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THE
KENSAL GREEN
COLLISION

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THE KENSAL GREEN COLLISION ENQUIRY

by

Brian Hardy

The collision that occurred on Thursday 16 October 1986, where an 'up' LMR dc EMU ran into the rear of a southbound Bakerloo Line train north of Kensal Green tunnels, was reported in Underground News No.300, pages 175/6. The official public enquiry was held exactly four weeks later, on Thursday 13 November 1986, in the Great Western Royal Hotel, Paddington, under the Chairmanship of Mr.D.A.Sawer, Assistant Inspecting Officer of Railways, Department of Transport. He was accompanied by Mr.D.C.H.Simpson (Operating Officer, South, LMR HQ, Birmingham), Mr.A.C.Revitt (Area Signalling and Telecommunications Engineer, LMR HQ, Birmingham), Mr.J.McColl (Acting Passenger Business Engineer, LMR HQ, Derby), and Mr.C.G.Butcher (Divisional Operations Manager, Central & Bakerloo, London Underground Ltd., Baker Street).

Mr.Sawer opened the enquiry by stating that the evidence to be heard was only part of the enquiry procedure and further investigations and inspections would be necessary in the future. He said that the purpose of the enquiry was to find out the technical cause of the accident and to recommend measures to adopt to prevent it happening again. Mr.Sawer said that the enquiry was not a court of law and no further action would ensue from the evidence to be heard. Although there were no fatalities or serious injuries, an enquiry was needed, Mr.Sawer said, as the outcome could have been totally different if large numbers of people had been travelling on both of the trains involved.

Mr.D.C.H.Simpson then described the area involved and outlined the course of events leading up to the accident, and the result thereof.

At approximately 17.00 on Thursday 16 October 1986, 2C38 16.26 hours local passenger train from Watford Junction to Euston, which was composed of a three-car British Rail class 313 dual voltage electric multiple unit (No.313.012) travelling at approximately 20 mph, collided with the rear of 2A18 16.49 hours local passenger train (set No.201) from Stonebridge Park to Elephant & Castle, formed of a seven-car London Underground electric train (units 1052 + 1039), which was at a stand at signal KG6, situated some 22 yards from the mouth of Kensal Green tunnel. The weather was fine and clear with good visibility.

At the scene of the accident, there are six lines of way; reading from left to right when travelling southwards, Up dc, Down dc, which are the Watford Junction to Camden Junction local lines, then Up slow, Down slow, Up fast and Down fast, which form the West Coast main lines, together with a siding situated between the Down dc and the Up slow lines. Kensal Green tunnel has four bores - one for each of the dc lines, one for the slow lines and another for the fast lines.

The dc lines are fully track circuited and equipped with two and three aspect colour light signals, which are worked in accordance with special regulations. The area is controlled by Willesden New Station signal box. The adjacent West Coast main lines are under the control of Willesden Power signal box. The dc lines are electrified with a conductor rail system and energised at 650 volts direct current, with a negative current return rail being provided to facilitate the running of London Underground services. The West Coast main line route is

electrified on the 25kV overhead line system.

As a result of the collision the Underground train was pushed forward approximately 12 yards. The impact caused the driving cab of the BR train to be stoved in. The driving compartment and most of the passenger accommodation of the rearmost Underground car (1052) were completely demolished. This car was forced under the trailing end of the adjoining Underground vehicle (2052), which in turn was severely damaged.

None of the other lines were obstructed but an emergency isolation of the conductor rail was taken on the Up and Down dc lines. In consequence an emergency bus service was introduced between Willesden and Queens Park with a shuttle train service being worked to and from these stations. Trains on the West Coast main lines were, for a short period, run at caution. There was only slight damage to the track of the Up dc line.

The emergency services were immediately summoned and had arrived on site within minutes. The injured were conveyed by ambulance to the Central Middlesex and St.Mary's Hospitals.

There were some 20 to 25 passengers on the Euston train and approximately 20 on the Bakerloo train, of whom 23 were injured and conveyed to hospital, with all but one being discharged after treatment. The passenger who was detained in hospital was discharged on Saturday 18 October. In addition, five other passengers sustained minor injury which did not require hospital treatment. The London Underground train crew also suffered injury, necessitating hospital treatment.

The damaged vehicles were cleared from the site by 06.15 on Friday 17 October and after repairs to the track were completed, the dc lines were re-energised and re-opened at 08.33, although the running of London Underground services was not resumed until repairs to the negative current rail had been completed.

Mr.Simpson paid tribute to the most efficient manner in which the emergency services and the doctors, nurses and other members of the staff at the Central Middlesex and St.Mary's Hospitals responded to the emergency.

Mr.A.C.Revitt then explained the signalling system used on the Camden-Watford dc electrified lines.

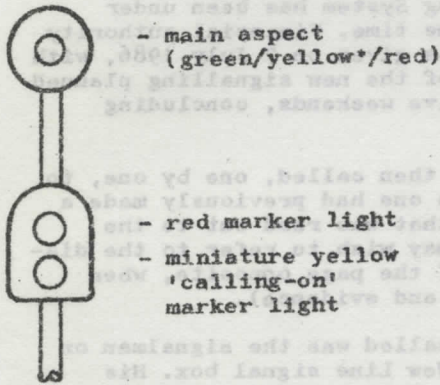
Dating from the early-1930's, the system is substantially unaltered from its original form, with the exception that it was immunised against the effects of the ac traction system then being installed on the adjacent West Coast main line in the mid-1960's. The signalling system is unique on British Rail.

The installation comprises two and three aspect searchlight type signals, with associated marker lights and train stops. The signals are of two basic types, stop signals and repeater signals. The stop signals are equipped with an associated train stop, with marker lights arranged vertically beneath the main aspect. Repeater signals do not generally have an associated train stop and the marker light is off-set to the left. (See Fig.1). Stop signals are identified by a number consisting of two alpha characters and a digit. Repeater signals are similarly identified but with a prefix 'R' on the signal number.

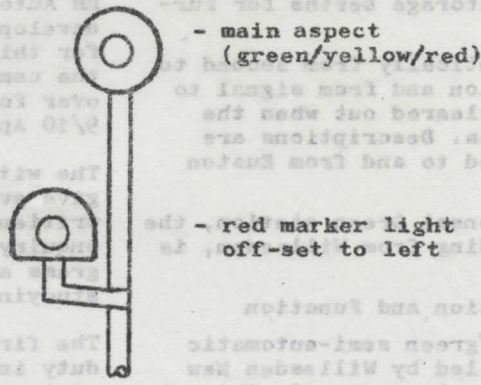
The signals are, in the main, sub-divided into two types, these being semi-automatic and fully automatic signals. These signals are distinguished by identification plates with the semi-automatic carrying a diamond sign with superimposed 'T' and the automatic signal carrying a

