DEPARTMENT OF TRANSPORT

RAILWAY ACCIDENT

Report of the Inquiry into the Collision at Bellgrove Junction on 6 March 1989

HMSO

DEPARTMENT OF TRANSPORT

RAILWAY ACCIDENT

Report of the Inquiry into the Collision at Bellgrove Junction on 6 March 1989

LONDON: HMSO

First published 1990
Second impression 1990

ISBN 0 11 550959 3


6
Warning
Do not trespass
on the Railway
Penalty £200
30


3

RAILWAY INSPECTORATE
DEPARTMENT OF TRANSPORT
2 MARSHAM STREET
LONDON SW1P 3EB

28th February 1990

The Permanent Secretary
Department of Transport
2 Marsham Street
London SW1P 3EB

SIR,

On Monday 6 March 1989 at 12.47 pm, two passenger trains collided head on at Bellgrove Junction, just over a mile east of Glasgow Queen Street Station on the Helensburgh-Airdrie suburban railway. Most regrettably the driver and a passenger on one of the trains were killed outright. A second passenger and the driver of the second train were trapped in the wreckage. The emergency services attended with commendable promptness and carried out an efficient and well coordinated rescue operation. Within an hour and a quarter of the accident all the injured, except the two who were trapped, had been taken to hospital. Surgery was needed to release the driver of the second train. He and the trapped passenger were freed about four hours after the accident and taken to hospital. Of the 54 people taken to hospital, all but 5 were discharged the same day after treatgment. The damaged trains were removed from the site early the following morning. Track and signalling repairs were completed in time for normal services to be resumed on the next morning (Wednesday 8 March).

We were appointed by the Secretary of State under Section 7 of the Regulation of Railways Act 1871 to conduct an Inquiry into the accident. Public hearings took place at the Merchants' House of Glasgow on 19, 20 and 21 April. Our report and recommendations are submitted herewith.

R. J. SEYMOUR
Chief Inspecting Officer
of Railways

A. WILLIAMS
Principal Railway Employment
Inspector

DESCRIPTION

The Site

1. Bellgrove Junction lies just over a mile east of Glasgow Queen Street Low Level Station on the line from Helensburgh and Milngavie in the west to Airdrie and Springburn in the east. The line forms part of the Glasgow suburban railway known as the North Electric System. In railway terminology, trains travelling from west to east are described as Up and from east to west as Down trains. Bellgrove is the junction at which the Springburn Branch deviates from the main line in a north easterly direction. The Main line at this point originally had four tracks but with the closure of a goods yard at High Street, between Queen Street and Bellgrove, the two northernmost tracks were taken up in 1987. In April of that year, as part a major re-signalling scheme centred on Yoker, the double line junction was converted to a single lead junction as illustrated in the general plan in Diagram 1. The maximum permissible line speed in the area of Bellgrove Junction is 30 mile/h, through the junction to and from Springburn.

2. The collision took place on the Down Branch line, a short distance before the section of single line over which, following the conversion in 1987, Branch line trains pass in both directions under the protection of the signalling system. On leaving the Main line, the Springburn Branch curves to the left (minimum radius 362 yards) and rises at a gradient of 1 in 71.

3. The line is electrified at 25 kV AC on the overhead system. Most of the traffic consists of suburban electric multiple unit (EMU) passenger trains, providing a ten minute service through the city centre in both directions between the morning and evening peak hours. On leaving Queen Street, Up trains stop at High Street, then at Bellgrove Station which lies about 440 yards to the west of the junction. In every half hour there are two Airdrie trains, keeping to the Main line, and one Springburn train taking the Branch line.

4. In the Down direction, trains leave Springburn, stop at Barnhill, Alexandra Parade and Duke Street Stations, and pass through a series of short tunnels on the descending gradient before emerging into the open air some 440 yards short of Bellgrove Junction. Before the realignment in 1987 it was usual for

Up and Down trains to pass on the double line junction. With the introduction of the single lead it was necessary to modify the timetable slightly. Down trains are now timed to leave Bellgrove Station (having cleared the junction) one minute before Up trains heading for the Branch.

