

DEPARTMENT OF TRANSPORT

RAILWAY ACCIDENT

Report on the Derailment that occurred on 23rd November 1983 at Paddington Station

IN THE
WESTERN REGION
OF BRITISH RAILWAYS

LONDON: HER MAJESTY'S STATIONERY OFFICE

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SIR

I have the honour to report for the information of the Secretary of State, in accordance with the Direction dated 1st December 1983, the result of my Inquiry into the derailment of an overnight Penzance to Paddington passenger train that occurred at about 06.11 on Wednesday 23rd November 1983 on the approaches to Paddington Station, in the Western Region of British Railways.

The train was 1A07, the 21.35 Penzance to Paddington passenger train. It was hauled throughout its journey by Class 50 diesel-electric locomotive 50041, 'Bulwark'. On leaving Penzance it consisted of the locomotive and 11 vehicles, including three sleeping cars, and at Plymouth a further three vehicles, including one additional sleeping car, were added. The total weight of the train, from Plymouth onwards, was 606 tons, its maximum permitted speed was 90 mile/h, and it was air braked throughout.

The train left Penzance on time and the journey was comparatively uneventful until the final approach to Paddington. Different drivers worked the train between Penzance and Plymouth, Plymouth and Exeter, Exeter and Bristol, and Bristol and Paddington, and the guards changed at Exeter and Bristol. All station stops were made correctly and without difficulty up to and including the final one before Paddington, at Reading.

From Reading onwards the train ran normally until about two miles from Paddington where, instead of slowing to observe the 60 mile/h speed restriction on the Up Main line, it continued at speed. It was still travelling in excess of 65 mile/h when it entered a crossover, half-a-mile outside the station and over which the maximum permitted speed was 25 mile/h, and became derailed.

The locomotive was the first to become derailed and, after running thus for some distance, it became separated from the train, overturned on to its left side, and came to rest on the rails of No 8 Platform line under Bishops Bridge having run derailed for some 400 metres. Behind it, the first 12 of the 14 vehicles were completely derailed, some on their sides or leaning over, one axle of the 13th was derailed, and the 14th remained on the rails.

The emergency services were quickly summoned, although there was some delay in alerting the Fire Brigade. The first ambulances arrived at 06.23, closely followed by the Police. Meanwhile, passengers from the train were led along the track to the station by members of the station staff and other railwaymen. Three passengers were taken to hospital suffering from minor injuries and shock but none was detained. The driver was uninjured and was able to climb unaided out of the cab once a ladder had been produced.

Damage to the track and signalling equipment was extensive. Train services into and out of Paddington were severely curtailed for the rest of the day. Main Line services, which were curtailed in number, were dealt with at Ealing Broadway and a local service was operated between there and Westbourne Park to enable passengers to transfer to and from London Transport. Platforms 1-5 at Paddington were restored to service on the day after the accident, 24th November, and Platform 6 on 26th November. Normal services, except for the use of Platforms 7 and 8, were resumed on 2nd December although repairs to the track continued until 14th December.

Along the route of the train the weather had become progressively colder during the night of 22/23 November. At the time the train left Penzance, the air temperature was about 3°C; at Plymouth it had dropped to just above freezing; it was about minus 3°C at Exeter, and only just above this at Bristol. From Bristol to Reading it became colder, the temperature dropping to about minus 5°C at Swindon with freezing fog from Chippenham onwards. The fog cleared at Twyford and conditions approaching Paddington were clear with good visibility although it was still dark. The relative humidity increased from about 90% at Penzance to between 93% and 95% all the way from Taunton to Paddington. Details are shown in Figure 1 at the back of the Report.

DESCRIPTION

The site and signalling

1. Between Reading and Paddington the train was routed along the Up Main line. For much of the way the maximum permitted speed on this line is 125 mile/h, although the train itself was restricted to a maximum of 90 mile/h. Near Acton, 4½ miles from Paddington, the permitted line speed reduces to 85 mile/h, and a permanent speed restriction of 60 mile/h applies between 1 mile 50 chains and 0 miles 48 chains, distances being measured from the station buffer stops. From 0 miles 48 chains, a permanent speed restriction of 25 mile/h applies over the connections leading from the Up Main line to Platform 9, the route set for the incoming train. Standard 'cut-out' speed limit indicators applying to the Up Main line are located at the 4½ mile post, at 1 mile 50 chains and at 0 miles 48 chains. Advance warning indicators ('Morpeth' warnings) are not provided.

2. The railway from Reading to Paddington runs approximately west to east. The lines are mainly straight or gently curved and, apart from a short section near Reading, the gradients are nowhere steeper than 1 : 1200. Immediately approaching Paddington there are three curves forming a double reverse at Westbourne Park, 1½ miles from the station, and a more severe curve at Subway Junction ½ of a mile from the station and ¼ of a mile from the point of initial derailment. At Subway Junction the Eastbound and Westbound lines of London Transport's Metropolitan Line pass under the Western Region lines and from there to Paddington run parallel to and north of them. London Transport's Royal Oak station is situated on the Metropolitan Line at 0 miles 48 chains. The LT lines are electrified on the four-rail system; none of the Western Region lines concerned are electrified.

3. Even by night there are many distinctive features along the railway approaching Paddington. After passing the signal box at Old Oak Common, the line goes under a bridge carrying the West London line and then under a skew bridge carrying the Up and Down engine and carriage line and passes Kensal Green carriage station with its carriage washing machine. These are on the north side and are normally brightly lit. Three-quarters of a mile further on, Westbourne Park Station is separated by only one line from the Up Main; it, too, is normally lit at night and the M40 motorway bridge crosses the line above the station. Royal Oak Station, also brightly lit, lies just beyond Signal 57 and from here Paddington Station is visible ahead under the three large bridges (Ranelagh, Westbourne, and Bishops) which cross the line.

4. During the night of 22nd/23rd November, an engineer's occupation was taken of the Up and Down Main lines between midnight and 05.30. The diversion points were Subway Junction to Acton West on the Down Main line and West Ealing to Subway Junction on the Up Main. It was intended to carry out tamping work on both lines but, because of a fault on one of the machines, no work at all was done on the Up Main line.

5. All running lines approaching Paddington are worked under the Track Circuit Block System, controlled from Old Oak Common Signal Box which is situated on the south side of the line at 2 miles 64 chains. Signals are 4-aspect colour-lights with associated Automatic Warning System (AWS) equipment. From Old Oak Common East Junction, 3 miles from the station, the signal sequence is as follows, with the approximate distance between signals, in yards, shown in brackets. (All signals unless shown otherwise have the prefix 00 standing for Old Oak): 45 (968), 47 (968), 49 (792), 51 (748), UMI (396), 55 (539), 57. Trains approaching Paddington along the Up Main line normally receive clear signals until reaching Signal 57 which normally displays a double-yellow aspect. On the route taken by the train the next signal is Signal 00.69, 352 yards from Signal 00.57, and this normally displays a single yellow aspect, leading to the red stop light at the buffer stops.

6. Diagrams showing the main features of the line and the signalling, together with the position of the train after the derailment, are shown in Figs 2 and 3 at the back of the Report.

The train

7. The train was 1A07, the 21.35 Penzance to Paddington passenger train. From Plymouth, where it was re-marshalled, it travelled in the following formation:

Class 50	Loco	50041		Bulwark (No. 2 end leading)
Mk. I	BG	M92030)	
Mk. I	BG	M84576)	Vehicles attached at Plymouth
Mk. IIIA	SLEP	10563)	
Mk. I	BG	SC84513)	
Mk. IIIA	SLEP	10561)	
Mk. IIIA	SLEP	10711)	
Mk. IIIA	SLEP	10598)	
Mk. IID	FK	W13594)	
Mk. IIE	TSO	W5857)	Vehicles through from Penzance; M93874 shunted
Mk. I	BG	M84320)	from front to rear of train at Plymouth
Mk. IIE	TSO	SC5814)	
Mk. IIF	TSO	M6031)	
Mk. IIF	TSO	M5913)	
—	GUV	M93874)	

The locomotive weighed 117 tons and the 14 vehicles 489 tons, making 606 tons in all. The overall length of the train was 306.15m.

8. The English-Electric Class 50 diesel-electric locomotives are all of 2700 hp and Co-Co arrangement. A total of 50 were built in 1967–68 and they were at first allocated to the London Midland Region, being based at Crewe. From there they worked passenger and freight services throughout the Region and into Scotland. From 1974 onwards they were all transferred to the Western Region. From their introduction, the locomotives were provided with automatic air brake equipment. The driver's safety device (DSD) took the form of a foot-operated pedal which had to be maintained in the depressed position during running. Release of it applied the brakes automatically within 5–7 seconds. Vigilance devices were originally provided, but were later removed.

The course of the accident and damage caused

9. Details of the initial mode of derailment of the locomotive and the subsequent derailment of the vehicles, together with details of the damage to the locomotive and vehicles, are given in the Summary of Evidence (paragraphs 46 to 55).

SUMMARY OF EVIDENCE

10. This summary is based on evidence given at two public hearings and at subsequent interviews. It also includes some supporting evidence given at British Railways' own internal inquiry together with information supplied to me by members of the public.

The examination and maintenance of the train before it started its journey

11. The Paddington-Penzance-Paddington sleeper services are worked by two sets of coaches. On arrival at Paddington in the morning the coaches of one set are worked to Willesden Carriage Sidings for servicing and maintenance and return to Paddington in the evening to form 1B02, the 00.05 Paddington to Penzance. On arrival at Plymouth a portion of the train is detached and stabled there until the return working, 1A07. At Penzance, the sleeping cars from 1B02 remain there all day whilst the non-sleeping car coaches are worked to Plymouth on the 10.05 empty coaching stock train and return on the 16.35 stopping passenger service. The only exception to this pattern is that a Motorail GUV is conveyed on 1B02 and 1A07 but is provided independently and does not go with the other coaches to Willesden.