Figure 1: CAMDEN-WATFORD 'NEW LINE' SIGNALLING SYSTEM

STOP SIGNAL

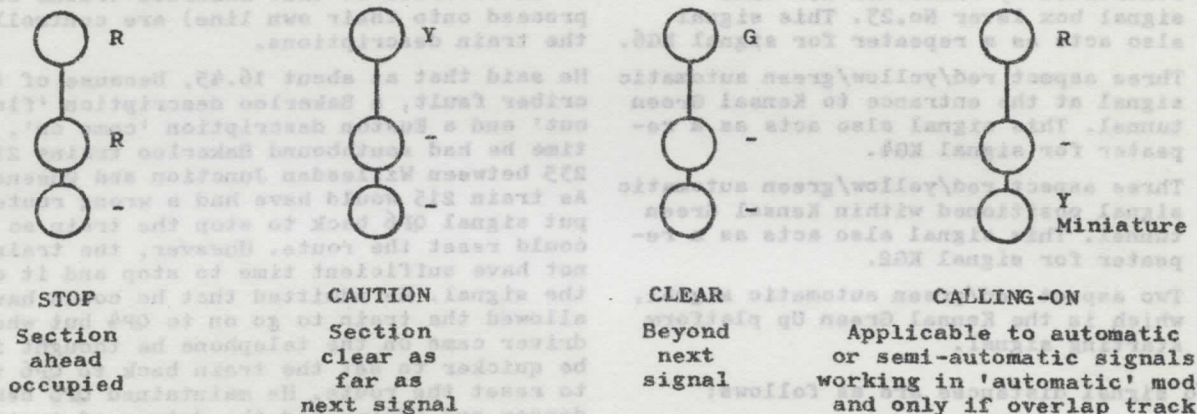


REPEATER SIGNAL



Note * Only where a separate repeater is not provided for the next stop signal in advance.

Figure 2: OPERATION OF STOP SIGNAL ASPECTS



plain diamond sign with a supplementary 'A' plate.

The normal aspect exhibited at an automatic and semi-automatic signal when working automatically is clear. After the leading wheels of a train pass such a signal, the aspect changes to danger and the signal is held in this position until the rear of the train passes a point beyond the next stop signal in advance. Repeater signals will normally exhibit a caution aspect when the next signal in advance is at danger and a clear aspect when this signal is displaying a clear or caution aspect. Should the line be occupied between a repeater signal and a point beyond the next signal in advance, a danger aspect will be displayed. The marker lights display a red aspect when the main aspect is also red and are extinguished when the main aspect displays a proceed aspect. If a main danger aspect continues to be displayed on an automatic or semi-automatic signal when working automatically, the red marker light will change to a yellow

calling-on aspect after the berth track circuit for the signal concerned has been occupied for a time. The time is so set as to normally require a train to be at a stand at the signal concerned for about 60 seconds before the presentation of the calling-on aspect. Drivers are instructed not to proceed on a calling-on aspect until the train has been at a stand at the signal for one minute. (See Fig.2).

The section of line between Queens Park and Stonebridge Park inclusive comprises the Willesden New Station signal box control area. The Willesden station area is controlled by the lever frame in the box, whilst the Queens Park and Stonebridge Park station areas and junctions are controlled from an OCS (One Control Switch) route setting panel in the box. Between these controlled areas are automatic sections in the Kensal Green and Harlesden station areas. The main running signals throughout the box area can be set to work automatically for straight running by reversing the relevant levers in the

lever frame or by turning the OCS switches to a third position.

Train describer panels are provided on each side of the signalling console to indicate the first and second trains approaching selected signals in the Stonebridge Park, Willesden and Queens Park areas, with blind storage berths for further descriptions.

Descriptions step automatically from second to first approaching position and from signal to signal and are finally cleared out when the train leaves the box area. Descriptions are automatically transmitted to and from Euston box.

Between Willesden and Kensal Green station, the Up line signalling, reading from Willesden, is arranged as follows:

Signal	Description and Function
WL2	Two aspect red/green semi-automatic signal, controlled by Willesden New Line signal box, lever No.20. This signal incorporates a junction aspect for the line to Kensal Green Junction and is the Willesden platform No.1 starting signal.
RKG8	Three aspect red/yellow/green repeater for signal KG8.
KG8	Two aspect red/yellow semi-automatic controlled by Willesden New Line signal box lever No.23. This signal also acts as a repeater for signal KG6.
KG6	Three aspect red/yellow/green automatic signal at the entrance to Kensal Green tunnel. This signal also acts as a repeater for signal KG4.
KG4	Three aspect red/yellow/green automatic signal positioned within Kensal Green tunnel. This signal also acts as a repeater for signal KG2.
KG2	Two aspect red/green automatic signal, which is the Kensal Green Up platform starting signal.

Signal to signal distances are as follows:

RKG8 to KG8 - 270 yards
KG8 to KG6 - 680 yards
KG6 to KG4 - 245 yards
KG4 to KG2 - 247 yards

Mr.Revitt then went on to describe recent alterations to signalling in the area affected.

In late-1985 a retaining wall situated on the Up side of the dc line between signals KG8 and KG6 became unstable and necessitated extensive repairs. During the course of this repair work it became apparent that the repeater signal for KG6 (numbered RKG6) would be obscured by scaffolding and sheets associated with the repair work. To permit the urgent repairs to continue, arrangements were made for signal RKG6 to be removed. Due to the removal of the repeater signal, the short term expedient of controlling signal KG8 to maximum yellow was adopted. This solution preserved the green,yellow, red sequence when KG6 was displaying a danger aspect and minimised the amount of modifications to signalling controls necessary at a time when the cable and lineside plant was being severely disrupted due to the wall reconstruction works. Subsequent works on the retaining wall completely obliterated the site and the structure of signal RKG6, necessitating a complete renewal.

These signalling alterations were implemented on

Sunday 23 March 1986 and restoration of RKG6 was scheduled for Saturday 22 November 1986.

Mr.Revitt concluded by saying that because of the age and unique nature of this signalling, its renewal with conventional three aspect track circuit block signalling with associated BR Automatic Warning System has been under development for some time. Financial authority for this renewal was given on 7 July 1986, with the commissioning of the new signalling planned over four consecutive weekends, concluding 9/10 April 1988.

The witnesses were then called, one by one, to give evidence; each one had previously made a written statement that was read out to the enquiry. (Readers may wish to refer to the diagrams at the top of the page opposite, when studying the facts and evidence).

The first witness called was the signalman on duty in Willesden New Line signal box. His statement said that he came on duty at 14.00 and the only problem encountered was an on-going train describer fault. The signal lever frame was working in 'auto' and there was no need to touch it - he was 'phoning Euston power box with descriptions. When the peak hour Bakerloo service started running he had to manually interpose Bakerloo descriptions. This was because No.106 facing points at Queens Park (which had to be reversed so that Bakerloo trains could proceed onto their own line) are controlled by the train descriptions.

He said that at about 16.45, because of the describer fault, a Bakerloo description 'flashed out' and a Euston description 'came on'. At the time he had southbound Bakerloo trains 215 and 235 between Willesden Junction and Queens Park. As train 215 would have had a wrong route, he put signal QP6 back to stop the train so he could reset the route. However, the train did not have sufficient time to stop and it overran the signal. He admitted that he could have allowed the train to go on to QP4 but when the driver came on the telephone he thought it would be quicker to set the train back to QP6 in order to reset the route. He maintained QP8 behind at danger and instructed the driver of train 215 to set back, after cautioning the driver of the following train (235) not to leave Kensal Green. The manoeuvre took longer than he expected and a queue of trains built up behind train 215.