Signalling

5. The line is provided with colour light signals controlled from signal boxes at High Street Junction, Bellgrove, Parkhead North Junction and Sighthill Junction under the BR Absolute Block Regulations. The system is designed to ensure that a train cannot be given a signal to proceed unless a predetermined section of track ahead is proved to be clear. Signals in the vicinity of the accident site are controlled by the Bellgrove Signal Box. They are to be completely replaced in the course of the Yoker re-signalling scheme. At the time of the accident the signalling system had not been modified except to the extent required by the realignment of the junction in 1987.

6. The line is also equipped with the BR standard automatic warning system (AWS) which provides drivers with both a visible and an audible indication of clear or restrictive signal aspects, and will automatically apply the train's brakes unless the driver acknowledges, by cancelling, the warning of a restrictive aspect. The line is fully track-circuited, so that the position of each train is indicated on the track diagram in the signal box, and signals are interlocked to prevent conflicting movements. More detailed information appears in the Evidence section of this report.

The trains

7. The trains involved were Class 303 3-car EMUs. Units of this class were in the course of refurbishment at the time of the accident. One of the units had been refurbished: train 2A02 the 12.20 Milngavie-Springburn (the Up train). The other remained in its original condition: train 2A01 the 12.39 Springburn-Milngavie (the Down train). The layout of each train, and the disposition of the passengers and crew, is illustrated in Diagram 2. It will be seen that the guard of the unrefurbished train was stationed in the Guard's Compartment in the centre coach. In the refurbished train the Guard's Compartment has been removed and replaced by a secure parcels area. The guard of the refurbished train was correctly stationed in the Driving Cab at the rear.

8. Each train was about 200 feet long and weighed 118 tons. Each was fitted with two independent braking systems: an electro-pneumatic (EP) brake and a 2 pipe automatic air brake. The passenger doors were power operated sliding doors under the control of the guard. Communication between guard and driver on these trains is usually conducted by means of a bell system, but there is also a telephone.

9. Each train was made up in a similar way, consisting of a Driving Trailer in the lead, followed by a Motor Open Brake carriage, with a Driving Trailer in the rear. When the two trains collided the leading vehicle of the Up train overrode the headstock and underframe of the Down train's leading vehicle, crushing the driving cab and compressing it back into the front passenger saloon. Photograph A illustrates the scene, with the Up train in the foreground. The leading vehicle in each train was severely damaged in the collision and had to be "written off". The two Motor Open Brake carriages sustained damage to their body frame and door assemblies. The two rear vehicles were undamaged.

Operating Instructions

10. The operation of the railway is subject to the provisions of the British Railways Rule Book. Relevant sections of the Rule Book are reproduced for reference in Appendix A (Section H: Working of Trains, 5.1.3 and 5.6). Section 21 of the current Working Instructions for Class 303 EMU trains on the Strathclyde Services is also relevant, and is reproduced in Appendix B.

Evidence

11. *Mr A Mackie, Regional Operations Superintendent*, ScotRail, gave a general description of the line and signalling arrangements with the aid of a video presentation showing the driver's view of the signals in each direction. He said that traction power supplies are obtained from the national grid via a feeder station and track sectioning cabins under the control of the Electrical Control Room at Cathcart. The Control operator is instructed, on receiving an emergency call, to discharge traction current immediately from the entire area served by the feeder station concerned.

12. Mr Mackie described Bellgrove Junction as "moderately busy" with two passenger trains per hour in each direction using the Springburn Branch, four per hour in each direction on the main Airdrie

line, and some freight and departmental traffic which he described as "not significant". The Up train involved in the accident was timetabled to leave Bellgrove Station for the Springburn Branch at 12.47, whilst the Down train was due to leave Bellgrove Station 1 minute earlier, having traversed the junction. Trains are commonly scheduled as close as this in intensive suburban networks and he did not regard the timetable as a device for keeping trains apart: that is a function of the signalling system. He accepted that following realignment Bellgrove is currently the only single lead junction carrying passenger traffic on the North Electric System but he said that there are other similar situations where close scheduling is acceptable under the control of the signalling system.

