves the cab to identify position of train, (but sustains injury doing so).
20. Service Controller authorises move back to ED23.
21. After traction current is recharged train 73 moves back to ED23.
22. Train 73 moves to platform 4 where passengers are detrained.

Conclusions

Immediate cause

161 The immediate cause of the incident was that train 73 did not stop at the authorised limit of the move (ED171) due to the person-in-charge of the WDM not recognising that limit and not stopping the train at it. The Train Operator also did not identify ED171 and proceeded past a signal displaying a STOP aspect.

Causal and contributory factors

162 Causal factors were:

a) Operating staff were inadequately trained in the application of WDM procedures through a lack of local knowledge. They were thus unfamiliar with the actions they were being asked to undertake. They did not make this lack of knowledge clearly known to others involved in the WDM (see paragraphs 115 – 117, 119 **Recommendation 1**).

b) There was confusion over the responsibilities of the person-in-charge of the WDM. The Duty Station Manager had the authority to order the train to stop at any time and this authority should have been exercised (see paragraph 125, **Recommendation 3**).

163 The following factors were considered to be contributory:

a) Control room staff did not take all the steps possible to identify the position of train (see paragraph 128, **Recommendation 4**).

b) Management of rechargeable equipment at High Street Kensington (torches and portable station radio) and filing of WDM forms was inadequate (see paragraphs 129, 132, **Recommendations 5 and 7**).

c) Knowledge was lacking about where emergency communications equipment such as the station train radio, station radio and portable phone could be expected to work (see paragraph 131, **Recommendation 6**).

d) Communications internal to the control room, and with station staff were not clear, unambiguous and disciplined (see paragraph 133, **Recommendation 8 and 11**).

e) Correct forms and paperwork were not completed by anyone associated with the WDM at the time of the incident (see paragraphs 67, 73 and 137, **Recommendation 1**).

f) Potentially misleading guidance on what actions are to be taken to manage and operate a WDM is contained in the LUL Reference Manual (see paragraphs 120 – 124, **Recommendation 9**).

g) The inadequate performance of the existing radio system played a significant part in changing a minor incident into a more complex one. Connect radio should be made available over the LUL network in the shortest practical time (**Recommendation 10**).

h) An incorrect route was set by the programme machine (see paragraph 140). No recommendation.

Underlying causes

164 Underlying causes were:

a) inadequate managerial understanding of the essential knowledge necessary for staff to carry out their duties (see paragraphs 115 – 117, 119, **Recommendations 1, 2 and 3**); and

b) inadequate managerial enforcement of operating practices within the control room and at stations (see paragraphs 125, 128 & 159, **Recommendations 3, 4 and 14**).

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

165 The replacement Connect Radio project is already subject to pilot scheme operation on the east end of the District Line.

166 LUL have introduced new Operational Standard OSN61 'Station Familiarisation Training – track' familiarisation in November 2006. This was in preparation at the time of the incident at High Street Kensington. The standard details the coverage and frequency at which staff should walk the track and be familiar with points, section switches, crossings and other track features.

167 LUL have prepared a new Rule Book that replaces the Working Reference Manual. This incorporates clear instructions on safety critical communications.

Recommendations

168 The following safety recommendations are made[1]:

Recommendations to address causal and contributory factors

1. LUL should reassess the standards, and the associated training, familiarisation and necessary local knowledge for staff required to carry out specific duties for WDMs. Procedures should be amended and a delivery programme implemented to ensure that the necessary knowledge is imparted and retained and that staff only work within their skill and knowledge base.

2. LUL should reassess the training, familiarisation and necessary local knowledge for staff required to use SPTs. Procedures should be amended to ensure that the necessary knowledge is imparted and retained.

3. LUL should rebrief their staff on the duties & responsibilities for undertaking WDMs, including emphasis on the person-in-charge having overall responsibility to instruct movement or stopping of the train, and, if appropriate, of the need to appoint a WDM Protector.

4. LUL should rebrief control room staff on the necessity of clearly establishing the position of any train before any recovery moves are authorised.

5. LUL should review procedures for maintaining emergency equipment in a state of readiness and amend them as necessary.

6. LUL should introduce procedures to ensure that staff are advised where emergency equipment such as station train radio, station radio and portable phones may be expected to work and where not.

7. LUL should consider the use of a common or standardised means of filing / locating WDM (and other operational) forms that may be needed at short notice at their stations and implement reasonably practical changes.

8. 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.

9. LUL should review the instructions for undertaking WDMs to ensure that it contains no requirements capable of misinterpretation and that the WDM form contains information that will remind staff of key procedures when carrying out the move.

continued

[1] 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

10. LUL should review the Connect Radio project to determine the feasibility of an accelerated implementation programme. If reasonably practical this should be implemented.

11. LUL should ensure that all operational staff are rebriefed about actions to be taken when a breakdown of safety critical communications occurs.

Recommendations to address other matters observed during the investigation

12. LUL should review the need to appoint a WDM Protector when route collaring or other suitable protection can be undertaken. The operating rules should be amended as necessary.

13. LUL should introduce procedures so that serious incidents of radio equipment failure or poor communication links are fully investigated. This should include full functional testing of the equipment involved.

14. LUL should review the capability, disciplines and capacity of the Earls Court Control Room for the control of the District Line in times of normal and disrupted operations. The review should include the time necessary for a disciplined application of working procedures.