12. The coaches involved in the accident had arrived at Paddington on the morning of Monday 21 November and were worked to Willesden, arriving at the Carriage Shed at about 15.00. There they were first inspected by *Workshop Supervisor D. Clarke* who then allocated work to the artisan staff. *Fitters Z. Martin* and *J. Brown* made a visual examination of the wheels, brake rigging, pads and blocks from alongside and under the train and checked that the brake pipes and cocks were in order. Following their examination they fitted 2 new brake pads to the disc brakes on vehicle 10711 and 8 new brake blocks to the clasp brakes on vehicle 13594. The train remained coupled and no brake test was carried out, or needed. It left Willesden later in the evening to go to Paddington where it formed the night train to Plymouth and Penzance. Both Martin and Brown had worked on coaches for about 15 years and on numerous occasions had had occasion to disconnect the air brake pipes between vehicles. They had never had to report the presence of water in an air brake system; on disconnecting air brake pipes they had never seen more than a few drops of condensation.

13. The locomotive involved in the accident, 50041, was based at Laira Depot, Plymouth. It was at Laira on the morning of 22 November and at about 07.30 it was given a fuel and fuel point examination. This was carried out by *Workshop Supervisor J. Matthews*, assisted by *Fitters M. Vinten* and *M. Andrews*. Mr

Matthews himself verified that no defects were marked for attention in the Repair Book whilst the fitters fuelled and watered the locomotive, checked the brake piston strokes and brake blocks, and blew down the compressed air system; this involved opening 4 drain cocks. On blowing down the compressed air systems on Class 50 locomotives, some water and oil was usually discharged; Matthews thought on average less than a quarter of a pint of water, but exceptionally about a gallon, whilst the two fitters thought that the maximum would be about 1½ pints. On this occasion only a little water was discharged.

14. Instructions for the servicing and maintenance of Class 50 locomotives called for the addition of mineralised methylated spirits to the compressor's anti-freeze reservoir as well as the blowing down of the compressed air system when freezing weather conditions were expected. Notice of such conditions was received at Laira either from Regional Headquarters at Paddington or from the local RAF station. When the servicing was carried out on 22 November no such notice had been received and no methylated spirits was added. Vinten said that no instructions to add methylated spirits had been received that autumn or winter, and although he had not checked he felt sure that any spirits remaining in the reservoir from the previous winter would have evaporated.

15. After examination and servicing, locomotive 50041 worked a special trip to Burngullow and returned to Laira at about mid-day where it was re-fuelled. It then hauled the 16.35 stopping passenger train from Plymouth to Penzance.

The formation of the train at Penzance and its journey to Plymouth

16. On arrival of the 16.35 train at Platform 2 at Penzance, the locomotive was uncoupled from the train by Senior Railman N. Chandler and the sleeping car portion was brought from the sidings by Senior Railman C. Brown and coupled to the coaches in Platform 2. The 10 coaches were then moved by the pilot locomotive to Platform 1. Meanwhile, Chandler coupled locomotive 50041 to Motorail GUV M93874 and he and Brown accompanied the locomotive and GUV on to the remainder of the train at Platform 1 where Brown coupled them up, thus completing the formation of 1A07. Both Chandler and Brown were certain that they had correctly coupled the train brake pipes and the main reservoir pipes throughout the train and that all the cocks on both pipes were properly open when they had completed the formation of the train. Throughout the shunting moves the automatic brake was in use and worked correctly. Both men said that on occasion, perhaps once or twice in several hundred coupling jobs, water came from the main reservoir pipes but that so far as they could remember none had come out when they coupled the train on 22 November.

17. Driver C. G. Wheeler took over locomotive 50041 at the head of 1A07 at about 21.00. The engine was running and the train heating was on. He checked the fuel and cleaned the driver's windscreen. He was joined by his guard, Guard K.A. Brown, who gave him the train particulars. Brown had walked up the platform examining the train. He had his lamp with him and had looked at the couplings but had not looked especially at the brake isolating cocks. After leaving the locomotive, Brown walked down the offside of the train on the ground to complete his visual examination. Having checked that the air pressure was showing correctly in the van in the 7th vehicle of the train he carried out the brake continuity test from the rear of the train. To do this he opened the brake pipe cock and heard the rush of air and re-closed the cock when the air had ceased to flow. He then returned to the working brake van, which was in the fourth vehicle from the rear, and observed that the brake pipe pressure gauge was showing a normal reading of 72½ psi.

18. The train left Penzance on time and the journey to Plymouth was uneventful. Nine stops were made at stations in Cornwall, and driver Wheeler had no difficulty in applying or releasing the brakes. The train arrived at Plymouth 2 minutes late. It had been cloudy and dark at Penzance but the sky had cleared at Truro and by Liskeard there was ground frost. At Plymouth, Wheeler was relieved by another driver whilst Brown stayed with the train.

The re-marshalling of the train at Plymouth

19. On arrival at Platform 7 at Plymouth, Senior Railman R. Wise uncoupled the train behind the first vehicle, the Motorail GUV, and the locomotive, with the GUV attached, set back into the through road under the control of Senior Railman E. Coombs. There, Coombs uncoupled the locomotive and went with it to Platform 8 where he coupled it to the Plymouth vehicles, 2 BGs and a sleeping car. This portion was then joined to the Penzance portion in Platform 7. Finally, the Motorail GUV was attached to the rear of the train. Coombs was quite certain that the coupling of the locomotive to the Plymouth vehicles was properly done and that all four air cocks were open. He was equally certain that the coupling of the two portions of the train was done properly. Neither he nor Wise took part in or observed the brake test but Coombs noted that the brake pipe pressure gauge was indicating normal pressure during the movement of the Plymouth portion on to the train.

20. Guard Brown had watched the coupling of the two portions of the train in Platform 7 and when Driver Wheeler had been relieved he collaborated with the new driver in carrying out the brake continuity test, this being conducted exactly as at Penzance and the results being equally satisfactory.

The journey from Plymouth to Bristol

21. Driver A.T. McGowan took over the locomotive at Plymouth and drove it during the re-marshalling movements. He confirmed that the brake continuity test was carried out satisfactorily. The train left Plymouth on time and the journey to Exeter was normal except that there was a severe frost on the Hemerdon Incline and the locomotive slipped, causing an over-speed trip which shut down the diesel engine. McGowan and his assistant managed to re-start the engine before the train stopped. Once over the Hemerdon summit the journey was uneventful, with a booked stop at Newton Abbot. During the journey the brakes responded normally and caused McGowan no concern at all. The AWS was functioning correctly. In the cab the normal heating was working; the small electric cooking stove was not switched on.

22. Guard Brown confirmed that the journey to Exeter was normal apart from the temporary loss of momentum on the Hemerdon Incline. He spent most of the journey in the brake van in the fifth vehicle from the rear of the train and from time to time he observed the brake pressure gauge which was showing the readings he would have expected. The braking of the train appeared completely normal and he was sure that the brakes were being applied on all the vehicles in the train.

23. At Exeter, where the train arrived on time at 01.45, Driver McGowan and Guard Brown were relieved by Driver C. D. May and Guard P. C. Jays. The train left on time, at 01.57, and ran normally as far as Tiverton Junction Outer Home signal where the train was detained because of single line working between Tiverton and Wellington. Guard Jays joined the driver in the locomotive and then walked forward to the Inner Home signal where he met the Pilotman who had brought a Down train over the Up line. The Pilotman joined Driver May in the locomotive and Jays returned to his brake van. The single line section included several miles of falling gradient of between 1 in 80 and 1 in 90 and May used the automatic air brake to hold the train's speed to about 60 mile/h. He had no difficulty in controlling the train during the descent or in stopping the train at Wellington to allow the Pilotman to alight. A booked stop was made at Taunton. At Flax Bourton he reduced speed from 90 to 20 mile/h for a temporary speed restriction, and again the brakes responded normally with the brake pipe and cylinder gauges responding as expected. Because of the single line working they arrived at Bristol approximately 20 minutes late. Driver May described the weather as clear to Tiverton Junction with patchy fog developing between Whiteball and Taunton and continuous freezing fog from Taunton onwards. He had the demister and windscreen wipers working and had turned on the electric cooker to supplement the cab heating because it was cold. He kept his top coat on throughout the journey.

24. Guard Jays confirmed his driver's evidence. He had travelled in the same brake van as had Guard Brown, in the fifth vehicle from the rear of the train, and had seen the train brake pipe needle on the brake gauge rising and falling as the brakes were released and applied. He had felt the brakes being applied under his van.

The journey from Bristol to Paddington

25. Driver May and Guard Jays were relieved at Bristol by Driver R. N. Long and Guard P. Tutton. Long had signed on duty at Old Oak Common depot at 23.00 on 22 November and Tutton at Paddington at the same time. They met at Paddington, from where they were to work 1B02, the 00.05 Paddington to Penzance train as far as Bristol. After carrying out a brake test they left on time and arrived at Bristol 12 minutes early. They arrived early because the train had been routed via Bath instead of by the longer route through Badminton because of engineering works on the latter route. The journey had been without incident although there had been ice and fog, especially between Reading and Swindon. Long had no difficulty with the brakes and in the freezing conditions he made a number of running brake tests, reducing the train's speed by between 5 and 10 mile/h. Driver Long had worked the same turn on the previous night.

26. On arrival at Bristol at about 02.00 Long remained with the locomotive for some 12 minutes until the driver who was to relieve him arrived. He then joined Tutton in the train crew relief cabin where they remained for about an hour. One other driver was present. They had something to eat and drank several cups of tea, and Tutton dozed for about 15 minutes whilst Long talked to the other driver. At about 03.10, Long telephoned the signal box to enquire about the progress of 1A07 and was told that it was running about 14 minutes late. They both left the cabin at about 03.25 and waited on the platform until 1A07 arrived at 03.40. The train drew up normally in the platform and Long and Driver May exchanged a few words; May said that it was cold in the cab and advised Long to keep his coat on.

27. The train left Bristol at 03.55, some 19 minutes late. The run to Bath was under green signals with some patchy fog. Long had no difficulty in stopping the train at Bath, but soon after re-starting and with the

train still travelling slowly he noticed that the side window was not properly closed and in trying to close it he inadvertently released pressure on the foot-operated driver's safety device (DSD) pedal sufficiently for the brakes to be applied and the train to stop. Having looked back and seen someone on the platform exhibiting a green hand lamp, Long slammed the window shut and re-created the brake, the brake pipe pressure gauge having fallen to zero. Continuing the journey under green signals they ran into thick fog and ice in the Chippenham area. At Rushey Platt, Long observed a double-yellow signal and commenced his braking for the station stop at Swindon, which was made normally.