13. Mr Mackie said that the train driver is responsible for observing and obeying all fixed signals. Since Bellgrove Station is unmanned, the guards of trains stopping there are expected to observe Section H 5.1.3 of the Rule Book. This requires the guard to check that passengers have completed joining and leaving the train, and that the platform starting signal, where provided, is showing a proceed aspect before he closes the doors and gives the "ready to start" signal to the driver. Mr Mackie agreed that at Bellgrove Station the guard of a refurbished train has to leave the train and walk a short way across the platform in order to observe the starting signal. He considered it practicable for the guard to do this at Bellgrove and that there is no need for a special "off" indicator to show the guard that the signal has a proceed aspect, such as has been provided at some station platforms with severe curvature. He accepted that circumstances might change between the guard's observation of the starting signal and giving the "ready to start" signal. But once the guard has observed the signal he has discharged his responsibility under the Rule Book.

14. Mr Mackie also gave evidence later in the inquiry about the location specific instructions for Bellgrove Signal Box: these are described at paragraphs 19 and 113 below.

15. *Mr R C Nelson, Regional Signal and Telecommunications Engineer*, gave a detailed account of the signalling system and its history. He said that on the realignment of Bellgrove Junction in 1987, the points were converted from mechanical to hydraulic operation. This rendered the mechanical lever frame in Bellgrove Signal Box almost redundant, with the exception of three levers in the middle which were retained for working the detonator placers. The signalman could use these levers in an emergency to place detonators on the rails as a warning to drivers to stop.

16. The points and signals are interlocked by means of relays in Bellgrove Signal Box. The electrical circuitry is designed to ensure that the points are not moved and signals are not cleared when it is not safe for this to happen, for example when a train has already been legitimately signalled across the junction. Once the route has been set up, facing points are locked and the junction secured for the next train until it has completed its move, or sufficient time has elapsed to ensure an approaching train has stopped at the signals protecting the junction.

17. Under Absolute Block Working the signalman at Bellgrove cannot despatch a train towards any of the neighbouring signal boxes unless an electrical release is given by the signalman at the next box, allowing the relevant starting signal to be switched from red to yellow or green. Once the train has passed the signal it will automatically return to red and cannot be released again until the train has been proved by means of the track circuits to have arrived at the neighbouring signal box. Signalmen can communicate with one another by telephone but for speed and clarity, permission to send a train is sought and obtained by means of a code of bell signals associated with the block instruments.

18. *Mr Mackie and Mr Nelson* jointly explained the operation of individual signals in the vicinity of the accident: their locations, and the points and track circuits (TC) referred to by number in this report, are illustrated in the accident plan at Diagram 1.

Up signals

19. Signal *HS103* (identified at Bellgrove Signal Box as BL86R) is operated from High Street Signal Box, but under the Absolute Block Regulations it must not be cleared by the High Street signalman unless he has obtained permission by bell signal, and the block instrument at Bellgrove, has been switched to 'line clear'. In order to provide an adequate safety margin, the Bellgrove signalman is instructed not to give a line clear release to High Street Signal Box if a route is set from the Springburn Branch to the Down Main line (ie Points 47 and, 49 reversed). HS103 cannot be cleared if either of the two following TCs 286T and 305T are occupied by a train. If the next signal BL86 is at red, the interlocking will prevent HS103 from displaying double yellow or green, but it can be cleared to yellow. This indicates to the train driver that he can proceed at caution but he must be prepared to stop at BL86. In this situation the driver will normally have had a double yellow at HS 105, the preceding signal, as a preliminary caution.

20. *BL86* is the platform starting signal at Bellgrove Station: a 3-aspect signal with a route indicator consisting of a diagonal row of 5 white lights mounted above the main signal. (Photographs B and C illustrate this signal — it will be noted that it is situated on the righthand side of the track instead of in the customary lefthand side position.)