At 17.00 he heard that the circuit breakers were going on and off between Willesden and Queens Park; the Electrical Control Room Operator gave an emergency dc isolation at 17.05. At first he thought this was due to rubbish on the track - a common problem - but then he was told that a BR train had run into a Bakerloo.

When questioned by Mr.Sawer, the signalman said that he had been a signalman since 1972 (working in the Bletchley area. He had spent the last four or five years on the North London and Watford dc lines) and had worked at Willesden since June 1986.

He said that drivers had not complained about signals being put back and the 'missing' repeater signal in the section (RKG6) had not really delayed trains. He knew that train 2C38 had passed signal KG8. The marker lights of signals are not repeated in the signal box - just the main aspect. He said that the train describer problem hasn't got a good track record and is subject to 'pretty regular' failures. It didn't usually catch him out, but it caught him this time. Questioned by a Trade Union Representative,

Figure 3: POSITION OF TRAINS LEADING UP TO THE COLLISION

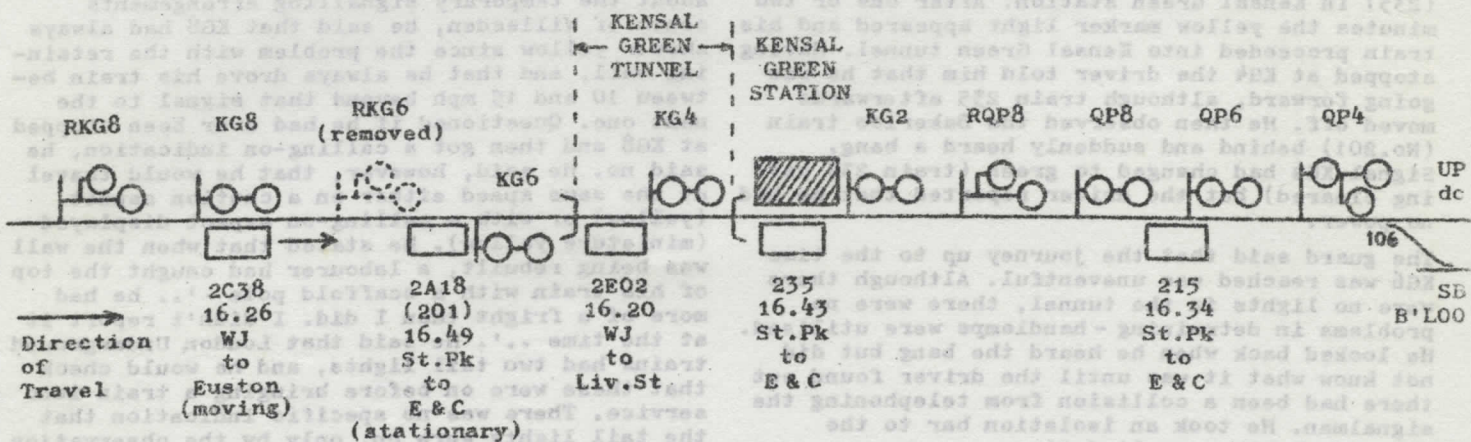
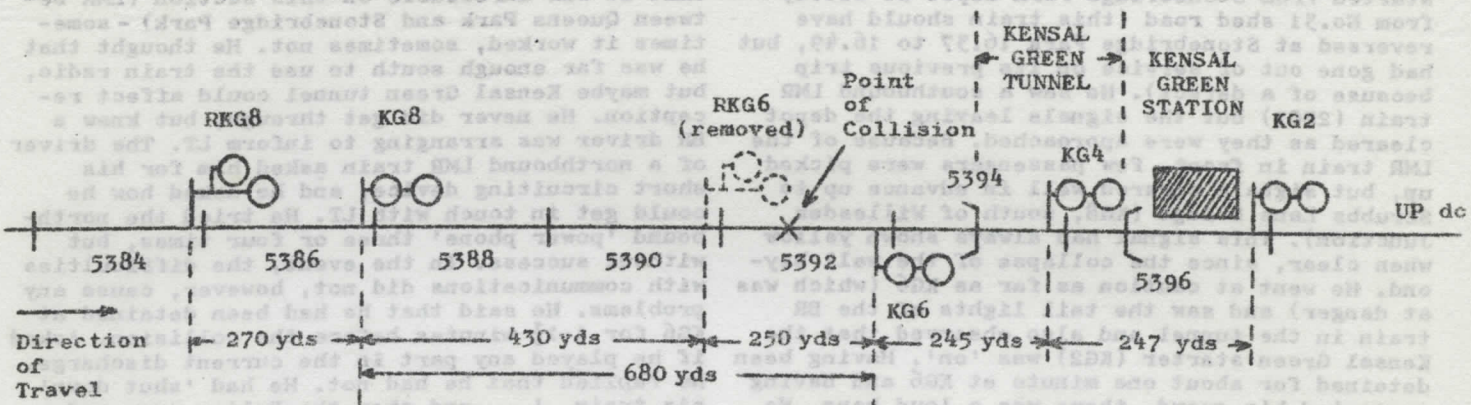


Figure 4: SIGNALS AND TRACK CIRCUITS IN COLLISION AREA



he said that since working at Willesden box there hadn't been any previous signal problems there, but was aware of failures in other locations, such as Kenton, Harrow and Bushey. He was asked by Mr. Butcher about the state of the southbound service just prior to the incident and replied that trains were running no more than two minutes late. However, train 215 eventually left at 16.57 to the Underground system at Queens Park, some 15 minutes late.

The second witness was the driver of train 2E02, the 16.20 Watford Junction to Liverpool Street. The driver told the enquiry that when the accident occurred he was in Kensal Green tunnel. On the way from Willesden he had passed KG8 which was showing a yellow aspect as usual. He found KG6 at danger and stopped his train. After about one minute the calling-on light illuminated and he then took his train forward to KG4 in Kensal Green tunnel. He saw an LU train (No. 235) ahead in Kensal Green platform and then proceeded to walk to the station to seek information. However, he had only gone about ten yards when the train moved off. He then returned to his train and '... heard rail noises'. On arriving at his train, signal KG4 was showing green, but he discovered there was no traction current. Only then did he realise that something had happened in the rear. He then detrained his passengers forward to Kensal Green station.

Questioned about the usual length of the class

313 stock, he said that these were three-cars, but six-cars did operate on empty stock movements and during special events at Wembley. He was also fully aware of the length of London Underground trains, and the recognition differences between BR and LU trains when following them. The Inspecting Officer then asked what speed he would drive if following a train on a calling-on aspect, to which he replied at his own discretion, regardless of the train length ahead. Between KG8 and KG6 he would normally drive at line speed (30 mph), but if he was passing KG8 at danger, knowing RKG6 was missing, he would drive at caution all the way to KG6 due to the restricted view, even though this section was unusually long at 680 yards. Asked how many marker lights he would see in a trip he replied very few - many a day is completed without them at all, although signal failures were fairly common on the dc lines. He could not recall, however, any failures in the Willesden-Queens Park section on previous occasions in two years driving from Watford, nor had he been inconvenienced by the missing repeater signal (RKG6).