Appendices

Glossary of abbreviations and acronyms — Appendix A

IBJ	Insulated Block Joint
IMR	Interlocking Machine Room
LUL	London Underground Ltd
RAIB	Rail Accident Investigation Branch
SPAD	Signal passed at danger
SPT	Signal Post telephone
SS	Station Supervisor
WDM	Wrong Direction Move

Glossary of terms — Appendix B

6 foot	The area between two adjacent tracks.
ac capacitor-fed single rail track circuit	A common type of track circuit on the LUL system. See also description of *track circuit.*
arbour lights	An arrangement of white lights above a colour light signal that displays the diverging route through a junction to the train operator.
auto telephone	The internal network-wide phone system linking *LUL group* locations.
back-tripped	The unwanted condition when the rear trip cock on a train applies the brakes.
base station	The local transmitting and receiving station located by the lineside. It is connected to the Control Room by hardwired copper or fibre optic-links.
berth	A section of railway that may be occupied by a train. It may consist of one or more track circuits.
C Stock	Trains built by Metropolitan Cammell in two batches between 1969 and 1977 that operate the Circle, Hammersmith & City, and Edgware Road to Putney Bridge services. They were originally designed for operation with a driver and guard but have since been converted to one-person-operation. They were given a substantial half-life overhaul in the late 1990s. The two-car units have a driving cab at one end only; they always operate in passenger service as six-car trains approximately 92 m long.
car	London Underground term for a passenger coach.
collaring	A device used by the service operator to remind that a particular electrical switch push-button or plunger should not be operated due to an obstruction
controlled signal	A signal that can be operated directly by the service operator. This enables the service operator to command it to show a red or green aspect.
correspondence	The condition when an item of equipment is in the desired condition, ie when points are commanded to and lie in the normal position.
cut out (of tripcock)	Making the tripcock inoperative.
discharge (of traction current)	The isolation of the conductor rail system from the electrical supply.
eastbound	LUL identifies directions of train on the District Line by the terms 'eastbound' and 'westbound' irrespective of the actual direction of track at a particular location. Trains travelling from Earls Court to High Street Kensington do so using the eastbound track.
home signal	the signal immediately before a station platform.

Insulated Block Joint	A rail joint in which one rail is electrically insulated from the abutting rail. They are used to separate various sections of the railway into sections for train detection purposes.
Interlocking	An electro-pneumatic machine that provides the controls between points and signals that prevents conflicting routes to be set up.
local knowledge	Knowledge that is specific to a defined area of the railway that supplements the universal information contained in the Working Reference Manual and other LUL publications. Local knowledge includes an understanding of relevant local instructions and familiarisation with the position and, where necessary, the operation of equipment in that area.
LUL group	The main group of duty holders comprising LUL, Metronet SSL, Metronet BCV and Tubelines.
main signal	A signal that controls train movement authority on a running line and is not a shunting signal.
normal (direction of points)	The default position of a set of points, generally the position for the most used route. The opposite of Reverse.
outer home signal	The first stop signal encountered when approaching a station.
programme machine	An electrically operated machine that controls the setting of routes and signals according to a predetermined sequence, timing or trigger conditions.
programme machine roll	The replaceable plastic roll within a programme machine that contains timetable and train routing information.
(route) release	The action of cancelling a set route before a train has passed over it. It normally involves a set time elapsing during which all signals affected are returned to a STOP aspect, thus ensuring that trains come to a stand.
route setting controls	Buttons on the Service Operator's desk that set the route for a particular movement. Route setting avoids the need to set individually the direction of each set of points and the aspect of each controlled signal.
short working	The condition when a train is stopped short of its intended destination.
Signal Post Telephone	A telephone associated with a signal that connects directly to the Service Operator.
signalling diagram	The stylised track plan provided in a control room to assist the service operator. It contains track names, signal numbers, point number and platforms. It displays by means of lamps the status of sections of line, and by means of alphanumeric indicators the number of an associated train.
station train radio	A radio system with limited range used by station staff.

telephone concentrator	A selector panel on the service operator's desk that allows a particular call or line to be selected.
track locked	The condition that locks a set of points when a train is present. This prevents the points changing whilst the train is moving over them.
traction current	The flow or presence of electrical voltage on the conductor rails necessary for powering the train. On LUL this is nominally 630 volts direct current.
Traffic Circular	A weekly publication by LUL that provides details of train service and other operating information, including changes to the timetable.
track circuit	An electrical train detection system based upon the principle of proving the absence of a train.
train describer	A system that tracks trains along a route and allows the service operator to see where it is. It displays the train reporting number which moves from berth to berth.
trainstop	A mechanical device mounted to the side of the track that ensures compliance with a signal displaying a STOP aspect. When in the raised position it changes the position of the tripcock and automatically applies the brakes if the train passes it.
tripcock	A mechanical brake valve mounted on the outside of a vehicle close to track level that is operated by the raised arm of a train stop. The operation of the tripcock will cause the brakes to be applied thus bringing the train to a stand.
tripped	The condition when the front tripcock on a train applies the brakes, normally after passing a signal displaying a STOP aspect.
two-aspect colour light signals	Signals that can display one of two coloured lights, either: ● red (STOP) / green (PROCEED); or ● yellow (PROCEED) – next signal may be red) / green (PROCEED).
WDM Protector	A person who is appointed to stop any train from entering a section of line in which a wrong direction move is underway.
Working Reference Manual	The LUL Operations rule book
wrong direction move	The movement of a train in the opposite direction to normal and which is not controlled by signals.

Key standards current at the time — Appendix C

LUL Operational Standards	Notice No. 61 Effective 13th November 2006
LUL Reference Manual	Standard Fe100 Wrong Direction Movement 28 April 2002
LUL Working Reference Manual	Procedure Fe302 sections a - g Wrong Direction Movement 28 April 2002
WDM authorisation form	Fz004 issue 02
Earl's Court signal control centre, District & Piccadilly lines. Local knowledge & Desk familiarisation manual. Earl's Court desk area	Volume 4 19 February 2007

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