21. Interlocking allows Signal BL86 to show a proceed aspect only in the following circumstances:

for a train routed on the Main line to Airdrie, when Points 47 and 49 are Normal, TCs 305T, 311T and 312T (towards Airdrie) clear and signal BL85 lit. If BL85 is at red, BL86 will be at yellow, only clearing to green if BL85 shows at least a single yellow and the block instrument is switched to 'line clear'.

for a train routed to the Springburn Branch, when Points 49 are Normal, 47 and 46 Reversed, TC 286T occupied, TCs 305T, 293T, 297T, 295T and 786T clear, Signal BL106 lit and BL86 route indicator lit with at least 3 lamps. If BL106 is at red, BL86 will be at yellow, with the route indicator illuminated. If BL106 shows proceed, BL86 will be at green with route indicator illuminated.

22. To check the speed of trains routed for the Springburn Branch, Signal BL86 is *approached-released*: it cannot be cleared for the Branch until the train arrives at TC 286T, at Bellgrove Station. TC 305T also incorporates a *route holding* interlock to ensure that once a train starts to traverse the junction, Points 49, 47 and 46 remain set and locked for the required route until the train has passed. *Approach-locking* is also provided so that in the unlikely event of BL86 having to be replaced to red as a train approaches, the route will be held until the train has either been proved at a halt or has passed clear of the junction. This is achieved by means of a time-release mechanism, which prevents the junction points being moved until 45 seconds after BL86 has been restored to red.

Down Branch line

23. *BL82* is the platform starting signal at Duke Street Station. Interlocking prevents it being cleared unless a route is set from the Branch to the Down Main line. Points 46 must be Normal, 47 and 49 (the crossover from Up to Down Main) reversed. TCs 297T, 293T, 305T, 472T, 474T and 475T (as a safety overlap) must be clear. Signals BL86 and BL81, protecting the junction from the Main line, must be at red. TC470T must also be clear, proving that a train from Airdrie has not passed signal BL81 on the Down Main line. If BL83, the next signal after leaving the Branch, is at red, BL82 can show yellow. It will only show green if BL83 shows a proceed aspect, for which release is required from High Street Signal Box.

24. *Mr D Forrester, Signalling Works Engineer Contracts*, ScotRail, gave evidence about the Yoker Resignalling Scheme. He explained that the signalling at Bellgrove Junction was remodelled as part of the scheme but added to the existing signal box pending completion of the whole scheme, which would retain some of the existing signals including BL86. It was decided to provide a switch panel for the signalman rather than attach the new signalling on to the existing levers. The only levers retained for use were those for operating the detonator placers.

25. *Mr Forrester* said that since the conversion of Bellgrove from a double junction to a single, in April 1987, no further alterations had been made to the circuitry under the control of Bellgrove Signal Box. The single lead junction is a standard arrangement which has been used in other places for the best part of 20 years. He agreed that it is simpler and cheaper to install but he did not think cost was the only reason for this kind of arrangement. His responsibility was to ensure that the interlocking and the signals are installed in such a manner that safety is paramount.

26. *Mr P Summerhayes* was the *Traction and Rolling Stock Engineer*, ScotRail at the time of the accident. He described the trains involved — which information is given earlier. For their braking characteristics he told us that by extrapolating from prepared braking performance charts, that took into account the track gradient (1 in 71), he estimated that from an initial speed of 30 mile/h, the stopping distances, excluding any distance travelled during the drivers' 'thinking' time, were 132 yards and 175 yards for the Up and Down trains respectively. From the damage sustained he estimated that, at impact, the combined speed of the two trains was of the order of 30 mile/h. There were no designed characteristics of the front end of the leading vehicle of the two sets that could explain why the train that was travelling on a rising gradient overrode part of the other train.

