



DEPARTMENT OF TRANSPORT

RAILWAY ACCIDENT

**Report on the Collision that
occurred on 11th September 1975
at Bricklayers Arms Junction**

IN THE
SOUTHERN REGION
BRITISH RAILWAYS

LONDON: HER MAJESTY'S STATIONERY OFFICE

£1.25 net

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SIR,

I have the honour to report, for the information of the Secretary of State, in accordance with the Order dated 11th September 1975, the result of my Inquiry into the collision between a passenger train and an empty coaching stock train that occurred at 09.43 on that day at Bricklayers Arms Junction in the Southern Region of British Railways.

As the 09.02 electric multiple-unit passenger train from Epsom Downs to London Bridge was travelling under clear signals from the Up Slow line to the Reversible line at Bricklayers Arms Junction, it collided at between 20-25 mile/h almost head-on with the diesel locomotive hauling the 09.42 empty coaching stock train from London Bridge to New Cross Gate Carriage Sidings. The empty coaching stock train had been brought to a halt by its driver on seeing the approach of the electric train after he had passed a multiple-aspect colour-light signal at Danger, under the impression that the subsidiary position-light signal was exhibiting a proceed aspect.

The emergency services were rapidly alerted both by the signalling staff at London Bridge Signal Box and by witnesses of the accident. The collision blocked the Reversible, and the Down and Up Spur lines and discharged the 750V DC traction current; in order to evacuate the injured and other passengers and staff from the site and to allow clearance work to be undertaken, current was also discharged from the Up and Down Fast and Slow lines which were closed, trains being stranded over a wide area.

The majority of the 82 passengers and railway staff who were injured suffered only minor injuries or shock; 9 were detained in hospital but of these only 2, both members of the railway staff, were kept there beyond the following day. The Down Fast and Slow lines were re-opened at 11.22 followed by the Up Fast and Slow lines at 14.45 and the remaining lines were re-opened at 21.30 on 11th September.

DESCRIPTION

The Site

1. To the north of New Cross Gate Station, travelling in the Up direction towards London Bridge, there are four lines of railway, with the Up lines on the west side. At Bricklayers Arms Junction, where there are crossovers between the Up and Down Fast and Slow lines, the lines towards London diverge to run on three separate formations, with the Up and Down Goods lines to the left leading from the Up Slow line to North Kent West down a falling gradient; to the right the Up Fast and Down Fast and Slow lines continue curving to the right on a slightly rising gradient towards Blue Anchor; and on the centre formation curving to the left before becoming straight on a rising gradient of 1 in 162 steepening to 1 in 106, the Up Slow line becomes the Up Spur line and there are connections from the Up Fast and the Up Slow lines to the Down Spur line and the Reversible line which lie to the east of the Up Spur line. The collision occurred where the connection from the Up Slow (Up Spur) line joins that from the Up Fast and the lines then divide to become the Reversible and Down Spur lines. At the point of collision the Spur and Reversible lines lie approximately south-east to north-west and are running on an embankment some 20-30 feet above land containing factories, houses and playing fields. Normal line speed over the Spur, Reversible and Up Slow lines is 60 mile/h; over the diverging route at a set of points the speed limit is 25 mile/h. The layout of the lines and signals in the area together with the routes of the two trains concerned is shown on the plan at the back of the report.

The Signalling

2. In the area of Bricklayers Arms Junction trains are signalled under the Track Circuit Block Regulations using equipment which was commissioned in July 1975 controlled from a standard British Railways entrance-exit panel at London Bridge Signal Box through a micro-core link to a local relay room at New Cross Gate which contains the safety interlocking equipment. Four-aspect colour-light running signals are used with theatre-type route indicators for slow speed routes and junction indicators for higher speed routes. Shunting and subsidiary signals are of the position-light type with theatre-type route indicators where necessary; when mounted independently they display a red and white aspect for Danger and two white aspects for proceed, mounted in conjunction with a main running signal they are normally not illuminated and for a proceed aspect display two white aspects at 45°. Point machines are electrically operated with AC detection circuits. All the lines are fully track circuited and electrified on the Southern Region standard 750V DC system. As its name implies the Reversible line is signalled and equipped for movement in either direction.

3. Bricklayers Arms Junction is protected by Signals L543 on the Reversible and L545 on the Down Spur line. Both are mounted on a right hand bracket with the red aspect of Signal L545 16 feet 6 inches above, and 3 feet to the left of, the left-hand running rail. As they control slow speed movement they are equipped with theatre-type route indicators each displaying two routes. Signals L543 and 545 are provided with a shared overlap of 174 yards towards the connections at Bricklayers Arms Junction and reduced overlaps of

47 and 49 yards respectively for movements over the common section beyond No. 965 points. To the right of each of the bottom (red) aspects a subsidiary signal is provided with its centre 2 feet to the right of the main signal red aspect. These control movements from the lines concerned into the 2 Carriage Road lines at New Cross Gate. The illumination of position-light subsidiary Signal L545 is approach controlled by the occupation of a track circuit commencing 360 yards in rear of it. Signal L545 is 174 yards from the point of collision.