He was then asked if he had any difficulties when detraining passengers from Kensal Green tunnel. Although passengers had to walk along a narrow catwalk, he said that the only problem was the lack of lighting. The tunnel did not have any and the train only had its emergency lighting.

The third witness was the guard of train 2E02. In his statement he said that when stopped at KG6 he looked forward and saw the Bakerloo train (235) in Kensal Green station. After one or two minutes the yellow marker light appeared and his train proceeded into Kensal Green tunnel. Having stopped at KG4 the driver told him that he was going forward, although train 235 afterwards moved off. He then observed the Bakerloo train (No.201) behind and suddenly heard a bang. Signal KG4 had changed to green (train 235 having cleared) but the driver reported that he had no power.

The guard said that the journey up to the time KG6 was reached was uneventful. Although there were no lights in the tunnel, there were no problems in detraining - handlamps were utilised. He looked back when he heard the bang but did not know what it was until the driver found out there had been a collision from telephoning the signalman. He took an isolation bar to the driver, who then applied it.

The fourth witness was the driver of Bakerloo train 201, which was involved in the collision. In his statement he said that the train had started from Stonebridge Park depot at 16.47 from No.31 shed road (this train should have reversed at Stonebridge Park 16.37 to 16.49, but had gone out of service on its previous trip because of a defect). He saw a southbound LMR train (2E02) but the signals leaving the depot cleared as they were approached. Because of the LMR train in front, few passengers were picked up, but signals cleared well in advance up to Scrubbs Lane Bridge (KG8, south of Willesden Junction). This signal had always shown yellow when clear, since the collapse of the wall beyond. He went at caution as far as KG6 (which was at danger) and saw the tail lights of the BR train in the tunnel and also observed that the Kensal Green starter (KG2) was 'on'. Having been detained for about one minute at KG6 and having contacted his guard, there was a loud bang. He was lifted from his seat, thought he was going to hit the windscreen but fell back into his seat and cracked the left side of his head on the rear panel of the cab. Although dazed, he was able to see the air gauge had registered zero, but thought he could have been 'tripped' on a red signal. He 'lapped' the drivers brake handle (which had no effect) and then shut the DBVIC. Having staggered through 'J' door into the saloon, he found that the passengers were calm and all seemed OK. He looked towards the back of his train and was shocked with what he saw. He saw his guard at track level, bleeding from his head. The guard told him that he'd gone back to check the tail lights and saw the BR train. He ran forward with a passenger. There was a man trapped in the car in the air (2052), but the man was OK. The driver tried the train radio twice, but got no reply. He had observed that a northbound LMR train had stopped, the driver of which had asked to borrow the short circuiting devices from the LU train to cut off the northbound current, as his hadn't worked. (In the event they were not needed, as current was off). He continued to try the train radio to LU control, without success. He advised his passengers that they would be detrained by walking forward, but the passengers from the BR train that had hit his train were being taken up the embankment.

The Inspecting Officer then asked the driver if he had recovered from his injuries. He replied that his neck was OK, but he still had spinal problems, which could not be solved until the inflammation subsides. However, he was fit and

willing to give evidence. The driver said that the journey had been normal from Stonebridge Park - the weather had been fine and dry. Asked about the temporary signalling arrangements south of Willesden, he said that KG8 had always shown yellow since the problem with the retaining wall, and that he always drove his train between 10 and 15 mph beyond that signal to the next one. Questioned if he had ever been stopped at KG8 and then got a calling-on indication, he said no. He said, however, that he would travel at the same speed either on a caution aspect (yellow) or with a calling-on aspect displayed (miniature yellow). He stated that when the wall was being rebuilt, a labourer had caught the top of his train with a scaffold pole - '... he had more of a fright than I did. I didn't report it at the time ...'. He said that London Underground trains had two tail lights, and he would check that these were on before bringing a train into service. There was no specific indication that the tail lights were on, only by the observation of the buttons in the relevant cab. Asked by the Inspecting Officer where the tail lights were situated, he replied that they were low down.

On the subject of train radio, the driver said that it was unreliable on this section (LMR between Queens Park and Stonebridge Park) - sometimes it worked, sometimes not. He thought that he was far enough south to use the train radio, but maybe Kensal Green tunnel could affect reception. He never did get through, but knew a BR driver was arranging to inform LT. The driver of a northbound LMR train asked him for his short circuiting device, and he asked how he could get in touch with LT. He tried the northbound 'power phone' three or four times, but without success. In the event, the difficulties with communications did not, however, cause any problems. He said that he had been detained at KG6 for 1-1½ minutes before the collision. Asked if he played any part in the current discharge, he replied that he had not. He had 'shut down' his train, '... and then the Police came and took me away to talk, away from other people'. He had no idea who took care of the passengers or his train, as the situation had been taken out of his hands by the emergency services.

The driver was then questioned about the running of his train and the train radio. He said that the train came out of depot at the scheduled time - it was not an additional train. He was aware that the train radio communicated with the London Underground Bakerloo Line Controller, except in Stonebridge Park depot, where contact was with the Tower Operator. He never previously had the need to use train radio between Queens Park and Stonebridge Park. (It was pointed out at the enquiry that train radio was NOT designed to work over this section). The driver had not previously experienced such 'blocking-back' of trains, although he had worked quite regularly over the section. He had not experienced LMR signal failures before, but 'bobbing' signals were quite common (a 'bobbing' signal is one which goes green-red-green quickly). He was asked by the enquiry how he was examined on dc lines rules when qualifying as a driver, to which he replied that the Area Manager explained the dc lines rules and signalling as part of his road training. The weekly Traffic Circular, made available to all staff, advised on changes to signalling, such as the removal of RKG6.

The fifth witness was the guard of Bakerloo Line train 201. His statement said that the train had stopped north of Kensal Green tunnel and he was told by his driver that there was another train

ahead in the tunnel. At 16.57 he removed his position switch key (which, when inserted, activates the door circuits) and walked back to check the tail lights. He saw that these were 'on' and then saw the LMR train coming. He ran forward, calling to a passenger, the train was hit and they were sent flying. He found out that the passenger was alright and helped him to the side of the track. The passenger in the next car (2052) was also alright, but was trapped due to the communicating door being jammed. He met his driver half-way along the train at track level and went to check the passengers in the third car (9053) from the rear. He spoke to the driver of the LMR train that collided with his train, who was OK, but shaken. The guard then stopped a northbound LMR train, using his hands as a hand signal. The BR driver noticed that the guard's head was bleeding and by then the Police had arrived.

The Inspecting Officer asked the guard if he was now fit, having been injured. He replied that he had six stitches in his head and two in his back and had cuts on his right shin, leg and elbow, but was now fully recovered and fit. He said that the journey up to KG6 signal had been normal. Asked why he took his position switch key out, he replied that it was to go and check his tail lights in accordance with the Rules. The driver had told him about the delay and it was necessary to check the tail lights as protection. He said that these were switched on from the rear cab and had been checked prior to leaving Stonebridge Park depot - it was part of his duty. It was necessary to open the back cab door and lean out to see they are properly illuminated.