28. The freezing fog persisted after Swindon and at Challow Long made a running brake test, using the automatic air brake to reduce speed by between 5 and 10 mile/h. Approaching Steventon at 90 mile/h Long again applied the brake on observing a double-yellow signal, followed by a single yellow at Foxhall Junction. The train speed reduced normally, down to about 15 mile/h entering the platform at Didcot, where the train was not due to stop. About halfway along the platform Long received the AWS bell and saw the signal at the London end of the platform at green. He accelerated back to 90 mile/h and continued under green signals until the double-yellow signal before the booked station stop at Reading. The brakes continued to respond normally and the train stopped at its proper mark in Platform 5.

29. Having left Reading the fog cleared at Twyford. Long did another running brake test at Slough, reducing speed from 90 to 80 mile/h before accelerating back to 90 mile/h. He was quite sure that the brake response was normal and that the brakes were having a proper effect throughout the train and not just on the locomotive. The train was still travelling at 90 mile/h at Longfield Avenue, between West Ealing and Ealing Broadway and just under six miles from Paddington, when he closed the controller and allowed the train to coast. With the power off the train began to lose speed and the speed had reduced to 85 mile/h at the commencement of the 85 mile/h permanent speed restriction at the 4½ mile post at Acton. Approaching Kensal Green the speed had further reduced to between 70 and 75 mile/h and at a point which Long identified as just on the country side of the engine and carriage overbridge at Kensal Green, 2½ miles from Paddington, he made an initial application of the automatic brake. The gauges showed the train pipe pressure dropping, exactly as he would have expected, and the brake cylinder pressure rising but the train did not appear to be slowing down. He accordingly continued to advance the brake handle, through the full service position and on into the emergency position, but with still no impression that the brakes were slowing the train. By this time the gauges were indicating that the train brake pipe pressure had fallen to zero and that full pressure had been reached in the brake cylinders. Long thought that he had made the brake application virtually as a continuous movement, from initial to emergency, and that it had been a few seconds only between the initial application and reaching the emergency position.

30. With even the emergency application of the automatic brake producing no apparent retardation, Long next applied the locomotive straight air brake. He did this almost immediately after reaching the emergency position on the automatic brake, and he agreed that the train would by then have been close to the 2-mile post, near the Kensal Green Carriage Station. There was still no discernible response from the brakes even though the gauges continued to show that a full application was being made. On applying the straight air brake he had noticed that the needles on the brake cylinder pressure gauge remained steady and did not flicker. At 1 mile 50 chains, where the 60 mile/h permanent speed restriction commenced, the speed was still around 70 mile/h. The next thing that Long could recall positively was the locomotive, in his words "fighting the rails with the flanges because we were going over-speed at Subway Junction". He did not think that there had been any unusual or rough riding between Kensal Green and Subway Junction. He next saw Signal 57 ahead at double-yellow, this being the first restrictive aspect since leaving Reading. Passing over the AWS magnet he could not be sure whether the horn sounded in the cab or not but he thought that it did; he could not however remember whether he cancelled the warning or not, or whether the horn continued to sound. The locomotive then entered the crossover (points 647 reversed) where the maximum permissible speed is 25 mile/h, at a speed of between 60 and 65 mile/h. It rode through the points but then became derailed, rolling violently from side to side before finally turning over on to its side and coming to rest.

31. Long was questioned closely, twice by myself and several times during the course of the Railway's own Inquiry, about his actions from passing Kensal Green until the point of derailment. Each time he repeated his evidence as I have summarised it above. He was quite sure that he had shut off power and applied the brakes at the places, and in the manner, that he had indicated, and that his recollections of the speedometer readings and the behaviour of the brake gauges were accurate. He confirmed that at no time had he released the DSD, that he had not sounded the locomotive horn, and that after applying the straight air brake near the 2-mile post he had remained in his seat and taken no further action, even though he had realised that a serious accident, either derailment or a high-speed collision with the buffer stops, was by then inevitable. I pointed out to him that, based on his own evidence as to the speed of the train, it would have taken about 78 seconds for the train to cover the distance from the 2-mile post to the point of derailment, and that during this relatively long period of time he might have been expected to have made some attempt to apply the

handbrake, or to release the DSD, or to leave his seat, but he reaffirmed that he had done none of these things and had merely remained seated and hanging on.

32. After the locomotive had come to rest, Long remained in the cab. He was unhurt. He shut down the locomotive engine and switched off the electric cooker, which had remained on during the journey from Bristol, but he did not otherwise touch the controls. Various railwaymen appeared around the locomotive, and one, Driver's Assistant Hewitt, climbed on to the side of the locomotive and asked if he was all right. Eventually a ladder was produced and he climbed out unaided. Shortly afterwards he was interviewed by the Traffic Manager responsible for train crews, Mr Morgan, and by Traction Inspector Stewart.

33. *Guard Tutton* confirmed his Driver's account of the journey from Bristol until approaching Paddington. When the train stopped unexpectedly on leaving Bath, Tutton had assumed that Driver Long had released the DSD. The brake gauge in his van, in the fifth vehicle from the rear, had indicated that the train brake pipe pressure had fallen about halfway between its normal reading and zero. Tutton had carried out checks of the passengers before and after Swindon; excluding passengers in the sleeping cars, there were 2 passengers travelling First Class and 84 travelling Second Class before Swindon, and 2 First Class and 87 Second Class thereafter. Apart from the station stops at Swindon and Reading, both of which had been made quite normally, he could not recall any brake application being made during running and he had not had occasion to look at the brake gauges. After Reading he had carried out a ticket check and had returned to his van by the time the train had reached the Old Oak Common area. The lights were on in the van and he had started to put his books away in his satchel. He recalled passing Kensal Green, which he identified by the strip lighting at the carriage washing machine, and somewhere near Westbourne Park he realised that the train was not slowing down and that its motion was unusual. In his words, "I recall the shaking of the train, the motion seemed like rolling looking from my compartment towards the coaches behind me through the gangway doors which were open, I could see the coaches twisting, the one relative to the other, and one or two passengers in trying to get up falling against the tables. I could not see anything from outside at all". His first thought was to apply the brake valve, but looking at the brake gauge, which is mounted just above the brake valve, he saw the train brake pipe needle falling, as it had done at Bath, and he concluded that the driver had applied the brakes. He did not operate the brake valve but sat down and seconds later there was a very large bump and he realised that the train had become derailed. At no time did he feel or hear the brakes being applied under his van. When the train stopped he got down from his derailed van and telephoned the signalman who assured him that he would protect the train with signals. He then returned to the train and gave what assistance he could.

34. *Mr J. R. Cooper*, a BR (Southern Region) Deputy Chief Controller based at Waterloo joined the train at Reading. During his career he had acquired considerable experience of vehicle running, including work with the BR high-speed track recording coach. He watched the train arrive in the platform at Reading and noticed that the front of the locomotive was white with frost. He joined the eighth vehicle from the front and dozed lightly for much of the journey until approaching Paddington. He remembered passing Kensal Green but was not brought fully awake until Westbourne Park when the train began to oscillate and he realised that it had not slowed down as it should have done. Having travelled the line on numerous occasions since the accident he was convinced that the oscillation, in which the coach had swayed at right angles to its direction of travel, had started in the Subway Junction area. After this quite unusual oscillation there had been a period of smoother running, lasting for perhaps ten seconds, before the violent shock of the derailment. During this time Mr Cooper, realising that there was going to be an accident, had sat on the floor between the seats. He had not considered pulling the communication cord. He had not been aware of any brake application between Reading and the Subway Junction area and, in his original evidence, he said that he had been unaware of any brake application up until the moment of derailment. However, at the second public hearing, he concluded that he *had* been aware of the brakes being applied beneath the vehicle in which he was travelling but that this had been for just an instant, a second or two at the most, before the shock of the derailment. His impression was that the train had been coasting and not under power during the final approach to Paddington. After the derailment he assisted passengers and, some 15 minutes after the derailment, he felt the wheel tyre on one of the Mark 1 BG vehicles at the front of the train and it was quite cold.

35. *Sleeping Car Attendant M. Coote* was travelling in the sleeping car marshalled third from the front of the train. He described the journey as normal and smooth until, approaching Paddington and with his back to the engine, he was making tea in the pantry when there was a sudden severe lurch going first to his left and then to his right and two of the twelve trays of crockery stacked on the shelves fell to the floor. He bent down to pick up the pieces and for about six or seven seconds the train ran smoothly but there was then another, more violent, lurch and the coach swayed and bounced until it came to rest. At no time did Mr Coote feel the brakes being applied and he had not been able to see outside his pantry to establish where the train was.

36. *Sleeping Car Attendant F. Carroll* had just attended to a passenger in the sixth vehicle from the front and was about to return to his pantry in the fifth vehicle when he felt a severe sideways lurch which lasted for about two seconds. The coach then seemed to right itself, but a few moments later there was a continuous lurching and he was thrown to the floor. He noticed a smell of fumes immediately after the derailment and thought that this had come from the brakes.

Events at Paddington immediately before and after the accident

37. *Signalman H. Bowler* was on duty in Old Oak Common Signal Box. He described the approach of 1A07 to Paddington as apparently normal with the train running under clear signals. The route was set for it from the Up Main to Platform 9 and he confirmed that the first restrictive signal would be Signal 57. The route lights were correctly illuminated on the panel. At about 06.11 track circuit indications on the panel suddenly showed occupied over a wide area on the approach to the station and an unidentified caller from a signal post telephone reported that an engine was on its side. Shortly afterwards, Guard Tutton reported the accident and Bowler assured him that he had already replaced signals to Danger to protect the affected area. No-one asked for the emergency services to be called and Bowler did not call them.

38. *Supervisor J. M. Coffey*, on duty in Old Oak Common Signal Box, agreed with Signalman Bowler's evidence and confirmed that, although it was a frosty night, there had been no problems with either the track or signalling equipment. He gave details of the engineering possessions on the Up and Down Main lines and confirmed that no work had been carried out that night on the Up Main line.