27. As to AWS indicator displays in the cabs, Mr Summerhayes said, that a black indication represented a train approaching a clear signal. When a train approaches a signal displaying a restrictive aspect, a horn is activated in the cab and the driver must press his reset button within 3 seconds or the brakes will apply automatically. As soon as the button is pressed, the AWS indicator will show yellow and black.

28. Later, he tabled photographs taken of the AWS indications after the accident. For the device still in the leading cab of the Up train, the photograph showed the AWS indicator displaying a black circle; for the Down train, a photograph of the AWS indicator, which was found detached from the leading cab, showed a yellow and black (Sunflower) configuration.

29. He added that for the above displays he had been advised that either display ie black or yellow and black, could be possible following an impact of this kind and, he said, "one would be hard pressed to draw any conclusions from the positions they are found in."

Evidence of passengers

30. *Four passengers gave evidence: Mrs E Russell, Mr R Gilmour, Mr D C Deans and Mr S Menzies.* All of these except Mrs Russell were in the employment of British Railways, but were travelling as passengers at the time. Mrs Russell, Mr Gilmour and Mr Deans were travelling on the Down train.

31. *Mrs Russell* boarded her train at Duke Street Station, where she took a seat on the righthand side in the front portion of the leading coach. She said that she used the route fairly regularly and on this occasion she considered the train to be running at least 2 minutes late and as she was anxious about the time she had available to conduct business during the lunch period she rose from her seat, bent down and checked the state of the signal before the train moved; she observed the signal aspect change from red to orange and then green and the train moved off shortly after. She recalled that as the train was about to emerge from the tunnel its speed was reduced. Next she saw a train but a short distance away coming straight towards the one she was on. She said that she saw the driver of the other train leap out of his seat and move to his left. Someone then shouted "duck" and Mrs Russell put her head down just before the collision, which she considered to be inevitable, occurred.

32. *Mr Gilmour*, a guard employed by ScotRail, said he was a regular traveller on the route. He boarded the train at Alexandra Parade Station, where he estimated it was running about one minute late. As he did so he noted that Signal BL105 was displaying a single yellow aspect. He took a seat on the lefthand side of the leading vehicle, about the middle of the coach; from there he could see the driver ahead. He said that he heard two bells sounding in the cab and immediately they were repeated, as if an acknowledgement was being given. At Duke Street Station, where the train stopped, he heard again the same sequence of bells being sounded. He was not in a position to see the signal (BL82) there. When traversing Duke Street tunnel at a normal speed of about 20 mile/h he heard the driver shout whereupon Mr Gilmour stood up; he observed the driver, who he said, "slammed on his brakes, stood up" and moved over and then saw the "canopy" of another train approaching on a collision course. Next Mr Gilmore was thrown back and onto the floor. After picking himself up, he considered the plight of others on the train and he described the actions he took to see to their release or comfort. He assumed that given the crushed state of the cab, the driver was beyond aid. Again he came across a person lying over a seat; he lifted him up to find that he also had succumbed to his injuries.

33. *Mr Deans* told us that he was employed by British Railways as a guard and was en route to work another train at the time. He said that he was seated on the righthand side of the leading vehicle, about the middle of the coach. After the train had left Duke Street Station he felt the brakes applying fiercely. He looked towards the front cab and saw the driver move to his right and then there was, he said "a bang"; he did not see the other train.

34. *Mr Menzies* told us that he boarded the Up train at Queen Street Station at about 12.44 and that the train left on time. He took up a position in the first carriage, facing the direction of travel. He did not pay any particular attention to either the display of lineside signals or the sounding of bells or buzzers within the train. However, he was surprised when the train ran without stopping between High Street and Bellgrove Stations: from his experience that was the first occasion that the train had not stopped in the tunnel before Bellgrove Station and he assumed that the train from Springburn was either running late or had been cancelled. He estimated that his train stood at Bellgrove Station a half minute and then moved away normally. He felt nothing unusual affecting the ride of the coach he was in and when he was about to pass the Bellgrove Signal Box, on his right, he glanced in that direction as a friend worked there. He saw two persons standing there and next he heard an explosion which he recognised to be that of a bursting detonator. He looked out of the window and saw a flame outside of the coach. Some two seconds later he heard the brakes being applied and within the next 5 seconds there was, he said, "a bang".