Asked about the approach of the LMR train, the guard said he first saw it after he closed the back cab door. He still had the picture in his mind of the bright yellow front, framed in the cab window, coming towards him. He saw that the headlights were on and estimated the distance to be 90 feet, but said that the distance would be deceptive because of the rebuilt wall and the curve of the track - at the end of the wall the track straightens out. He was asked how fast the LMR train was travelling, to which he replied, '... it was hard to say, but was fast enough to know that it wasn't going to stop. There was no way he was going to stop - he's going to hit me'. To the only passenger in the car, he shouted, '... get the hell out of here!'

The guard said he had five years experience of working on the line. Many times had trains come close behind him before, but never like this - this incident had 'put the wind up him'. He told the enquiry that at this time, trains were scheduled at three-minute intervals apart (see table below).

TABLE 1

SCHEDULED SOUTHBOUND SERVICE - TIMES

Trains	Stonebridge Park (depart)	Willesden Junction	Queens Park (arrive)
215	16.34½	16.38	16.43
235	16.43½	16.47	16.52
2E02	16.46½	16.50	16.55
201	16.49½	16.53	16.58
2C38	16.53	16.56½	17.01

Prior to the accident, his train had stopped at KG8 and he had observed the top aspect at red by opening the off-side guard's door. After about one minute the train moved off at caution speed, 10 mph at the most, and slower than usual. He felt the brakes being applied as the train rounded the bend and then it stopped at KG6. The guard said that it was clear and sunny when he saw the LMR train approach, with the sun being straight ahead (i.e. to the rear of his train). He did not notice the LMR driver as the train came at him - he had turned and run and he could not say whether the driver was there or not. He said that the collision occurred when he was about ¼-of-the-way down his (rear) car, just by the leading pair of double doors. He did not try to use his short circuiting device, but derailed the one passenger and himself through the shattered double doors. He could not tell if current was off, but they avoided the live rails. The 2000 car (2052) was shunted up into the air.

The sixth witness was the driver of the LMR train (2C38, the 16.26 Watford Junction to Euston) that collided with the Bakerloo train (No. 201). In his statement he said that he had booked on duty at Watford at 15.53 before working the 16.26 service to Euston, comprising three-car EMU 313.012. The statement said that he had been detained at KG8 for about three minutes, but about 30 seconds before he moved off the main yellow aspect illuminated. He moved off and at about 20 mph saw the Bakerloo train ahead. He put the brake in No.3 position but the dynamic brake was a bit slow coming on and he ran back into the car shouting to passengers as we hit.

The uninjured driver told the enquiry that he had been a driver since 1963 and had been working on the dc lines since 1969. He was fully familiar with the line and its signals. He had passed out on the class 313 stock on 27 February 1985 and since then had no sickness. He was feeling well - just returned from holiday - had not been attending a doctor, had not been taking medication, and had not been drinking alcohol. He did have his proper rest from performing his previous duty (which finished at 23.00 the previous night). He had no problems on his mind and did not wear glasses. Although he said he could do with glasses for reading, he had no doubt that his eyesight was up to standard for driving trains.

The driver did not prepare the train for service - he took over after its arrival at Watford Junction and made a full brake test before departure. The brake had performed satisfactorily on the 13 or so stops up to the incident. The driver told the enquiry that he had stopped at KG8 which was showing a red aspect, and waited about three minutes. He knew he should have rung the signalman after one minute but knew there was a Bakerloo train ahead and did not want to be a nuisance. He saw the marker light illuminate but did not move off for another 30 seconds or so. Before he moved off he was sure that the marker light went out and the main yellow aspect came on. Whilst standing at KG8 he was leaning over the controller looking down and saw the train stop arm go down. (This would have happened when the marker light came on). He proceeded at no more than 20 mph (he estimated) and then saw the roof of the Bakerloo train - he did not see the tail lights of that train. Nor did he see signal KG6 - indeed, by that time, realising what was going to happen, his main concern was making his exit. He applied the brake in step 3 - could not recall the effect - but dropped the deadman's valve, got out of the cab and ran

through the guard's compartment, into the passenger saloon, and shouted to the passengers to 'get down!'. He was just on the passenger side of the sliding door (between the guard's compartment and saloon - which should normally be kept locked!) and grabbed hold of a seat upright as the collision occurred.

The driver was then questioned about his procedure on passing signals. He stated that he would go faster on a main yellow aspect than on a marker light alone. On the latter, he would drive his train '... very, very slowly' - at under 5 mph. He was aware that signal RKG6 was missing, having been over the route many times since. If RKG6 had been there, he would have gone slower, but knew he was alright as far as KG6, which he expected to find at danger. After the crash, the driver's first problem was to get out of the train. He did so by forcing the first pair of doors open. He advised the passengers to stay put until he had rung Willesden Power Box from the slow line signal telephone, to get current off. He said that he had just drawn his pay after having been on holiday. It made his wallet bulky in his back pocket, so he put it on his desk, along with his cigarettes and lighter. He was adamant that these had not caused him to become distracted while driving.

In response to questions, the driver stated that he did not know why he had not proceeded as soon as the marker light appeared at signal KG8. He had never before deliberately waited for a main aspect to clear before passing a marker light, but said that he subconsciously knew there was no point in going round a blind corner with the Bakerloo train ahead.

After the main yellow aspect appeared, he had moved off with (he thought) the power in stage 2. He didn't know how far he was from the Bakerloo train when he first saw it, but thought his speed was no more than 20 mph. However, he knew his speed was all right to stop at signal KG6, which he was expecting to be at danger.

He did not know why he put the brake on in step 3 (maximum application) rather than emergency, but stated that step 3 was as strong as an emergency application, and acted about as quickly. The brakes were applying before he let the deadman's handle go, but he couldn't remember how hard.

He stated that there are two other locations (at Watford High Street on the Down road and at Bushey on the Up road) where a similar signalling situation applied - i.e. a marker light would clear to yellow without there being a repeater signal between it and a train ahead.

The seventh witness was the guard of LMR train 2C38. His statement said that he took over the train at 16.57 at Willesden Junction. After closing the doors he gave the driver two bells to start. He recalled being stopped at signal KG8 for 2-3 minutes after which the train proceeded at 15.20 mph. He had noticed it slowed down a little, but then there was a loud bang. He fell over, got up, and went forward. He observed that the front of his train had been smashed in. He took an isolating bar to the driver, but current was already off. The Area Manager asked if he had put down detonators, to which he replied he hadn't, so the Area Manager then put them down. Then the guard assisted the passengers as best as he could and the emergency services assisted with detrainment.

The guard said that he had only been on the train a few minutes when the accident occurred. In that short time he didn't speak to the driver,

nor did he do so via the train telephone. He confirmed that the train had been detailed at signal KG8, and looked out of his door. He could not, however, see the signal (due to the curve of the track and the height of his train) as the train moved off. From the speed at which the train moved off, he thought that they were passing a yellow marker light rather than a main aspect. At the time of the accident he was sitting on his seat in the rear cab/compartment and had noticed slowing down just prior to the bang.