39. As the train approached the station, *Driver N. Libby* and *Driver's Assistant D. Hewitt* were in the cab of the station pilot locomotive, a Class 08, in Platform 13. They were awaiting the arrival of the train, and watching out for it, since it was their job to detach the Motorail GUV on arrival. From the cab they had a good view of the trains approaching on the Up Main line, extending well to the west of Ranelagh Bridge. An incoming train was first seen virtually head-on and then its southern side came into view as it commenced to traverse the crossovers leading towards Platform 9. Soon after 06.00 they watched a westbound London Transport train depart from Platform 15 and then, from somewhere beyond Westbourne Bridge, they saw sparks which at first they associated with the LT train. However, the sparks increased in intensity and were obviously approaching and Libby concluded that they were being caused by a full brake application on a locomotive. From being general sparking they developed into several "separate circles of fire, like catherine wheels", and he saw that it was a locomotive approaching with severe sparking coming from its wheels. He saw it appear to hit the end of Nos 8/9 Platform and realised it was a Class 50. He ran to a telephone and asked the operator to call the emergency services.

40. Hewitt confirmed Libby's evidence. He first noticed the headlight of an approaching train and saw sparks coming from near rail level. The sparking was continuous and approaching but did not appear to him to be circular in pattern. He saw the locomotive tip over and appear to strike the platform. Both men went to the locomotive. A shunter (Brophy) was already there and had climbed on to the side of the cab. The locomotive engine was running and Hewitt shouted to the driver to shut it down, which he did. There was then no sound of escaping air. Hewitt followed Brophy on to the side of the cab, discovered that the driver was Long, whom he knew well, and that he was unhurt. Hewitt asked him what had happened and Long replied that he had "put the lot in and nothing had happened". The cab door was open and there was no warm air coming from inside the cab. Long had thrown his coat out and Hewitt passed it back to him when it became apparent that he could not get out unaided.

41. *Chargeman Shunter A. Brophy* was in the Inspector's office on Platform 8 watching out for the arrival of 1A07. He said that he had a good view down the line and at about 06.10 he saw sparks, which he immediately associated with 1A07. As they approached he could see that they were coming from the wheels of a locomotive and he was quite sure that at this stage there were coaches still attached to the locomotive. As the train turned from what he took to be the Up Main line towards Platform 9 the sparks appeared as circles. They were coming continuously from all the wheels of the locomotive but he could not see any coming from the coaches. Someone then shouted that the train had derailed. He took a fire extinguisher and went to the locomotive. He saw the driver in the front cab, climbed on to the side, opened the cab door and checked that the driver was unhurt. He could not remember any rush of warm air as he opened the door. He did not ask the driver what had happened.

42. *Driver G. A. W. Cullen* had been driving trains on London Transport's Hammersmith and City line for some 12 years. At about 06.10 he was driving westbound Hammersmith Line train No 227 and was at a stand in Royal Oak Station. From his position at the controls he had a clear view of the adjacent BR lines and saw a long train going towards Paddington at what he immediately realised was an excessive speed. His attention was drawn towards the back of the train where sparks, which he described as "like you get when

using a chisel on a grindstone" were coming from the wheels of the last two vehicles. He thought at first that the train was on fire. The sparks continued as the train passed and went out of his sight.

43. After he had given his evidence I went with Driver Cullen to Royal Oak Station and from the cab of a train he identified the point on the ground where he had first noticed the sparking: this was approximately two coach lengths to the west of the $\frac{1}{2}$ mile post.

44. *London Transport Guard G. D. Sitton* was in the rear driving cab of train No 227. He, too, saw the sleeper train go past at what seemed to him an excessive speed. When he first gave evidence he thought that he had seen the train when his own was between Paddington (LT) and Royal Oak, but he later thought it likely that his train had already arrived at Royal Oak. He watched the train turn left, having passed under a signal gantry and come to an abrupt stop. As the last two or three coaches in the train had passed his cab he had seen a mass of sparks coming from underneath them. Before his train left Royal Oak he saw that these rearmost vehicles were at a stand, still upright and apparently on the rails.

45. *Metropolitan Police Constable Mundy* was a passenger in train No 227. He was sitting in the middle of the second car from the front. Whilst at a stand in Royal Oak Station he became aware of a Main line train heading towards Paddington at a much faster speed than normal. From his seated position he could not see below the floor level of the train but he saw the locomotive and a number of the following coaches going by before his own train left Royal Oak.

The post-accident examination of the locomotive and train

46. *Mr R. G. Kethro*, the Senior Shift Maintenance Controller at Paddington, was told about the accident at 06.15, and for the next 45 minutes was occupied in relaying information in the control office. At about 07.00 he went to the locomotive and, in company with *Traction Inspector M. R. Dancer*, made a preliminary examination. During the course of this, at about 07.15, he felt the tyres and brake blocks on 5 or 6 wheels on the 2 bogies, both of which were detached from the locomotive, and they were warm to the touch. He had not been wearing gloves. Inspector Dancer, who had been wearing gloves, felt the tyres some time after 07.30 and to him they felt quite cold.

47. Their examination established the following. The locomotive had been driven from the No.2 end and this leading end was heavily coated with ice below the cab windows; the windows themselves were free of ice and reasonably clean. The leading end headlamp was alight. All the leading end brake cocks were closed. Inside No.2 cab, the cab lights were switched off; all the gauges were reading zero; the brake selector indicators showed 'air passenger'; the automatic brake valve was in the 'full service' position; the straight air brake valve was in the 'off' position; the power handle was in the 'closed' position; the selector handle was 'forward'; the AWS isolating handle was 'on' with the visual Indicator 'all black'; the cab heater was 'full on' and the cooker off; and the demister was 'on'. There did not appear to be any physical damage to any of the controls or equipment in the cab.

48. They next examined the No.1 end. There was no sign of icing and the train air pipe and the main reservoir pipe cocks were in the open position. The correct shut down procedure had been carried out and the automatic brake valve was secured in the shut-down position.

49. *Mr H. Evans*, HQ Locomotive and Rolling Stock Inspector, examined the locomotive at about 09.10. He observed that ice had accumulated at the brake pipe ends and brake cocks at the No.2 (leading) end but concluded that this was from frost deposit rather than from any leakage. His examination established that both aftercooler manual blowdown valves were half open; No.1 blowdown valve was full of water, with emulsified oil present; No.2 blowdown valve, which was half a turn undone, emitted 5 ml of water; 4 brake cylinders, which had become detached, were in the 'on' position; the undamaged cylinders which had remained attached were in the 'released' position; and the tyres were not severely damaged and showed no signs of excessive heating. Finally, Mr Evans examined the AWS equipment at both ends of the locomotive. Both indicators were showing 'all black'. The equipment was little damaged, except that the receiver harness had been torn away from the junction box.

50. *Mr B. N. Bedwell*, Coaching Stock Engineer, Paddington, inspected the coaching stock at about 11.30. The two rearmost vehicles had already been removed from the site and the brake cocks were closed at the rear of the 12th vehicle, which was now the last vehicle in the train. All the brake cocks at both ends of all the remaining 12 vehicles were open, except on the first vehicle from which they had been torn off at the London end, and on the 3rd vehicle on which the reservoir pipe cock at the Bristol end was between the 'latched open' and 'latched closed' positions. Mr Bedwell concluded that this must have been the result of derailment damage since if the cock had been closed before the derailment it would have remained in the 'latched closed' position. All the distributor and brake isolating cocks were open except on the 3rd vehicle where the distributor isolating handle was half-turned in the closed position, but again Mr Bedwell was

satisfied that this had occurred during the derailment—there was considerable damage around the handle. During his examination, Mr Bedwell saw no signs of icing in any of the brake pipes, or extraneous water or oil dripping from any part of the brake system. Although the air temperature was by this stage above freezing there was still frost on the sleepers.

51. Mr J. F. Smith, the Regional Inspection Engineer, had earlier examined the coaching stock, at about 08.50. He had seen no ice on the brake pipes and orifices and no extraneous water or oil dripping from them. Later, at about 11.00, he looked at the brake pipes and reservoir pipe cocks throughout the train and noted the same situation as recorded by Mr Bedwell.

The post-accident examination of the track in the area of the derailment

52. The track in the area of the derailment was examined from about 15.20 onwards by Mr M. McLoughlin, a Principal Scientific Officer in the BR Research Department at Derby. The first signs of derailment were between the crossing in the Up Main line (647A Points) and the connection into the Down Relief line (647B points). The marks commenced some 17 m after the crossing and gave a total derailed running distance to where the front of the locomotive came to a stand of 390 m. The marks were consistent with a wheel flange having climbed the lefthand rail and the tread corner of the opposite wheel having marked the righthand rail as it derailed into the four-foot space.

53. Examination of the switches in the turnout from the Up Main line revealed no signs of damage; all the track components were intact and well secured. However, the nose of the cast crossing had been bruised and deformed slightly to the righthand side, whilst the opposite check rail showed signs of hard contact by the backs of the wheels and, directly opposite the crossing gap, marks which indicated that one or more wheels had almost succeeded in getting on to the head of the rail. Beyond the crossing, there was evidence that high lateral forces had been applied to the outer rail of the turnout, causing strain and some slight damage to the track.

54. Mr McLoughlin then traced the path of the initially derailed wheelset forward. The wheelset had run straight across the connection with the Down Relief line, grinding flats on the rails. The fact that the wheels had continued in a straight line and not been deflected by the rails at this point indicated a high speed. Approximately 46 to 55 metres beyond the point of initial derailment there were signs of multiple derailment and from this point on there was severe damage to the track. On reaching the locomotive, Mr McLoughlin observed that the leading wheels of the leading bogie were the most severely damaged, with bruising of the treads and gouging and scoring of the metal on the face of the wheels. This pattern of damage was present on the other wheels of both bogies but was considerably less severe. From his examination of damaged components on the track, he concluded that the locomotive had overturned some 92 metres prior to striking the platform ramp, and some 146 metres before it came to rest.

55. Mr McLoughlin's conclusion was that the leading wheelset of the locomotive was the first to become derailed and that the mechanism of derailment was by flange climbing caused by a grossly excessive speed through the turnout, which was subject to a speed restriction of 25 mile/h. Based on the mode of initial derailment and the subsequent distance travelled by the locomotive, he gave his opinion that the speed of the train when it derailed would have been in the order of 60 to 70 mile/h. Finally, Mr McLoughlin considered that the locomotive wheels, when they struck the rails of the Down Relief line, would have caused sparking and that since the wheels would still be revolving at this point, the sparks could have appeared circular when flying off the wheel.