4. The signals controlling movements towards Bricklayers Arms Junction on the Up Slow line are L556 and L552. Signal L556 is at the north end of the platform at New Cross Gate on the upright supporting a signal over the Up Fast line. To the left of its bottom (red) aspect is mounted a subsidiary signal controlling movements into the Carriage Road from the south. Signal L552 is the signal immediately protecting the junction and has a 3-position junction indicator; it is mounted at the top of the upright supporting a bracket for another signal, immediately to the left of the bottom (red) aspect of Signal L552 is a subsidiary signal controlling movements onto the Up Goods line. Signals L556 and L552 are normally respectively 322 and 232 yards but Signal L556 has a reduced overlap of 181 yards. All signals are equipped with signal post telephones. On the parapet wall beside the Reversible line there are two lights showing in both directions as a warning to staff working on the track. One white light is illuminated when an Up train is signalled over the Reversible line and two when a Down train is signalled.

5. In London Bridge Signal Box the entrance-exit route setting panel has a separate line diagram mounted vertically above and behind it. When a signalman wishes to set a route forward from a signal he presses the entrance button and a flashing white light appears at its base, he then presses the exit button at the end of the route and, provided the route is available and can be set, a row of white lights appears on the display panel along the route and the indication for the signal aspect changes from red to green indicating that a proceed aspect is being displayed. Different indications are not given for green, single, and double yellow aspects but there are separate indications for main and subsidiary signals. Where there are alternative overlaps for a signal an exit button is provided at each overlap point and, for instance, when a route is to be set from Signal L537 which is the signal preceding Signal L545 and the full overlap is not available in advance of Signal L545 then the reduced overlap exit button is pressed, and the clearance of Signal L537 is approach controlled to ensure that the speed of the train has been reduced prior to it entering the route. When the full overlap is available then the clearance of Signal L537 is not under approach control. AWS is not yet provided on the lines concerned. The staff warning lights referred to in paragraph 4 are repeated on the diagram and, in addition, an arrow on the diagram is illuminated to indicate in which direction a train is signalled over the Reversible line.

The Trains

6. The 09.42 locomotive-hauled empty coaching stock train from London Bridge to New Cross Gate Carriage Sidings (5D33) consisted of locomotive No. 33 041 hauling 8 gangwayed vestibuled coaches and (trailing at the London end) locomotive No. 33 047. This train had a tare weight of 424 tons 10 cwt and an overall length of 632 feet. This formation is adopted to remove the train locomotive with the coaching stock from the terminal platforms in order to avoid two separate movements out of the station. The two locomotives were both built in 1961 and were of identical construction. The coaches were built to the BR Mk I design between 1953 and 1962. They were of all-steel design with 'Buckeye' couplers and Pullman gangways and 2-pipe air braking was in use. The 09.02 Epsom Downs to London Bridge (2H27) consisted of British Railways Class 405/2 4-car suburban unit (4-SUB) electric multiple-unit (EMU) No. 4704. This train had a tare weight of 132 tons 4 cwt and an overall length of 257 feet 5 inches over buffers. The underframes of the 2 motor coaches (end vehicles) of the EMU were built in 1925 and converted to their present form in 1950 the bodies being built at the same time. One of the trailer coaches (centre vehicles) was built in 1929 and then rebuilt in 1950 with a body built at the same time and the other was built in 1947. All had steel frames with sheet steel cladding and the coaches were permanently coupled together with centre buffers and 3-link couplings. The unit was fitted with Westinghouse automatic air brakes.

The Course of the Collision and the Damage Caused

7. Having brought his train to a stand on the Down Spur line at Signal L545 the driver of 5D33, under the impression that the subsidiary position-light signal was exhibiting a proceed aspect for his movement to the Carriage Road, released the brakes and moved his train forwards. Almost immediately he became aware of the approach of 2H27 which was travelling towards him on the Up Slow line and then proceeded to cross his route from his right-hand to his left-hand side in order to gain the Reversible line. He applied the brakes, and with his secondman evacuated the cab by the side doors; the train was almost at a stand when a glancing head-on collision occurred. The driver of the EMU also made an emergency brake application when he saw the diesel locomotive coming towards him but could do no more than to reduce the speed of his train before the collision. The two trains met at a slight angle which resulted in the leading coach of the EMU being lifted up and pushed past the locomotive, coming to rest leaning over at an angle with the passenger accommodation effectively intact. The cab of the locomotive and that of the EMU were completely destroyed by impacting into one another. The front of the EMU was pushed back into the guard's van, the buffer beam was bent approximately at right angles from the mid-point, and the underframe rode up over the locomotive frame allowing the locomotive buffer beam to push the motor bogie back to a point near the trailing bogie. The under-frame equipment of the leading motor coach was extensively damaged but the remaining three coaches of the EMU were effectively undamaged. The front of the leading locomotive was pushed back approximately