The eighth witness was the driver of northbound LMR train 2C55, the 16.37 Euston to Watford Junction, which was due at Kensal Green at 16.48 but was running late, arriving there at 16.55. In his statement the driver said that he observed a Bakerloo train (235) in the up platform. He saw smoke or fog at the north end of the tunnels so he coasted to be able to stop if necessary. As he came to the end of the tunnel he was able to see the cause of the smoke, which was by then clearing, and therefore stopped his train. He got out and tried to apply his short circuiting bar, which did not work. He then went to see the driver of the collision LMR train who was using the telephone on the ac lines (there were none on the dc lines in this area). Twice more he tried to use the isolation bar without success, after which the power went off anyway. He told the passengers what had happened and rendered what help he could.

He told the enquiry that although trained in their use, he had never used the SR-type isolation bars before, but had used the LMR type, although they did not always work. He had previously reported non-working isolation bars in the form of written reports at the end of his duty. He did not see the collision take place, but did observe trains stopped on the southbound as far back as Queens Park. Having been a regular driver on the dc lines since 1970, he went on to tell the enquiry that there has been signal problems on the line for the last two years - they are an everyday occurrence. He had reported trouble regularly but the particular signals involved with this incident hadn't given him problems before. Questioned by the Inspecting Officer on the problems with isolating bars, he said that the dc lines instruction book had been amended to give information on the newly-introduced SR type, but had received no instructions about 'cleaning' the conductor rails - '... the rust was solid and wouldn't clear'. It arose that there had been other instances of isolating bars not working and it was concluded that the line on this occasion had been isolated by the Electrical Control Room. Tests have shown that the SR-type bars did not always work the breakers! Local instructions have since been issued to staff not to conclude that current was off until confirmation had been received from the Control Room Operator. The driver stated that the application of an isolation bar does not guarantee that current will remain off - indeed, on one occasion in the past, the current was recharged and welded the bar onto the rail!

This concluded the evidence from those staff 'on the spot' and the enquiry continued with the 'technical' staff.

The ninth witness was the Supervisor on duty at Willesden, from the Signals and Telecommunications (S & T) department. His statement said that he was informed of the collision at 17.00 in Willesden Power Box. He made his way to the site and instructed the Technician (next witness) to proceed to the New Line signal box to check the position of the levers. He found track circuit

5392 occupied and the track relay 'down'. Both signals KG8 and KG6 were at danger and then he tested the marker light on KG8. This showed 'proceed' after 82 seconds. This proved that TC 5390 had been modified after the removal of RKG6. Further tests were made and at 23.00 he handed over to AS & TE staff, but stayed on site to assist.

Questioned by the Inspecting Officer, he said that he had no special responsibility for the dc lines signalling - everything in the area came under his control. He was fully familiar with the operation of the signalling system and its equipment. He arrived on site between 17.10 and 17.15 and found that track circuit occupation corresponded with the position of trains - there were no discrepancies. On hearing that the driver of 2C38 said he saw the marker light clear on KG8, he said that this would happen after the berth track (5386) had been occupied for 80 seconds, and the following two circuits (5388 and 5390) were clear of trains. The LU train (201) and BR train (2C38) were both on TC 5392 and the marker light on KG8 cleared after the prescribed time. He said that the yellow marker light on KG8 could also be displayed if the track circuit in advance of KG6 was unoccupied, but the train was still in the 'overlap' (safe braking distance) beyond KG6. For the marker light to go out and the main yellow to come on, it would need the track clear between KG8 and KG6 and the overlap of KG6 clear and KG6 proved ON. In other words both trains would need to be beyond KG4 for KG8 to clear to yellow. Asked if he thought it was possible for such a failure to occur, he said that it was not possible without many other simultaneous failures occurring at once.

On testing of the equipment the Supervisor said this occurred every three months on track circuit relays. This proved that track circuits were operating within specification. The last recorded tests were on 6th or 8th August 1986. Further, all relays concerned were checked after the accident and were further re-examined and retested after the trains had been cleared.

He was then asked by Mr. Butcher what track circuits had to be clear for KG8 to display a main yellow aspect, to which he replied 5388, 5390, 5392 and 5394. At the time of the collision the LMR train to Liverpool Street (2E02) was standing on TC5394 (at KG4) and the Bakerloo train (201) on TC5392 (at KG6). Asked how the Bakerloo Line train had got onto TC5392 with a train on TC5394, he replied that a calling-on light (at KG8) was needed; the train could not have got there on a main yellow.

Mr. Sawyer then stated that the drivers' Union, ASLEF, had expressed concern over the reliability of the dc lines signalling over the last couple of years. Among the points raised was about calling-on light lenses. It was alleged that some had full size lenses, but it was stated at the enquiry that the one on KG8 was of the correct miniature type. This followed a written complaint from ASLEF and subsequently all were checked on 9 June 1986 and were correct. (Full size lenses could be confused with the main aspect). Another criticism was that marker lights often did not work, possibly because the time delay was defective. It was said that if this was the case, then this would not affect safety, as the train would continue to be detained at the signal. Main aspect failures were often not rectified for up to 24 hours, it was alleged, in which case it was possible for a driver to encounter them three or four times during the course of a duty. These

continuing failures bred contempt. For instance, if a failure was encountered on a second or third trip, the driver could be misled into believing it was a signal failure and not a train ahead. The problem of 'bobbing' signals was also mentioned; here, the problem was said to be with hydraulic trainstops. Where a signal was 'off' for a long time, the gradual leakage of hydraulic pressure caused the train stop to go into the up position. This resulted in the main aspect 'bobbing' momentarily from green to red until the motor came on to restore hydraulic pressure. The enquiry was told that this problem was almost solved, with a newer type of train stop being used. The final point raised by ASLEF was that of repeating signals changing from green to red without warning. It was said that this, although a nuisance to a driver, was completely safe.

Thus, the enquiry was told that none of ASLEF's concerns were relevant to the KG8/KG6 situation.

In concluding his evidence, the S & T Supervisor said that with a train standing on TC5392 or TC5394, signal KG8 would display a calling-on marker light, so the Bakerloo driver of train 201 would have received this at KG8. If the driver had had a main aspect, then TC5394 would have had to be clear.

The tenth witness was a Technician on duty at Willesden Power Box at the time of the accident. Having heard of the crash he immediately went to Willesden New Line Signal Box, arriving at 17.06. He saw that TC5386 and TC5388 were clear and TC5390/2/4 occupied. On the down line TC5215/7 were occupied - all other track circuits were clear. Lever No. 23 of signal KG8 was observed to be in the reverse position and was showing 'on'. He then went to the site, meeting the previous witness, where TC5390 was clear and TC5392/4 were occupied. Many tests were carried out on the signals and cables and all were successful - no faults were found, and none of the tests gave cause for concern. Whilst on site at KG8 from 17.37 to 18.10 he did not observe a main yellow aspect during this period. Concluding his evidence, the Technician was asked if a marker light could clear before a train got to the signal. He replied that it was possible if a driver was to cover the 270 yards in 80 seconds or more - immediately the approach track circuit (TC5386) was occupied, timing would commence.