The subsequent detailed examination of the locomotive and rolling stock

56. Soon after the accident, the locomotive and coaches were removed to Old Oak Common Depot where they were subjected to detailed examination and testing over a period of weeks. Coordinating these tests, under the direction of Western Region's Chief Mechanical and Electrical Engineer, was Mr O. Kupferle, the Region's Assistant Inspection Engineer. Mr Kupferle's report on the tests, which was made available to me at an early stage in the Inquiry, occupied some 60 pages. The following summarises the main elements of the tests, and Mr Kupferle's conclusions. Before he presented his evidence, I asked Mr Kupferle whether, in his opinion, the damage done to the locomotive and rolling stock during the course of the accident had prevented him from reaching valid conclusions as to the state of the braking system before the derailment. He replied that, in the case of the locomotive, he was reasonably confident that the tests disclosed the state of the braking system immediately before derailment; in the case of the coaches the situation was a little more difficult because of the extent of the damage to some of the brake components but he was nevertheless satisfied that the tests were valid for most, if not all, the coaches.

57. The initial examination at Old Oak Common showed that very little water was present in the main reservoir and brake system, although the severance of pipes and the detachment of bogies would have had the

effect of blowing down the system. However, when main air reservoir pressure was applied a week after the accident, the bogie brake cylinder pressures built up to 70 psi, indicating that some control air had remained trapped and that any significant amount of water in the system should then have been detectable had it been present.

58. The most significant of the early findings came from examination of the locomotive brake cylinders. Five of these had been torn away from their connections during the accident; of these three were so badly damaged that no valid conclusions could be reached as to their state at the moment of derailment but examination of the remaining two showed the cylinders to be jammed with the pistons extended to about 140 to 152 mm stroke, proving conclusively that these cylinders at least had been in the 'brakes applied' position when they were torn away.

59. The detailed tests on the locomotive covered the driver's brake valve, the straight air brake valve, the anti-slip brake, the AWS and DSD, the distributor, the straight air brake relay valve, the proportional relay valve, the cab brake cylinder gauge double check valves, and the 100 psi reducing valve. No malfunction was found, except that the driver's brake valve handle was binding on the indicator plate; but the latter was slightly distorted and this could well have occurred during the course of the accident. There was no evidence of dirt or other extraneous material in any brake pipe, valve, or other part of the braking system. The brake blocks were well within tolerance for thickness, but showed slight roll over signs at the edges. Mr Kupferle considered this to be indicative of a relatively short sharp brake application, not one of long duration. There was no evidence of overheating, either of wheels or blocks, and the wheels had no abnormal flats. Adjustment of the brakes so far as it could be determined, was good.

60. On the coaches, the brake cylinder application timings of every vehicle, except BG 84576 on which the distributor was fractured, were checked and satisfactory results were obtained, although marginally extended times were found on some vehicles. All the distributors reacted to a fall in brake pipe pressure consistent with an initial brake application. The brake cylinder pressures in full service and emergency applications were satisfactory on all except two of the vehicles, and on one of these at least the unsatisfactory response was almost certainly due to damage caused during the derailment. All vehicles were checked for main reservoir pipe feed into the brake pipe, with negative results. The adjustment of the brakes, so far as it could be established, was satisfactory throughout the train and the condition of the brake blocks and discs was normal, with no signs of overheating. The electronic wheel-slide protection fitted to the four Mark IIIA sleeping cars was specially tested to eliminate the possibility that some axles had run unbraked due to a malfunction in the wheel-slide protection system.

61. On completion of the static testing at Old Oak Common, the principal brake equipment components on the locomotive were removed and sent to the main works of British Rail Engineering Limited at Doncaster for further testing. All items worked satisfactorily and were dimensionally within permitted tolerances. The undamaged brake cylinders were tested at sub-zero temperatures and worked satisfactorily.

62. Additionally, the brake distributors from all the coaches were sent to the suppliers, Westinghouse Brakes Ltd and Davies & Metcalfe plc for bench testing. The results were satisfactory; water was present in two distributors (from the 1st and 14th vehicles) but both distributors still worked satisfactorily. It was not possible to test one distributor, from the second vehicle, because of derailment damage.

63. In summarising the results of the tests, Mr Kupferle said that he had been unable to find anything in either the locomotive's or the coaches' braking systems which would have prevented a proper brake application being made. He was satisfied that, at or soon after the moment of derailment, the brakes of the locomotive at least had been applied, although the brake application had not been a prolonged one.

Further investigation of the train's braking system

64. Mr D. B. Nicholas, Brake Engineer, British Railways Board, was associated with all the tests and technical investigations carried out on the train's braking system. Long before the accident at Paddington he had studied the performance of braking systems under adverse weather conditions, and in 1982 he had summarised experience on BR in a technical paper presented at a UIC (ORE) colloquium in which he described the effects of adverse weather on the operation of air brake equipment on traction and rolling stock.

65. Mr Nicholas was satisfied that the tests carried out under Mr Kupferle's direction, together with the further examination of components at Doncaster and by the suppliers, were sufficient to demonstrate with reasonable certainty that the individual components of the brake equipment, on both the locomotive and the coaches, were in proper working condition at the time the train became derailed, and that the brakes should have been capable of responding to a brake application initiated either by the driver or automatically by the passage of the locomotive over an AWS magnet. The available evidence also suggested that the brakes were in fact applied on the locomotive, and probably on the coaches, for a short time immediately before derailment.

66. In view of Driver Long's evidence, Mr Nicholas examined possible modes of failure which might explain the gauge readings observed by the driver and guard and at the same time a zero brake application throughout the train. He concluded that it was impossible to postulate any credible failure, or series of failures, which would be fully consistent with the evidence given. For an application of the automatic brake, followed by application of the straight air brake, to produce a zero brake application throughout the locomotive and train, the locomotive's bogie double check valves or the hose connections to them would have to be obstructed. Simultaneously the air brake pipe would have to be obstructed between a point on the locomotive and the leading vehicle in the train. Or there would have to be a simultaneous failure of the distributor on every vehicle in the train. But the examinations had found no physical obstruction in the air brake pipe, and the detailed examination of the double check valves had proved them to be in proper working order.

67. Mr Nicholas then examined the possibility that ice had formed in either the brake pipe, or the bogie double check valves, or the vehicle distributors. Had this been the case it is possible that, by the time the locomotive and vehicles were first examined after the accident, the ice would have melted. However, Mr Nicholas drew a distinction between the train air brake pipe (ABP) and the main reservoir pipe (MRP). In the ABP, the air pressure is lower but there is more movement of air, and the air entering it from the compressor is at higher than ambient temperature such that the temperature within the pipe will normally be between 1° and 3° above ambient. In winter, with low ambient temperatures, the amount of moisture per unit mass of air decreases, and this, together with the pressure regulation system and the separation in the reservoirs, reduces the quantity of moisture discharged to the ABP. In practice, no trace of water was found in the ABP and the coupling heads during the train's journey and this is in line with the expected situation.

68. Under the climatic conditions prevailing in the early hours of 23 November, Mr Nicholas would have expected the MRP to show the first signs of failure if any icing had occurred. However, Guard Tutton's observation of the brake gauges suggests there was no such failure; nor was there any evidence of adverse riding in the Mark III vehicles, which have an air suspension system fed from the MRP and venting to atmosphere. He therefore concluded that in the absence of any evidence of ice in the MRP it was most unlikely that icing would have occurred in the ABP.

69. So far as the locomotive's bogie double check valves and the vehicle's distributors were concerned, Mr Nicholas said that it was not possible to obtain direct evidence but that the possibility of ice having formed sufficient to prevent the brakes applying could be assessed against experience under service conditions. Difficulties, as detailed in the paper mentioned in paragraph 64, had been experienced in air braking systems under adverse weather conditions, but these conditions had generally been far more severe than those on the day of the accident. Even so, the history of known failures did not equate to the evidence provided by the driver and guard.

70. At Mr Nicholas' request, the suppliers of the brake valves and distributors were asked for their comments on the low temperature and high humidity operation of their equipment. Davies & Metcalfe plc confirmed that their equipment is designed to meet UIC Code 541-5, which calls for satisfactory operation over a temperature range of -50°C to +50°C. They quoted experience extending over a period of some 35 years and said that some hundreds of thousands of sets of brake equipment were in operation in Russia and Eastern Europe, Switzerland and Canada, as well as several thousand on BR, and that they were unaware of any case of malfunction due to working in sub-zero temperatures. Similarly, experience in countries such as Kenya and Tanzania, where humidity can reach 100 per cent, had shown no history of brake failure due to humidity. They concluded by saying that if there was any risk that their valves or distributors would not operate satisfactorily under conditions of sub-zero temperatures and/or high humidity, they would have learnt of it long ago.

71. Westinghouse Brakes Limited, who supplied the P4 distributors, responded to Mr Nicholas by saying that more than 34,000 valves had been manufactured since 1964, most of them were in service on BR, and that at no time during this period, which included a number of severe winters, had there been any reported in-service failures due to low temperature. In the construction of the valves, the nylon reinforced nitrile rubber diaphragms were suitable for operation at temperatures below -20°C, and the porous plastic filters fitted do not absorb water and cannot be blocked by freezing even after total immersion in water. To confirm this, Westinghouse carried out a number of special tests in their climatic test chamber, using a service exchange distributor and one obtained from BR that had been in service for a comparable time to those on locomotive 50041. Both functioned satisfactorily at temperatures down to -20°C.

72. From his detailed consideration of all the available evidence, Mr Nicholas concluded that "The locomotive and vehicle braking system has been found to be in satisfactory working order. The possible modes of failure have been considered and assessed against the evidence. From this and previous service experience, taking into account the probabilities, the balanced judgement is that the brake system performance was satisfactory and available to the driver."

73. Mr J. G. Butt, Chief Mechanical and Electrical Engineer, BR Western Region, summarised the history of the Class 50 locomotives. Fifty were constructed between 1967 and 1968 and most had been working on Western Region during the past 10 years. Some difficulties arose in 1979 with air blowing past the brake cylinder piston seals and modifications were made which cured the problem. Since then, Mr Butt said, he was unaware of any complete brake failure on a Class 50 locomotive in service, despite considerable running in severe winter conditions.

74. On the subject of the use of methylated spirits, or ethynol, the principal reason for adding this was to reduce the chances of the brake system freezing up during prolonged periods of shut down. In running, the addition of ethynol gives increased protection to -2°C and, in view of the ambient temperature on the morning of the accident and the distance that the train had already run, with few stops, the presence or absence of ethynol would have made no significant difference to the performance of the braking system.