15 ft and considerable damage was caused to the leading end of the engine compartment. Both solebars were bent, the air pipes, conduits and brake gear of the bogies were damaged, and the headstock at the leading end was badly bent. All the front fittings were severely damaged and the buffers were torn off. The rear end of the leading locomotive and the front of the leading coach of the train were slightly damaged where they had impacted and this had resulted in the leading bogie of the leading coach being derailed. The remaining coaches and the trailing locomotive of the empty coaching stock train were effectively undamaged.

EVIDENCE

As to the Way in which the Trains were Signalled

8. *Area Inspector D. Mutton* was on duty on a 12 hour shift in London Bridge Signal Box on the day of the accident supervising signalmen in their training which he had been doing since the signalling was commissioned on 27th July 1975. He told me that there were two panels, numbers 8 and 9, in use, the latter controlling the terminal part of the station. One signalman was appointed to each of the two panels and because of the newness of the work and the pressure, a third man was allocated to act between them. The areas in which they worked were not closely laid down and the panel was split up between the men as they liked. There was no objection to their overlapping or to one signalman setting a route in that part of the panel controlled by another signalman since the safety interlocking only permitted safe routes to be set and only one route could be set at a time. At about 09.45 he noticed Signalman Thomson turning round whilst speaking on the telephone and then saying, while pointing to the panel display, "that train up there has collided with that train there and they want ambulances". He arranged for the alerting of the emergency services and then with the aid of the signalmen supervised the isolation of the traction current, and arranged for the safe detraining of the passengers. After the accident he noticed that the two Carriage Road lines were indicated as being occupied, and this meant to him that the empty coaching stock train must have been held at Signal L545. He also noticed that Signal L545 was indicated as being at red and there was no indication that the subsidiary signal was exhibiting a proceed aspect. Points No. 965 were lying Normal which meant that they were set for a route along the Reversible line. The train describer display showed 5D33 in the berth of Signal L545 and 2H27 was in the display on the Reversible line. Immediately after the accident all the entrance buttons were pulled out in order to put all signals to Danger.

9. Mr. Mutton told me that the booked working for 2H27 was via the Up Spur line but that since the Reversible line has a clear run into Platform No. 12 in which the train was due to terminate, the signalmen may route the traffic as circumstances permit and in this case they acted quite correctly in routing the passenger train as they did. He could not remember there having been any failures of Signals L545, L552, or L556; nor had he heard any complaints in respect of the sighting of those signals from drivers and could not recall any occasions when drivers had telephoned on the signal-post telephones to query whether a signal was exhibiting a proceed aspect or not. Later on, after the accident, a driver did telephone from a signal, probably L554, and asked the signalman to tell him whether the subsidiary position-light signal was exhibiting a proceed aspect because the sun was shining on the gantry, but up until that time he had no knowledge at all of drivers telephoning about this problem.

10. *Signalman H. J. Floyd* was on duty on No. 9 panel on the morning of the accident. He told me that he cleared the signals for 5D33 which although due to leave at 09.42 actually left at 09.38, he then discussed with Signalman Chick the running of 2H27 on the Reversible line to avoid a conflict with a train proceeding on the Up South London line. He told me that he actually asked Signalman Chick to let the Epsom travel on the Reversible line and that he replied "all right". The last exit button which he used for 5D33 was that by Signal L511 and the train was travelling on its booked route. When he heard that there had been an accident he replaced the signals for a train which was just about to depart from London Bridge but apart from that he had not had any occasion to alter or reverse any signals that day. He told me that he had been in the old London Bridge Signal Box for 3 years and had moved into the new signal box when it was first commissioned. He could not recollect drivers expressing difficulty in seeing signal aspects, nor could he remember an occasion when a driver had telephoned him and asked whether or not a signal was showing a proceed aspect.

11. *Signalman E. T. Thomson*, who was in charge of No. 8 panel told me that the trains were running nearly on time and that he had discussed with the signalman in the middle and the man on No. 9 panel which way they should run 2H27. All three had agreed that it should travel in the Up direction on the Reversible line so he signalled the train in that way using the entrance button on Signal L552 and the exit button on Signal L536. Although he had originally said that both the Carriage Road lines were empty, upon reflection he was sure that they were occupied, consequently the intention was to detain the empty coaching stock train on the Down Spur line. At about 09.44 there was a telephone call from Signal L547 on the Goods lines and someone who described himself as secondman on the empties on the Down Spur line said "we've run into the Up passenger train, we thought we had the signal—can I go now to help get the people out". He said that after telling the secondman that he could do so he turned round and asked for the emergency services and, when the current was cut off over the whole area, carried on answering the telephone when drivers rang up because they had lost traction current.