The eleventh witness was a Principal Technician from Birmingham, who was sent to the site at 19.00, arriving at about 22.30. His statement said that RKG6 had been removed temporarily, but KG8 had been modified to display maximum yellow. A new relay had been added to lengthen the overlap. He too performed many tests and stated that TC5388/90 were clear, confirming that the LMR collision train (2C38) was clear of TC5390. In his written statement, he had stated that the yellow marker light on KG8 was NOT of the miniature type. However, he admitted to the enquiry that he was not very familiar with the dc lines signalling. He was not aware that the marker lights were supposed to be miniature - the yellow one had seemed quite bright. He had been unable to reproduce the alleged fault which had caused KG8 to display a yellow main aspect with a train in front.

The twelfth witness was an Acting Technical Support Assistant from Birmingham, who participated in and completed the tests made by the previous witness. All tests were satisfactory, as were the signals and their overlaps. He had watched trains pass KG8 and signed the signal

off at 19.00 the next day (Friday). He found no faults that could account for a main yellow aspect in signal KG8.

The thirteenth and final witness at the enquiry was a Quality Control Assistant from Hornsey depot - where the class 313 stock is based and maintained. In his statement he said that he tested unit 313.012 in Willesden depot on 17 October. The brake cylinders on the two country-end cars were tested and found OK, but could not test the London-end car (62540) as it was too badly damaged. Also, as the unit was outside the depot, he was unable to make an examination from a pit. When it was suggested to him that the dynamic brake might have been slow in applying, he told the enquiry that the primary brakes of the train are air brakes operating on all axles. The dynamic brake operates on eight axles (on the motor cars) in place of the air brakes when certain conditions are satisfied. The brake control has three normal positions (1, 2 and 3). Position 3 gives maximum brake pressure, while positions 1 and 2 are one-third and two-thirds respectively. The emergency braking position (No.4) has no dynamic brake, and either position 3 or 4 should give equal brake cylinder pressure and speed of application. The operation of the power camshafts (which were found to be in position 'R' after the accident) was then explained. Position 'A' is used to start the train, then they run up to position 'R', which is full speed. In dynamic braking they go from 'R' back to 'B'. When power is shut off the camshafts stay put until dynamic braking is called for. This means that the train had obtained weak field position when the power was shut off. To get the camshafts to 'R', the driver would have had to put the controller to notch 4. (The camshafts could only get to 'R' otherwise if coasting at over 40 mph - they will run to 'R' ready for dynamic braking). Speeds need to be 20-25 mph to get full weak field ('R') depending on voltage of traction supply. The collision would not have affected shafts - one on each power car - both were 'R'. When brakes are applied, air brakes come on first and then a transducer starts the dynamic brake and the camshafts start to run down. Dropping the deadman's valve cuts out the dynamic brake. The camshafts would leave position 'R' maybe two or three seconds after the brake handle was put into position 3. Nothing could be found to suggest that the dynamic brake was not functioning correctly. The driver could have had this brake cut out from the cab, but the position of the circuit breaker couldn't be ascertained after the crash. A driver can tell if his dynamic brake operates by hearing the whine of the motors. He also did not think the driver could have got into brake step 4 without knowing - there are distinct notches on the brake handle.

In concluding the enquiry the Inspecting Officer reiterated ASLEF's queries on the dc lines signalling - drivers could forget they are running on calling-on marker lights if they have to do it too often. In the 1962 collision (also on 16 October) Col.Reed queried the operation of trains on the dc lines, and some of his reservations made then still stand, despite the different circumstances of this collision. The Inspecting Officer was also concerned about BR rolling stock being much stronger than London Underground's - clearly, the latter's came off worst. Despite all this, Mr.Sawer said that the line had a good safety record over the years. He said that there had been no serious injuries in this incident, but 'chance' had played a large

part in that. His report would be published in due course.

THE KENSAL GREEN COLLISION ENQUIRY

A PERSONAL VIEW

by

Nick Mitchell

As the title of this article implies, the views expressed below are my own, and do not necessarily represent those of the Society, or of anybody else for that matter.

In his closing remarks the Inspecting Officer mentioned the earlier 1962 collision, which (by a strange coincidence) also occurred on 16 October. On this earlier occasion, an up LMR train had also run into the back of a Bakerloo Line train, after passing a red signal on the authority of a yellow marker light. The 1962 collision took place between Watford Junction and Watford High Street, following a signal failure in foggy weather conditions. Again, the LT train came out of the encounter a very definite second best, and two passengers in it were trapped and seriously injured.

The accident was blamed on the LMR driver who had proceeded past the yellow marker light without sufficient care, in the belief that the track ahead was clear and the main red aspect was being displayed as a result of a signal fault. A contributory factor was that, due to a fault in the timing relay, the yellow marker light had appeared before the train had come to a halt, so the driver had not stopped at the signal.

In his report on the 1962 accident, Col.Reed expressed his misgivings about the unconventional nature of the signalling on the dc lines, and recommended that the system be altered so that a yellow marker light would not appear at a red signal until one minute after the driver had stopped and depressed a plunger, which was to be provided on the signal post.

It would appear that British Railways subsequently saw fit not to follow this recommendation. Had they done so, the course of events at Kensal Green would very probably have been different, and BR's omission is to be depreciated.

Turning now to the Kensal Green collision, my first comment concerns the Willesden signalman's unorthodox action in setting back Bakerloo train 215. As he himself implicitly admitted at the enquiry, this was an error of judgement: with hindsight it would have been quicker and less disruptive to send the train on. However, the manoeuvre should not have been a dangerous one as there should have been adequate protection for the following trains. The signalman's action therefore, was not a direct cause of the collision and I do not think he should be blamed for the accident.

Neither do I believe that brake failure played any part in the accident. Although the LMR driver said his dynamic brake was slow in coming on, no defect was found in it, and from the technical evidence it would appear that it does not operate until after the air brake comes on. In the circumstances it would have been only natural for the driver, with a collision imminent, to have dropped the deadman's handle before the dynamic brake had had a chance to operate, in order to beat a hasty retreat from his cab. Once the deadman's valve had been operated, the

dynamic brake would have been cut out. From the position of the camshafts, it would appear that this happened within two or three seconds of the brake handle being put into step 3. The driver cannot be criticised for not making an emergency brake application, since this would not have stopped his train any sooner. It seems fairly clear, however, that he was not expecting to find a train ahead, and that he was not driving with the caution and vigilance which the rules demand that drivers exercise when passing a signal at danger on the yellow ('calling-on') marker light. From his evidence, it appears likely that the driver was looking out for signal KG6 just before the collision occurred.

In this case, because of the greater height of LMR trains, and the height of the signals, it seems likely that the roof of the Bakerloo train would have been below the driver's line of sight (as was the case in the 1962 collision) and the driver might therefore have - literally - overlooked the Bakerloo train for a few vital seconds before noticing it. (I am not aware if any sighting tests have been carried out which would confirm this, or if any braking tests have been done to try and establish the speed of the LMR train or the point at which the brakes were applied).