75. Finally, in answer to my questions, Mr Butt said that he was completely satisfied that the extensive tests carried out by Mr Kupferle would have revealed any faults in the train's braking system had they existed. He was satisfied that nothing had been found that brought into question the train's ability to stop within its normal braking distance. Nor had he or his professional colleagues been able to postulate any credible situation, including the icing up of components, that would accord with the evidence given by the driver and guard of the train.

Further investigation of train behaviour approaching Paddington Station

76. Mr McLoughlin, who had earlier given evidence on the course of the derailment, described the results of theoretical and practical investigations of train behaviour on the curves approaching Paddington. Three sets of curves had to be considered; those at Westbourne Park, those at Subway Junction, and those through 647 points. The theoretical investigation showed that at speeds up to about 85 mile/h the ride of the train through the Westbourne Park curves would not have given rise to passenger discomfort or alarm even had they been standing. At Subway Junction, any speed above about 70 mile/h would have caused noticeable discomfort and speeds above 80 mile/h would have caused standing passengers to be thrown about. At 647 points a train speed of 50 mile/h or less would not have caused derailment, whilst a speed of 79 mile/h or more would have caused the locomotive to overturn towards its righthand side on the turnout.

77. A computer simulation was made of the train's run from Reading to Paddington. The graph at Figure 4 shows the last six miles, from Longfield Avenue to the point of derailment. The simulation shows that, with no braking and a speed of 65 mile/h through 647 points (Driver Long quoted the speed entering the turnout as between 60 and 65 mile/h) the speed through the Subway curves was likely to be too low to accord with the evidence of discomfort to standing passengers. If, on the other hand, the brakes had been applied at or soon after the Subway Junction curve, the corresponding speed through the Subway curve would have been significantly higher, in the range of 73 to 81 mile/h, and this would have given rise to passenger discomfort.

78. These theoretical studies were supplemented by practical tests on a similar sleeping car train. These were designed to monitor the experience of observers as the train ran through curves at known cant deficiencies, to test their ability to detect brake applications, and to demonstrate the behaviour of trays of crockery in the pantry at different cant deficiencies and rates of change.

DISCUSSION

79. There can be no doubt from the evidence that the locomotive was the first to derail. It did so approximately 48 metres after entering the switches at the facing (A) end of 647 points and some 17 metres after passing, and damaging, the crossing. Theoretical calculations give a bracket for the locomotive's speed through the turnout; at less than 50 mile/h neither it nor the coaches would have derailed; at 79 mile/h or more the locomotive would have overturned. The extent of damage and the distance travelled by the locomotive after becoming derailed is consistent with an actual speed through the turnout of between 60 and 70 mile/h. And a speed of this order would be sufficient to cause a wheel flange to climb the rail into derailment. The driver gave the speed of the locomotive on entering the turnout as between 60 and 65 mile/h.

80. The driver of the train, Driver Long, consistently maintained that he applied the brakes in sufficient time to bring the train's speed down to the permitted speed of 25 mile/h through the turnout, and that at every stage of his brake application he obtained normal indications of train pipe and brake cylinder pressures on the gauges in the driving cab. He was equally adamant that at no stage did the brakes appear to slow down the train and that, in his view, they had at no time applied on either the locomotive or the coaches.

81. The guard of the train, Guard Tutton, saw evidence of a brake application on the gauge in his van in the 10th vehicle (out of 14) from the front of the train as the train approached Paddington. He could not be

sure where this occurred—he thought it was near Westbourne Park—but associated it closely in time with a relatively violent motion of the coaches, sufficient to throw standing passengers off balance, which occurred a short time before the derailment. Calculations of speed and cant deficiency show that a motion of this kind could not have occurred before the vehicles concerned had arrived at Subway Junction.

82. There can be no doubt that the brakes on the train were working properly throughout the journey from Penzance to Reading. Driver Long said that he made a running brake test after leaving Reading, near Slough, and that the brakes responded normally, reducing speed from 90 to 80 mile/h.

83. Detailed examination of the locomotive and coaches after the accident established that the brakes, on the locomotive at least, had been applied at some stage before the train came to rest. The evidence as to the position of the pistons in at least two of the locomotive's brake cylinders is conclusive in this respect. However, the condition of the tyres and brake blocks on the locomotive and train showed that this brake application could not have been a prolonged one although it could have been a short, sharp, one. Nor was the condition of the tyres and blocks on the locomotive such as to suggest that the brakes on the locomotive alone had applied for a prolonged period.

84. Passengers on the train generally were not conscious of any braking before the derailment although one, Mr Cooper, who was a railwayman experienced in train running and who was travelling in the 8th vehicle from the front, believed that an application was made a few seconds before derailment.

85. A number of witnesses described how they saw sparks, such as might have accompanied a heavy brake application, coming from the locomotive as it approached Paddington Station. These witnesses were at various points in the station area and I checked on the ground the view that they would have obtained of the approaching train. One witness would only have seen the locomotive after it had become derailed although the others could well have seen it before it derailed. Evidence was given that part of the damage to the locomotive's wheels, and those of the coaches, was caused by heavy rotating contact between the wheels and rails during the derailment and that this was likely to have caused sparking consistent with what was seen by the witnesses. Whilst some of the sparking seen by the witnesses could have come from a brake application on the locomotive before it derailed, it is equally possible that what they saw was sparking caused by the wheels running derailed.

86. Two witnesses, a London Transport driver and guard, saw sparks coming from the wheels of coaches at the back of the train before and during the passage of the train past Royal Oak Station. They identified to me the points on the ground where they had observed the sparks and, even allowing for some error in their estimation of the train's position, it is clear that the whole train was still on the rails at this point.

87. For the train pipe and brake cylinder gauge readings in the locomotive's cab to have given correct indications of a brake application without any retardation of the train, there would have to have been a blockage in the train pipe within the locomotive but at a point in rear of the take-off from the main brake pipe to the distributor which was located towards the No. 1 (trailing) end of the locomotive. At the same time there would have to have been a failure of both bogie double check valves, with the brake cylinder gauge double check valves producing false readings in respect of each bogie. Alternatively, a blockage would have to have occurred in the train pipe such that the brakes on the locomotive applied but not on the train. But this, if the application was made where the driver said it was made, would have produced a retardation that the driver could not have failed to notice and which would have left clear evidence on the tyres and brake blocks.

88. The possibility that the formation of ice somewhere within the braking system prevented the proper functioning of the brakes was examined at length. There was no evidence that external snow or ice on the brake rigging or discs prevented the brakes from applying. There was no evidence of any blockage in the train brake pipe; had one occurred other than within the locomotive, the locomotive's brakes would have responded normally when the driver made his first application. It is not possible to say with absolute certainty that a blockage did not occur on the locomotive but, for the reasons given in paragraph 87, the blockage would have to have been in a specific part of the train pipe, and to have been accompanied by the failure of a number of valves—failures for which there was no subsequent evidence. The possibility of a blockage within the locomotive is in any case less likely than one between the locomotive and the train, or within the train, because of the dynamic situation within the brake system. At the locomotive, the air movement is at its greatest since it has to compensate for any leakage in the train during running. Additionally, the historic data summarised in the evidence by Mr Nicholas shows that the likelihood of the locomotive's braking system failing because of ice formation is remote. Such a thing has never been reported during the 16 years that the Class 50 locomotives have been in service, even though they have operated in considerably worse weather conditions than obtained on the day of the accident. And enquiries made by the Railway Board's Director of Mechanical and Electrical Engineering have failed to discover any history of failures of this kind elsewhere, or

a single case of a complete failure of the automatic air brake to apply the brakes on a locomotive and train, even on railways where the winters are far more severe than in Britain.

89. The graphs in Figure 4, presented in evidence by Mr McLoughlin, show speed profiles between Longfield Avenue and the point of derailment. They vary from full power applied to coasting throughout. Superimposed on the speed profiles are braking curves based on speeds through 647 points of 65 mile/h, the probable actual speed, and 50 mile/h, the minimum speed for a derailment to have occurred. They also show corresponding cant deficiencies through curves at Westbourne Park and Subway Junction. The permitted speed through the Subway Junction curve is 60 mile/h, and at this speed the cant deficiency is 4.5° and the rate of change of cant deficiency is 55 mm/s. This is close to the upper limits set by BR for passenger comfort. If the train had coasted, without any brake application, from a speed of 90 mile/h at Longfield Avenue, its speed at Subway Junction would have been approximately 68 mile/h. This would have produced a cant deficiency of 6° , with a rate of change of 82 mm/s. This would have been noticeable to passengers but unlikely to create the effects noted by Guard Tutton. If, however, the speed had been 80 mile/h, the corresponding figures would have been 9° and 147 mm/s (or at 85 mile/h, 10° and 170 mm/s) and these values would certainly be sufficient to inconvenience standing passengers, and even to bring crockery off a shelf.

90. The reverse curves at Westbourne Park are of considerably greater radius. Even at 85 mile/h, the cant deficiency would not exceed 4° , with a rate of change of only 70 mm/s. This would be perceivable by standing passengers but would cause no alarm or inconvenience.

91. The evidence of witnesses on the train gives a picture of an initial, fairly violent lurch, followed by a short period of relative calm before the general shock of the derailment. All the evidence suggests that this initial lurch occurred at Subway Junction; Driver Long himself spoke of the locomotive "fighting the rails" at this point. For a lurch of this severity to have occurred, the train's speed would have to have been considerably higher than the 68 mile/h which would have been the case had the train coasted from Longfield Avenue. I believe its speed was at least 80 mile/h at this point.

92. If this is the case, then it is necessary to account for the reduction in speed between Subway Junction and 647 points, where I have accepted that the speed was in the order of 65 mile/h. The distance is just over 500 m and a reduction in speed of 15 mile/h over this distance could only have been achieved by a brake application. Calculations show that a driver's emergency brake application, initiated at the mid-point of the Subway Junction curve, would reduce the train's speed from 80 mile/h at that point to 65 mile/h at 647 points. The calculation allows 2 seconds reaction time from the mid-point of the curve. A similar brake application from 85 mile/h would reduce speed to just over 70 mile/h at the points, and from 73 mile/h to 55 mile/h.