12. He told me that after the accident he noticed that the routes were correctly set for both trains; that for 5D33 from Signal L537 on the Down South London line on the reduced overlap to Signal L545 on the Down Spur line. For 2H27 the route lights were illuminated on the panel from a position in advance of Signal L552 onto the Reversible line. The train description 5D33 was in the berth of Signal L545 and that of 2H27 was in a berth on the Reversible line. Since it had been accepted that 2H27 would run up the Reversible

line he did not think that another signalman would have attempted to set a conflicting movement for 5D33 because the interlocking would not have permitted it. He was quite certain that the reduced overlap button at Signal L545 had been pressed by the other signalman because the normal overlap would become occupied by 2H27. He could not remember which of the two trains had been signalled first, but it was only possible to set one route at a time. He had not received any official complaints from drivers who found difficulty in seeing the proceed aspect of the subsidiary Signal L545 but he had talked to drivers who had said that they did not like the new type signal hoods compared with the old ones.

13. Working between panels 8 and 9 in what is known as the 'middle-mans' position was *Signalman G. W. Chick* who said that he set the route for 5D33 from Signal L537 to Signal L545 using the reduced overlap button at the latter signal because it had been agreed that 2H27 would travel over the Reversible line. He could not remember which train had been signalled first, but he would not have signalled the empty coaching stock train right through to the carriage sidings at New Cross Gate because they had stock in them. He was sure that he had used the reduced overlap button at Signal L545 because to use the normal overlap button would have resulted in attempting to signal conflicting movements. Immediately after Signalman Thomson said that there had been an accident he replaced all the signals in the area to Danger but before that he had not had any occasion to set a route and then to cancel it. He had worked in the signal box for about 10 days when the accident happened. He knew that the approach locking prevented him reversing a signal and then changing the route in the overlap of that signal before a time release of two minutes had operated.

As to the Running of the Trains

14. Because of his injuries I was unable to interview *Driver R. W. Williams*, the driver of 2H27, until 17th October when I saw him at home with his leg in plaster in the company of his union representative. He told me that he left New Cross Gate normally and thought that there had been a single yellow aspect in Signal L556 and that on approaching Bricklayers Arms Junction he had seen a double yellow aspect in Signal L552. Because there are 4-car gaps in the conductor rail near the old signal box he was allowing his train to coast at about 30 mile/h when he saw the other train coming towards his line; after a second or so he made a full emergency Westinghouse brake application, let go of the DSD, realised that he could not stop short of the other train and that his side of the cab would get the worst of any impact, and went over to the other corner; he believed he had sounded the horn but was not certain. He thought that about 6 seconds elapsed between his brake application and the collision and the next thing he remembered was regaining consciousness in his cab and being trapped by his legs.

15. In charge of 2H27 was *Guard T. Martin* who remembered giving the ready to start signal with a green flag at New Cross Gate Station while the starting signal at the end of the platform was showing a single yellow aspect. He looked out of the brake van window to check his train as it drew away but withdrew his head and did not look out again until the collision occurred. He did not recollect the brakes being applied before the collision and thought that his train was travelling at about 25 mile/h, the normal kind of speed that it would have been doing in the Bricklayers Arms Junction area. He was unable to protect the train after the collision because he was injured, but he was assured by a permanent way man that this had been done.

16. In the leading cab of the locomotive at the rear of 5D33 was *Driver T. G. Wiltshire* who had driven a train from East Grinstead to London Bridge, the empty stock of which then became the train involved in the accident. The main controller of the locomotive was in the 'Off' position and the engine was not running so that his locomotive was being towed as part of the train. After the front locomotive had been attached to the train at London Bridge he remembered the train starting and having a very slow journey, its driver applying the brakes presumably at signal checks, until they came to a stand at Signal L545 where he estimated that they stood for at least half a minute. The train then moved forward again and had gone 4 or 5 coach lengths when there was an emergency brake application and almost at the moment at which the train came to a stand he felt the impact of the collision. He jumped out of the cab and ran forward on the right-hand side of his train but did not look at any of the signals on the way. On seeing the leading locomotive he realised that if the driver and secondman were still inside he could not help them. He obtained a short-circuiting bar which he put on the Up Spur line, went to a brake van in the EMU and took the emergency tools from it, and helped to free the driver of the EMU from his cab. He did not carry out protection of any of the trains involved. The driver of the EMU told him "I definitely had two yellows on that last signal" while the driver of the train to which his locomotive was attached told him "I definitely had the two white lights".