Therefore, the question which remains is, why was the driver proceeding in this manner? There seem to be three possibilities:

- (1) The driver had received a main yellow aspect at signal KG8;
- (2) The driver passed signal KG8 while it was showing a yellow marker light, but mistakenly thought he had received a main yellow aspect; or
- (3) The driver passed KG8 while it was showing a yellow marker light but, believing his road was clear at least up to signal KG6, drove too fast and did not keep a proper lookout for any obstruction ahead, as the Rules demand.

The first possibility would mean that there was a signal fault and the driver's evidence to the enquiry was correct. The second possibility would imply that his evidence, although given honestly, was mistaken, and the third possibility would imply that he was lying. Let us consider these in turn.

1. The driver of Bakerloo train 201 made no mention of signal KG8 being red, or of passing it at danger after the yellow marker light had come on. This signal should not have displayed a main yellow aspect while the BR train ahead was standing at KG4 in Kensal Green tunnel. Thus, this driver's evidence would appear to indicate that there was something wrong with the signal. However, his guard stated that the train had stopped at KG8 which was showing a red aspect, and then proceeded at a slower speed than usual. This would seem to imply that train 201 passed signal KG8 on a yellow marker light, and I can only surmise that the driver had forgotten about this as a result of the bang on his head that he received shortly afterwards. After the accident the signal was, by all accounts, tested very thoroughly, and nothing was found that could have caused the alleged fault.

2. It is interesting to note that the Principal Technician from Birmingham stated in his evidence that the yellow marker light of KG8 was not of the miniature type. If he could make this mistake then it is also possible that the LMR driver could have mistaken this light for the main aspect, especially if he had been looking

away from the signal and then glanced quickly back at it to see if it had yet cleared. In these circumstances he might have failed to register the position of the yellow light he saw, which would have told him he was looking at a marker light and not a main aspect.

3. From the LMR driver's evidence, it would appear that signal KG8 is one of only three on the Watford line where a yellow marker light can illuminate without the line ahead being clear as far as the next (stop or repeater) signal. This unusual situation arose as a result of the temporary withdrawal of RKG6. If the driver had, temporarily, forgotten or overlooked this fact then he would have believed the road to be clear ahead as far as signal KG6, a distance of 680 yards - much longer than the average spacing between signals. In these circumstances, it would have been very easy for him to drive too fast to be able to stop in the limited distance he could see ahead round the blind bend.

I do not think that, on the evidence given at the enquiry, any of these three alternative possibilities can be ruled out, or accepted, with any degree of certainty. However, I feel that an intermittent and untraceable electrical fault is less likely to have caused the accident than human error. I also find it suspicious that the driver of the LMR train in this instance unaccountably waited an extra 30 seconds after the yellow marker light appeared before he moved off, but had never done this before. (It has been conjectured that the driver was checking his pay packet, but this, of course, is pure speculation).

These considerations lead me to feel that, of the three explanations outlined above, the first is the least likely, and the second is less likely than the third. After all, excessive speed under 'stop and proceed' conditions has caused quite a few accidents in the past, and it seems a bit unlikely that an experienced driver could make a mistake about a signal aspect, even at a quick glance.

Although I feel that this accident was probably caused by driver error, I think that shortcomings in the signalling system were a major contributory factor.

A signalling system must, of course, be 'fail-safe', i.e. it must be designed so that no conceivable failure, or combination of failures, could ever result in a train being given a false 'proceed' indication. But this alone is not enough. The signalling system must also be reliable if it is to be safe in operation.

Frequent signal failures will tend to breed contempt among train drivers, whose natural tendency, on finding a signal remaining at danger, will be to assume that it has failed, and to ignore the possibility of there being a train ahead.

Several of the witnesses referred to the shortcomings of the signalling equipment in use on the dc lines, and it seems quite clear that drivers have little confidence in its reliability. I share their mistrust, and find it disturbing that there should be room for doubt as to whether signal KG8 did in fact display a main yellow aspect. It should also be borne in mind that the original delay to the service, which caused trains to 'block back', was caused by a faulty train describer.

Even if the equipment were more reliable, I think that the design of the signalling installation is open to severe criticism. On the dc

lines at the time of the accident, a yellow light could have had no less than four separate meanings.

The normal meaning of a yellow light, if it is a main aspect, is that the line is clear to the next signal, which is at red. But in the case of KG8, the yellow main aspect only told the driver that the line was clear to the next signal, which could have been showing any aspect. This arrangement was undesirable, I feel, because drivers would quickly have become familiar with it, and any 'warning' message the yellow light might have conveyed would soon have tended to become devalued, since the next signal would normally have been found at green.

Thirdly, a yellow light (if it is a marker light) would normally mean 'proceed at caution speed; the line is clear as far as the next signal'. However, in a few cases (including this one) it would only have meant 'proceed at caution speed; the line is clear for part of the way to the next signal, but not necessarily for the remainder'.

It cannot be right that the same colour of light had four different meanings. Such a situation is surely calculated to cause confusion.

The non-standard nature of the dc line signalling cannot be an advantage, either - the Principal Technician, who was sent from Birmingham to test and examine the equipment, admitted that he was not very familiar with the dc line signalling. And Kensal Green was a particularly unusual location, even for a non-standard system.

In short, the signalling on the dc lines is obsolete, confusing, unreliable, and non-standard. I am glad that, even before the accident, British Rail recognised that it is high time it is replaced, and that they are taking action accordingly.

Communication difficulties seem to arise after every accident involving Underground trains, and this case was no exception. The Bakerloo train driver made a number of fruitless efforts to contact his controller on the train radio, but

this is not designed to work on the line beyond Queens Park, and the train was not far enough south to be within transmission range. In the event, the communication difficulties do not appear to have caused a major problem, since the driver of the LMR train was able to get a message through to Willesden Power Box, and arrange for traction current to be cut off.

This was just as well, since the short circuiting devices carried on the trains did not appear to do their job very well. It is essential that train crews have the means of discharging traction current quickly in an emergency, and I trust that BR are taking urgent steps to ensure that the isolating devices carried on trains using these lines will operate the circuit breakers and cut off the current.

It is very fortunate that the guard of the Bakerloo train did his duty and checked his tail lights just when he did. If he had been at his position at the time of the impact, then he would almost certainly have been killed or seriously injured. Likewise it is fortunate that the Bakerloo train was lightly loaded, and that the few passengers who were on board escaped the serious injuries which might have been expected, given the extent of the damage to that train's rolling stock.

Because of their differing buffer heights, a collision between a Bakerloo and an LMR train, even at a comparatively low speed, is likely to have far more serious consequences than a similar-speed collision between two trains of the same type. For this reason it is especially important that all possible measures be taken to prevent collisions on the dc lines.

For adequate safety in 'stop and proceed' situations a signalling system is needed which will ensure firstly, that a train which passes a signal at danger is halted, thus alerting the driver, and secondly, that a very restricted speed is enforced thereafter while the line ahead is not proved to be clear. I hope that the new signalling installation will satisfy these criteria when it is commissioned in the spring of 1988.

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