93. Similar calculations have been made for a brake application initiated by the AWS inductor for Signal 00.57, which was displaying a double-yellow aspect. The inductor is 97 m past the mid-point of the Subway Junction curve, and 407 m in rear of 647 points. To reduce to 65 mile/h at the points, the speed over the inductor would have to be 73 mile/h and not much greater than this through the Subway Junction curve. This seems too low to accord with the probable actual speed through the curve.

94. There remains the question of the speed of the train between Longfield Avenue and the Subway Junction curve. Driver Long said that the speed at Longfield Avenue was 90 mile/h. It could have been less but the known timings of the run from Reading suggest that the train was travelling at near its normal speed and this would have entailed a speed of about 90 mile/h at Longfield. Driver Long claimed that he closed the controller at Longfield and thereafter allowed the train to coast. Had he done so, and there had been no brake application, the train would have gradually lost speed and would have been travelling at just under 70 mile/h when it passed through the Subway Junction curve. As explained in paragraph 89, this appears to be too low a speed to produce the violent lurch noted by those on the train some moments before the derailment and which I am satisfied occurred as the train passed through the Subway Junction curve. At the other extreme, if the driver had maintained full power the train's speed would not have dropped below 90 mile/h and this would have caused a very noticeable effect at Westbourne Park, a very severe one at Subway Junction, and a strong probability that the train would have overturned on 647 points. One is therefore led to the conclusion that Driver Long must have reduced power at some stage, without removing it completely, or alternatively that he removed power and then partially re-applied it. In each case it entails his having been in conscious control of the locomotive at Longfield Avenue.

CONCLUSIONS

95. The immediate cause of the accident is not in doubt: the train approached Paddington Station at a grossly excessive speed and became derailed after passing through the sharp curves in the turnout leading

from the Up Main to the Down Relief line. The reason why the train approached at such a speed cannot be established with absolute certainty. However, I am satisfied that the evidence is such that I can come to a conclusion as to the prime cause of the accident.

96. There are only two credible explanations for the train's failure to reduce speed in time. Either the brakes on the locomotive and train, having functioned perfectly throughout the journey from Penzance to Slough, failed totally to respond to the driver's initial brake application at Kensal Green, or for some reason the driver failed to make the required brake application, or made it too late. As for the first, the technical evidence is overwhelmingly against the possibility of a total brake failure, which at the same time gave correct indications on the locomotive's brake gauges, and which was followed by a full or partial application of the brakes shortly before the train became derailed. As to the second, I have to balance the driver's consistent account of his actions, so far as his efforts to apply the brakes are concerned, against the technical evidence and that of other witnesses and, not least, against what the driver, on his own admission, did *not* do. Driver Long repeatedly described how he shut off power near Longfield Avenue, just under 6 miles from Paddington, how he first applied the brakes near Kensal Green, still over 2½ miles from Paddington, and how the train failed to slow down even after he had made a full emergency application. Yet he was unable to offer any convincing explanation of why he did nothing more during the ensuing period of over a minute and a quarter during which time, on his evidence, the train was continuing unchecked towards certain destruction. He did not sound the horn, he did not release the DSD, he did not attempt to 'pump' the brake handle, he did not try to apply the handbrake, and he did not try to leave the cab. I would have expected him, as an experienced driver, to have done all or some of these things.

97. I think it most probable that, after reducing power near Longfield Avenue, or earlier, Driver Long lost concentration, either through drowsiness or by allowing his mind to wander, and failed to realise how closely and how quickly he was approaching the terminus. I believe that the sudden exceptional motion of the locomotive as it negotiated the Subway Junction curve brought him back to full consciousness and that at this point he made an emergency brake application and that the brakes applied through the length of the train seconds only before the locomotive became derailed. Such an explanation accords with a high percentage of the available evidence, and only Driver Long's evidence contradicts it completely.

98. In concluding that Driver Long was responsible for the accident I am not necessarily implying that he deliberately falsified his evidence. He may have done so, but I think it equally likely that after the highly traumatic experience of being involved in a high-speed derailment he may have convinced himself that he had handled the train as on previous occasions. If I am right in my conclusion that he lost concentration, then he would have had little real recollection of the events immediately preceding the derailment: running at 80 mile/h or more the train would have covered the distance between Kensal Green, where he should have made his initial brake application, and Subway Junction, where I believe he did make one, in not much more than one minute and his loss of concentration need not have lasted longer than this short period of time.

REMARKS AND RECOMMENDATIONS

99. The accident, and its subsequent investigation, brought to light a number of matters on which I need to comment. I deal with them in order of their importance.

(a) *Driver's Safety Device (DSD)*. This device, fitted to most locomotives and multiple-units, is designed to detect whether a driver has lost consciousness. In the case of the Class 50 locomotive, it is a foot-operated pedal, which must be kept depressed otherwise the brakes are applied. The circumstances of this accident, and others, suggest that some of the present designs of DSD may not be fully effective. In some locomotives it seems to be too easy for a driver to wedge his legs between the console and the DSD pedal, and in others it is probable that the weight of an unconscious driver could be sufficient to keep the foot-pedal depressed. I recommend that the Board reviews the current position so as to ensure that, in the event of a driver falling asleep or otherwise losing consciousness, a device, not necessarily the present form of DSD, is available to operate reliably and quickly to apply the brakes.

(b) *Vigilance Devices*. These devices supplement, or are an alternative to, the DSD. They require the driver to take some conscious action at set intervals and so prove that he is fully awake and concentrating on his tasks. Some require a foot-pedal to be depressed and released, others require some movement of the controls or the driver to touch some part of the console. I believe that in the past the Board has lacked a consistent policy on whether to fit these devices or not. At present, the High Speed Trains and other 100 mile/h plus locomotives are fitted, even though these units are invariably double-manned when travelling at these speeds. In the case of the Class 50 locomotives, all were fitted with an electronic

vigilance device when they were first introduced in the late 1960s but these proved troublesome and unreliable and they were removed. I believe that there are now efficient and reliable devices available. I recommend that the Board reviews its policy on vigilance devices in conjunction with the review of the current designs of DSD. With the prospect of even higher speed running in the not too distant future, the Board will no doubt be looking at cab signalling, which would make separate vigilance devices unnecessary. But whilst drivers, on their own in the cab, have to drive long distances between stopping places, especially at night, I feel there is a need for some device in the cab which will detect those rare occasions when a driver loses concentration or is taken ill. Without such an aid, the potential for a repetition of accidents such as the Paddington one is, in my view, too great.

(c) *Permanent Speed Restrictions.* The Paddington accident disclosed a situation which was dramatically highlighted by the subsequent accident at Morpeth. High Speed Trains approaching Paddington on the Main line are permitted to travel at 125 mile/h until reaching Acton, $4\frac{1}{2}$ miles from the station. All trains are then required to reduce speed to 85 mile/h until approaching Westbourne Park, just over 14 miles from the station, and to 60 mile/h until reaching Royal Oak. From this point, 48 chains from the buffer stops, a 25 mile/h restriction applies through to the platforms. According to the rules developed after the first Morpeth accident, in 1969, this 'cascade' of permanent speed restrictions just avoids the need to provide an Advanced Warning Indicator (a 'Morpeth board') with its associated AWS magnet at any of the changes in permissible speed. Approaching under clear signals, as did Driver Long's train, the first restrictive AWS indication was thus at Signal 00.57 — too late to prevent the accident. In the light of the Paddington and the more recent Morpeth accidents the Board has been reviewing the rules for AWIs and is about to issue a revised code of practice. According to this, a series of reducing permanent speed restrictions such as at Paddington will require the provision of an AWI and associated AWS magnet. In the interim, Western Region has completed plans to provide a differential 100/85 mile/h speed restriction in place of the existing 85 mile/h, and this will necessitate the provision of an AWI and magnet for the following 60 mile/h restriction.

(d) *Tachographs.* Unlike most Continental railways, BR has never fitted recording devices, such as tachographs, to its locomotives. There is no doubt that the lengthy, and expensive, investigation into the Paddington accident would have been greatly simplified had the locomotive been so fitted. However BR's view, which I share, is that the widespread fitting of tachographs would only be justified if to do so brought some positive advantages, in terms of increased efficiency or economy of operation, rather than merely providing a means of determining events after an accident. Since the Paddington accident, but not because of it, the Board has conducted trials of a currently available recording device.

(e) *Braking Faults in Locomotives and Trains.* During the course of the Inquiry, I reviewed the reported cases of fault or malfunction in the braking systems of locomotives and trains. In addition, the Trade Union representatives brought to my attention a number of cases, some involving Class 50s, that had not been previously reported to railway management. Whilst none of these demonstrated the kind of complete failure alleged by Driver Long, some suggested that a potentially, if not actually, dangerous situation could have arisen. All these cases were investigated by the Board's engineers and I am satisfied that the appropriate measures have been taken where these were shown to be necessary. What I feel is important is that drivers, on discerning or suspecting a fault in the braking system of a locomotive or train, should report the fact at once, and that after the matter has been investigated they should always be told what has been discovered and what action, if any, has been found necessary to put things right.

(f) *Arrangements for Dealing with Passengers after the Accident.* I received a number of letters from passengers on the train complaining that, after having been led from the derailed coaches to the ends of the platforms at Paddington, they had been left without any attention or information. I appreciate that, following a major accident at an early hour of the morning, the railway staff immediately available are going to be extremely busy, but the Railways' emergency procedures should provide for the proper care of their passengers throughout the aftermath of an accident. Had the accident taken place in the country, passengers would probably have been gathered together and provided with hot tea, etc until arrangements could be made for their onward journey. Because in this case the passengers could be taken quickly to the safety of the platforms, one suspects that their subsequent welfare was largely ignored.

(g) *The Response to the Emergency.* Apart from the cavil about the treatment of some of the passengers, the performance of the emergency services in dealing with the immediate aftermath of the accident and of BR's repair gangs, faced with the task of repairing the very extensive damage and restoring train services, was magnificent.

(h) *Acknowledgements.* In completing this Inquiry I should like to express my gratitude to the officers of Western Region, who themselves conducted a very thorough investigation into every aspect of the accident, to the other officers of the Board for their ready assistance, and to the Trade Union representatives who, whilst properly representing the interests of their members, gave me every assistance and kept an open mind.