17. The secondman of the leading locomotive of 5D33 was *Secondman P. G. Collins*. He had booked on at 05.25 and then travelled with a light locomotive to East Grinstead to work the 08.02 to London Bridge where the locomotive had been detached from the train and then coupled to the rear of a train to work it as 5D33 to New Cross Gate Carriage Sidings. He told me that after setting off from London Bridge they travelled normally and he thought that their speed would have been about 20 mile/h. He remembered seeing a single yellow aspect and junction indicator at Signal L537 but could not remember whether or not the signal had cleared to that aspect from red as they approached it; he said that Signal L545 was displaying a red aspect at the bottom of the Spur line. After standing at the signal for a short while he looked up, leant forward, and shielding his eyes from the sun saw the subsidiary signal through the dirty upper half of the windscreen. He thought it looked as though the signal was 'Off' but could not see it properly and so got up and went to the driver's side door. The sun was behind the signal and he did not see the aspect become illuminated but when he looked at it from the driver's door he did not think he had to shield his eyes. He said that he had seen a number of position-light signals both in the London Bridge and other areas and knew how they should appear when they were 'Off'. He described what he saw when he looked out of the driver's door as a light in each of the two glasses but not the same as he had seen in other position-light signals when

they were 'Off'; it wasn't as clear and with the sun behind it and the fact that they had been noted as bad signals he thought there might be something different. He thought he said to his driver "it looks as though it's off"; his driver agreed with him, and they moved off. He then saw the other train appear from behind the old signal box and realised after a few seconds that they were on a collision course. The driver made an emergency brake application, the horn was sounded, and then they both jumped. He thought his train was at a stand when he jumped and he went and telephoned from a signal close by. The signalman asked him who he was and he gave the details of what had happened. Although he went back to have a look at the position-light signal afterwards, he only looked at it from the ground because of the damage; it was not illuminated at that time. He thought the locomotive had stopped half a length away from the signal when they first came to a stand and said that because the signal was positioned more on the driver's than the secondman's side, he had gone over to the driver's window rather than looking out of his own.

18. Driving 5D33 at the time of the accident was *Driver D. P. Park* who told me that after leaving London Bridge he received mostly green aspects until approaching Signal L537 at about 15-20 mile/h and slowing down he received first a double yellow and then, at Signal L537, a single yellow aspect with junction indicator, but could not remember whether the signal was at Danger when he first saw it. He had travelled along the Down Spur line less than a dozen times since the introduction of the new signalling. As they approached Signal L545 the main signal was at Danger and they came to a stand at it with the cab about 6-8 ft back from the signal. He held the train stationary all the time they were standing at the signal with the automatic brake but did not look at it all the time to see the subsidiary aspect become illuminated. His secondman commented on the backplate and then got out of his seat, looked round the door, and said "we've got the road"; he leant forward to see the signal and in his own words "I wasn't a 100 per cent sure so I stuck my head out of the window and I could see the signals were illuminated". He had first looked through the windscreen but the sun was shining in his eyes and so he had looked out of the window. He would not have taken his secondman's word for the fact that the signal was clear and when he looked at it he thought it was as bright as other position-light signals he had seen. He was sure it was alight although the whole of the lens did not have the same illumination. He said that once they had started away he did not look up at the signal again and confirmed the evidence of his secondman concerning the actions leading up to the collision. He later isolated his locomotive and assisted passengers.

As to the Signalling Equipment and Subsequent Tests

19. At the time of the accident *Senior Technician C. Freemantle* was in the mess room at the New Cross Gate relay room. He confirmed that there was nobody in the relay room and nobody at any of the locations who could have been making adjustments or alterations that might have caused an irregular illumination of the subsidiary aspect of Signal L545. He had not had any occasion to carry out any modifications or adjustments in the relay room or in the location cupboard prior to the accident.

20. In the signal box at the time of the accident was *Mr. R. Bell* the *New Works Assistant (Construction) of the Chief Signal and Telecommunications Engineers Department* who had been responsible for the installation of the signalling equipment. He was waiting to test a new panel when he was told that an accident had occurred. He immediately crossed to the panel where he saw that a route had been set from Signal L552 to Signal L536 on the Reversible line and that 2H27 had passed along the route and was occupying track circuits WF and WG, the white route lights had extinguished in rear of the train but were still illuminated beyond the train to the exit from the route. The arrows beside the Reversible line on the diagram were illuminated to indicate that an Up train was signalled denoting that the locking was still effective for an Up train. One staff warning light was also illuminated on the panel again indicating that the route was locked for an Up train. He also saw that track circuit UU was occupied on the Down Spur line and the train describer berth in that line at Signal L545 was displaying the code 5D33. He explained that these indications were what he would have expected to see if an Up train was proceeding on to the Reversible line with a train waiting at Signal L545 on the Down Spur line. The detection of the points showed correctly No. 966 Reverse and No. 965 Normal. The panel indications for Signals L543 and L545 were showing red, the subsidiary signals were not repeated as being illuminated, and everything seemed in order except that there was no movement.

21. He told me that shortly after the accident every button was pulled in order to stop all traffic and that as soon as all train movement had ceased he attempted to call a route from Signal L545 into No. 1 Carriage Road using the exit button at Signal L1567 with track circuits WF and WG occupied because the wreckage was still in position; he did not expect to set the route and was unable to do so. All the cables feeding Signal L545 were disconnected, their insulation resistance tested, and the lamp voltages of the red aspects of Signals L543 and L545 were taken as well as ensuring that they were properly illuminated. There was no damage to signalling equipment as a result of the collision and after the wreckage had been completely cleared he set a route from Signal L552 to L536 and confirmed that with it set but not occupied it was impossible to obtain a route by pressing the entrance button at Signal L545 followed by the exit button at Signal L1567. He then simulated the passage of 2H27 by the sequential occupation and clearance of the track circuits from the berth track circuit of Signal L552 (PB) as far as track circuit WF. After each simulated movement of 2H27 he attempted to set the route for the empty coaching stock train from Signal L545 to the Carriage Sidings but was not at any time able to do so except on the clearance of track circuit WF. He also checked the approach locking of Signal L552 which was maintained until the 2 minute time delay had operated. He checked the interlocking by setting routes from Signal L537 to both the full and restricted overlaps of Signal L545 and attempting to set a route from Signal L552 to Signal L536; he found that it was impossible using the full overlap but that he could do so using the restricted overlap although no change of aspect occurred in Signal L537 until the berth track circuit (US) to that signal had been occupied for 15

seconds in accordance with the locking to make sure that the driver of a train proceeding on the Down Spur line with the overlap of Signal L545 restricted brings his train under control. He also checked the converse and arranged for the relays controlling the subsidiary aspect of Signal L545 to be tested; no mechanical or electrical irregularities were found in them which could have caused the signal to be irregularly illuminated.

22. Mr. Bell described the operation of the train describer equipment which, although not part of the safety signalling, is operated by it. He told me that if a route had been set for 5D33 from Signal L545 to Signal L1567 and the empty coaching stock train had occupied correctly the overlap of the signal and proceeded, the train description would have been extinguished from the berth of Signal L545 as the train entered the sidings. For the train description to be removed from the panel the route relay forward from the signal must be energised and the track circuit in advance of the signal must be occupied. If the route relay is not energised and the track circuit in advance occupied, the train description remains in the berth of the signal which is what had happened at Signal L545 on the panel after the collision. He told me that if the subsidiary aspect of Signal L545 had been illuminated the occupation of track circuit WF would have extinguished it. He thought that it might have been possible for an inexperienced signaller to confuse the two overlap buttons at Signal L545 when setting the route from Signal L537 to L545, but if the signaller had pressed the full overlap button and a route had already been set for 2H27 there would have been no reaction nor would there have been for the converse. The cable tests included those between the relay room and the location, and the location and signal head for the main signal, the route indicator, and the subsidiary signal, there were no signs of low insulation resistance or any other faults. In his tests he had covered all the possible faults which might have resulted in the irregular illumination of the subsidiary aspect of Signal L545 and he was quite satisfied that there was no way in which this could have happened.

23. Mr. Bell was in the signal box some 2 to 3 weeks after the new signalling had been commissioned when the driver of a train stopped at Signal L1559, telephoned the signaller, and complained that the signal was at Danger and that points No. 973 immediately beyond it were standing open. This signal is one of two subsidiary signals which must first clear before the subsidiary aspect of Signal L545 can be illuminated. His first assumption was that the points might have moved after the train had entered the route but he carried out tests to prove that the points were operating satisfactorily. The only other conclusion was that the driver of the train had passed the subsidiary and main aspects of Signal L545 at Danger with points No. 973 not detected Reverse and fortunately come to a stand when he saw Signal L1559 at Danger. This was his personal deduction because the driver had not made any comment about any other signals and the incident had occurred late in the evening when direct sunshine from the sun low in the sky behind the driver might have caused the subsidiary Signal L545 to appear to be illuminated and the driver had in good faith passed it. As a result he asked for extended hoods and backplates to be fitted to the subsidiary Signals L543 and 545. On Friday 22nd August he was in the signal box and overheard a driver telephoning one of the signallers to ask if the subsidiary Signal L545 was 'Off' or not. This incident occurred in the morning and as a result of it he expedited the changes to the hoods and the backgrounds of the two subsidiary signals which were completed before 11th September. He said that on two or three occasions drivers had telephoned the signaller asking if other position-light signals in the New Cross Gate area were 'On' or not, but in all the cases before the collision, apart from the one in which he assumed the driver must have passed the signal at Danger, the drivers had telephoned whilst standing at the signal.