I have the honour to be,

Sir,

Your obedient Servant

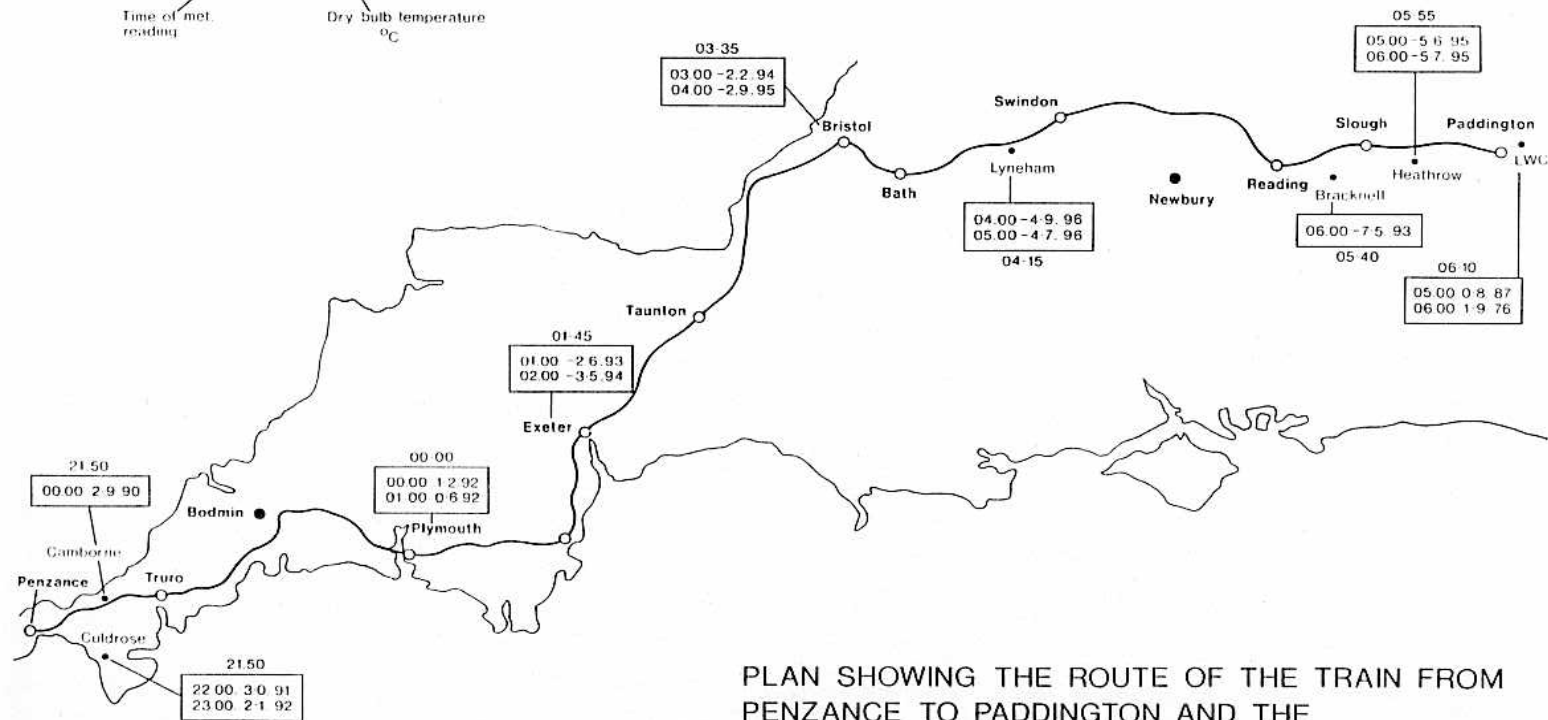
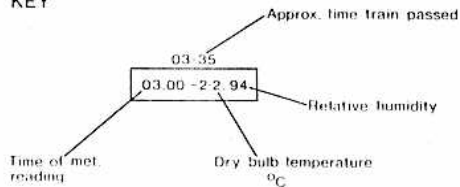
C. F. ROSE

Major

The Permanent Under Secretary of State
Department of Transport

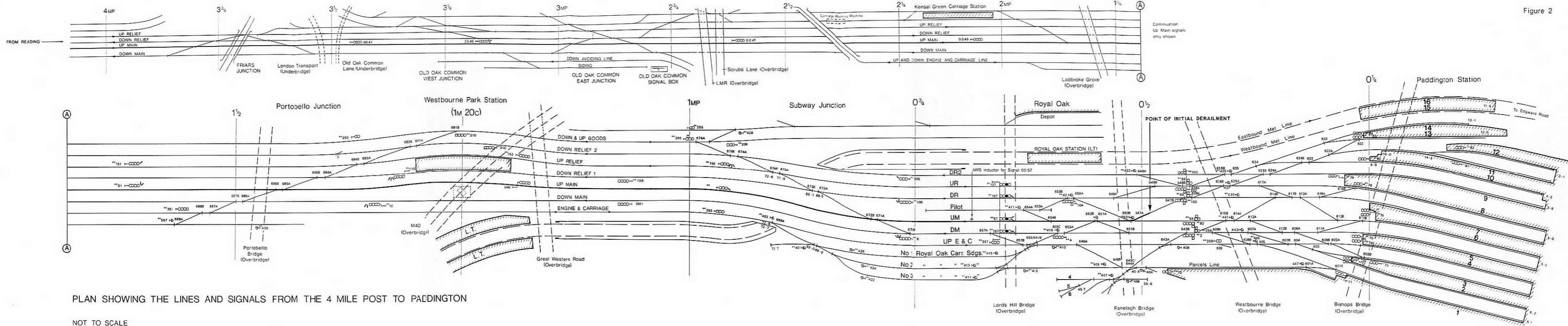
Figure 1

KEY



PLAN SHOWING THE ROUTE OF THE TRAIN FROM PENZANCE TO PADDINGTON AND THE METEOROLOGICAL CONDITIONS

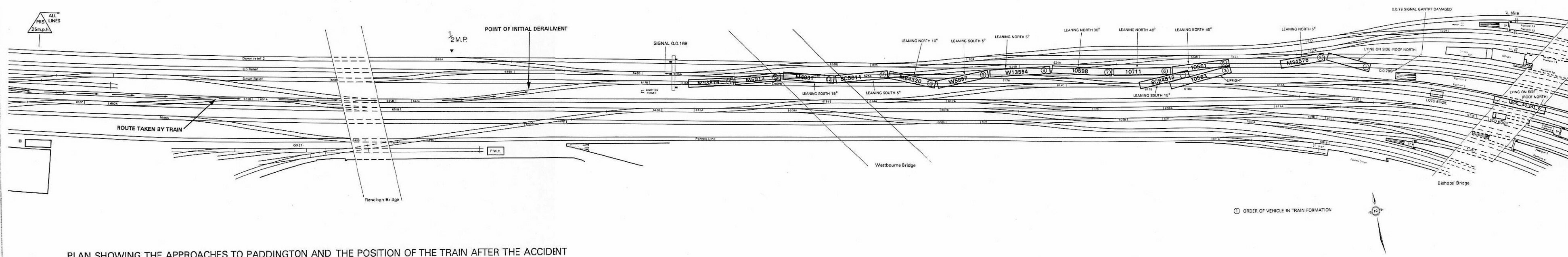
Figure 2



PLAN SHOWING THE LINES AND SIGNALS FROM THE 4 MILE POST TO PADDINGTON

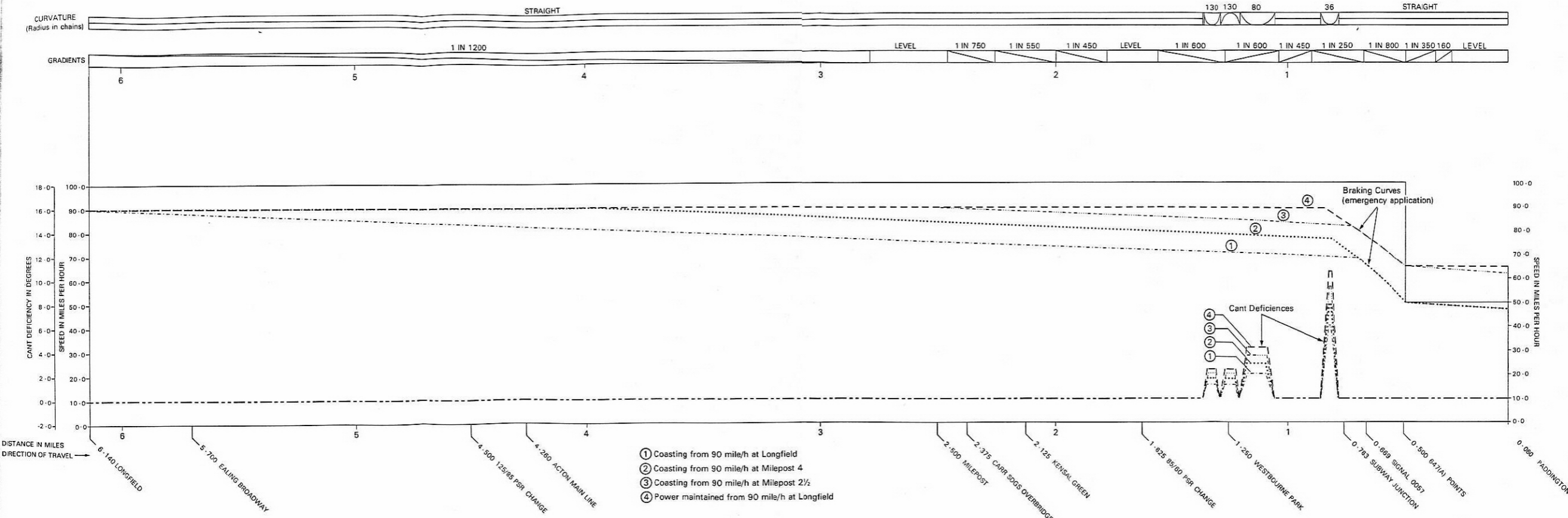
NOT TO SCALE

Figure 3



PLAN SHOWING THE APPROACHES TO PADDINGTON AND THE POSITION OF THE TRAIN AFTER THE ACCIDENT

SCALE 1:480



COMPUTER SIMULATION OF TRAIN SPEEDS AND BRAKING - LONGFIELD AVENUE TO THE POINT OF DERAILMENT