24. On Saturday 13th September, two days after the accident, using a Class 33 locomotive that was rather cleaner than the one involved, he took part in tests carried out to investigate the possibility of reflections at Signal L545 on the Down Spur line. Previously direct sunlight from immediately behind the train had caused reflections from position-light signals but this could not have been the case on 11th September when the sun was shining on the front of the locomotive. The locomotive was driven along the Down Spur line and approached the signal extremely slowly; about 50 yards in rear of it the locomotive was stopped and then moved a few yards at a time towards the signal. The tests took place at the same time of day as had the accident and it was again a bright sunny day. Mr. Bell told me that he was in the cab to see if light was reflected from within the position-light subsidiary Signal L545 and that as they drew close to it a phantom indication became apparent; the positioning of the locomotive was extremely critical and after moving backwards and forwards he managed to establish a strong phantom in the subsidiary signal which he estimated to be 60 per cent of the properly illuminated brilliance. The phantom was at its greatest intensity when observed either by looking out of the driver's window or standing in the doorway on the driver's side. Viewed through the secondman's or driver's windscreen it was less strong but the signal was extremely difficult to see because the sun was immediately behind it and it was necessary to shade the eyes because viewing through the windscreen was not as clear as looking out of the window or door.

25. He went on to the signal gantry during the tests to establish from what part of the locomotive the reflection was arising and found that it appeared to be coming from the yellow roof panels and the yellow paint of the upper part of the locomotive above the windscreen. He arranged for the signal to be cleared when the locomotive was in the most critical position and there was no doubt that the proper illumination was much brighter although of course a driver did not have the advantage of the comparison. He agreed that the improvements that he had carried out to the signal because of the complaints received would not have been effective against sunlight being reflected from the locomotive into the signal and then from the signal, resulting in an apparent illumination, particularly as there was a critical position for the locomotive. Mr. Bell also told me that, until further action could be taken and because the positioning of the locomotive for getting the intensive reflection was about 15-20 ft from the base of the signal depending on the angle of the sun, a stencil-type route indicator had been provided since the accident, mounted above the position-light signal, which must be illuminated at the same time in order to authorise a movement. The stencil indicator is

proof against the phantom and has a 60W bulb to make it a powerful indication. At the end of Mr. Bell's evidence I asked the *Assistant Signal and Telecommunications Engineer (Works) Mr. V. Brown* of the Southern Region for his comments and he said that he was satisfied that the tests had been carried out correctly and established that the signalling equipment was correctly installed and operating properly.

TESTS

26. Some days after the accident, on another bright sunny morning, I travelled on the locomotive hauling 5D33 and attempted to reproduce the alleged apparent illumination of the position-light subsidiary Signal L545, described by Mr. Bell in his evidence, by positioning the locomotive so that the maximum amount of sunlight was reflected by the paintwork above the windscreen onto the signal. I found that with the front wheels of the locomotive 15 feet from the signal, there appeared to be lights in the white aspects. From the secondman's side the upper aspect had bands of illumination from the centre towards the 1 o'clock and 8 o'clock positions, but the lower aspect was not apparently illuminated. From the driver's door and windscreen there appeared to be bands of illumination in the upper aspect from the 9 o'clock position to the 3 o'clock position and in the lower aspect from the centre to the 2 o'clock and 10 o'clock positions. From these tests, allowing for the change in the sun's elevation, a slight time difference, and having seen photographs taken during the tests on 13th September 1976 it was clear that under certain limiting conditions an illumination of this position-light signal could be produced by external light, although it was not as bright as the proper illumination of the aspects.

27. The position-light signal concerned is a Westinghouse Westlyte type to BR Specification No. 922A. Similar signals with different lens systems meeting this Specification and made by other manufacturers are used on BR. It was fitted with a 40W lamp behind each white aspect. After the accident the position-light Signal L545 was dismantled and found to be assembled in accordance with the manufacturers current drawings. The signals were initially catalogued in two different forms; one for mounting on an overhead gantry with a hood over each aspect of a minimum 6 inch length, to be viewed from below; and the other for ground mounting to be viewed from above. In 1969, as a result of representations that the optical performance was unsatisfactory and phantom illumination was possible, the two different forms were discontinued and that which had been used for ground mounting was adopted and appears in the catalogue now as "suitable for mounting on gantries or near ground level". This change was possible because the only major difference between the two forms was in the assembly of the lenses and filters. After the accident, tests were carried out with the position-light signal both ground and gantry mounted using a mirror to produce reflected light. The effect of the way in which the lens was assembled on the signals' tendency to apparent illumination could be clearly seen. With the lens assembled in the manner laid down for ground mounting prior to 1969 and subsequently adopted as standard and the signal placed on a gantry, reflection from below could be made to produce a clear phantom illumination. However, with the lens assembled in the manner laid down for gantry mounting prior to 1969 and the signal and mirror in the same positions, the phantom illumination disappeared.

DISCUSSION

28. All the tests carried out on the safety interlocking and signalling equipment show that it was designed, installed, and operating properly and the evidence shows that the two trains were correctly signalled. However the investigations carried out on the possibility of the irregular illumination, through reflected light, of position-light subsidiary Signal L545 have shown that this could occur and that the way in which the lens system was assembled would have increased the strength of any such illumination. The locomotive crew, knowing that their hooked route required the illumination of the subsidiary signal, approached Signal L545 at Danger with the sun behind it and did not keep it under continuous observation. The final movement of the locomotive coming to a stand and that of the sun whilst the train was stationary were probably sufficient to allow the reflection from the front of the locomotive to intensify the apparent illumination of the subsidiary signal to a level at which it attracted the secondman's attention. Both the driver and secondman initially expressed doubts about the illumination of the signal but they viewed it from two different positions within the locomotive cab, moving to obtain a good view because the sun was behind the signal. Both men were obviously satisfied that the aspects were illuminated although not in the same way as other position-light signals that they had seen. It must be remembered that the signalling was newly commissioned and that they did not have the benefit of being able to compare the illumination with a reference, as did those taking part in the tests afterwards.

CONCLUSION

29. I conclude that an apparent illumination of the position-light subsidiary aspect of Signal L545, occurred through a combination of the alignment of the line, the optical system of the lens, and the reflection of the sun's rays from the surface of the locomotive standing at the signal. The collision then took place because Driver Park, observing the illumination and having satisfied himself that a proceed aspect was exhibited, drove 5D33 past the signal, which in fact was still at Danger, into the route of 2H27.

REMARKS

30. I have discussed the reasoning which led to the decision in 1969 referred to in paragraph 27 with *Mr. R. Martin* the *Quality Assurance Manager of the Signal and Mining Equipment Division of the Westinghouse Brake and Signal Company Ltd*, and with *Mr. A. A. Cardani* the *Chief Signal and Telecommunications*

Engineer of the British Railways Board. They very kindly allowed me to see the correspondence relating to the change and I have been provided with diagrams showing the two different methods of assembling a lens and the way in which exterior light falling upon its surface might be reflected. The designer of a signal of this type has to strike a compromise between intensity of illumination for the driver and the need to avoid apparent illumination by reflection of exterior light; allowing for the position of the signal, the angle at which it is set, and the need to provide a good view to the driver of a locomotive standing close to the signal. It is clear that the decision to provide only one type of position-light signal, suitable for mounting on gantries or near ground level, was only taken after considerable discussion and some research. The possibility of light originating from outside below the horizontal axis of the lens and causing a phantom illumination was considered but was felt to be most unlikely. In the circumstances I feel that the decision was taken only after proper thought and that although with hindsight it might now be considered as having been unwise, the particular way in which the external light was directed at the signal with the sun behind it deepening the shade in which the signal lay, only came about through a very rare combination of circumstances which I do not think could have been detected during the exhaustive checking before commissioning of the new installation at London Bridge.

31. I do not think that Driver Park can be held responsible for the collision because, having approached and stopped at the signal at Danger, I do not believe that he would have driven his train past it unless he was sure that the position-light subsidiary signal was displaying a proceed aspect. I consider that both he and his secondman took care to satisfy themselves that the signal had cleared by their action in moving within the cab to observe the signal better against the sun.

32. I am assured by the Officers of British Railways that they have reverted to the two different forms of signal provided by this manufacturer prior to 1969 with the firm's agreement and that, after a thorough check, position-light signals now have the lens system assembled according to the elevation of the signal. Where difficulties have arisen over sunlight, hoods are being provided.

33. I am told that the optical performance of current position-light signals is not completely satisfactory and that an improved design of lens has been developed that will not require adjustment according to the elevation of the signal and which minimises the risk of phantom indications. I have been told that existing instructions, which have been brought to the attention of all concerned, make it quite clear how the lens is to be assembled in current designs and that should this type of signal be ordered in the future it will be specified whether it is required for gantry or ground mounting so that there can be no doubt as to the correct positioning of the lens.

I have the honour to be,

Sir,

Your obedient Servant,

A. G. B. KING

Major

The Permanent Secretary,
Department of Transport.

COLLISION AT BRICKLAYERS ARMS JUNCTION
 SOUTHERN REGION BRITISH RAILWAYS
 11 SEPTEMBER 1975

Plan of line between New Cross Gate and Blue Anchor showing
 derailment and routes of train

----- Route of 5D33
 - - - - - Route of 2H27
 OL = Overlap
 ROL = Reduced overlap