Evidence of the train crews

35. The guard in charge of the Down train was *Mr J P McManus*, who told us he was based at Yoker Depot and had some seventeen months' experience. He took up duty at 05.50 and met Driver H

Keenan with whom he worked until the time of the accident. Mr Keenan appeared to be his usual cheery self and remained so through the day.

36. Mr McManus described the journeys he made with Driver Keenan during the morning. After a meal break at about 10.00, they travelled as passengers to Hyndland Station where they took over a 3 car EMU working, at 12.04, to Springburn. There they waited some 11 minutes for passengers coming from a scheduled train from Cumbernauld. Their train, carrying between 15 and 18, persons, left Springburn about $1\frac{1}{2}$ minutes late. Mr McManus took up position in the Guard's compartment, set towards the rear of the middle coach of the train.

37. At Barnhill Station Mr McManus opened the train doors, when some people got on and others left the train. He noticed that the signal there displayed a green aspect. After closing the doors and giving his driver "two bells", that were acknowledged, the train departed for Alexandra Parade Station. There, Mr McManus could not recall definitely the state of the signal, but thought that it was "a yellow". In any event he said he would have satisfied himself that it showed a proceed aspect before giving "two bells" to Mr Keenan. At the next station, Duke Street, a number of passengers de-trained and Mr McManus observed, without difficulty he said, that the signal was "at red". Then, after closing the doors and checking their state on the rear carriage, he looked towards the signal to see that it had now changed to a green aspect whereupon he gave his driver the ready to start signal: this was acknowledged. He estimated the station stop to have taken between 30 and 35 seconds and the train departed about one minute behind schedule. As he passed the signal, Mr McManus closed his window and was walking to the window on the other side, with the train just out of the tunnel, when he heard, he said "a bang". He was thrown to the floor. He was conscious of there being a great deal of dust about. After picking himself up, he realised what had happened and rushed towards the front of the train. Mr McManus added that when going through the tunnel, the train was slowing down although he could not recall brakes being applied.

38. *Mr Robert Bain*, a railwayman of over 16 years experience, was the guard of the Up train. He had over 9 years experience as a guard, the last 2 years at Yoker Depot.

39. Mr Bain said that because the train concerned was a refurbished set, he was stationed in the Driver's cab at the rear end, rather than in the Guard's compartment in the middle, which is now used only for such things as mail. He described the early part of the shift on the day of the accident, starting at 05.54 when he booked on with Driver J M McCafferty whom he had not met before. They were delayed at one stage because of a points failure at Rutherglen, but they had a long break later. Mr McCafferty appeared perfectly normal. There were one or two things about his driving that Mr Bain found a little unusual. At one point, Mr Bain said, Mr McCafferty asked whether the route for a Down train would be via Yoker or Singer. On arrival at Dalmuir Mr McCafferty appeared to accept without question that the train was signalled on to the Down Main platform instead of the Bay platform, as it was booked to do. And at Westerton Station he left when the signal changed from red to green, without waiting for the bell signal from Mr Bain. However, Mr Bain did not think the driver had done anything dangerous at that point.

40. As to the circumstances of the accident, Mr Bain said it was unusual for the train to proceed straight into Bellgrove Station. It was always stopped at the signal under the bridge, he said, when there was a train coming off the Springburn Branch. Mr Bain admitted that after the train had stopped at Bellgrove Station he did not look at the starting signal before giving the driver the "ready to start" bell signal. Having had time to think about it, he believed the reason he had not done so was because the train had run straight into Bellgrove Station. It was so unprecedented in his experience that he put it forward as an explanation, though not an excuse, for failing to check the signal.

41. Mr Bain said he shut the doors, gave the bell signal and the train left. The next thing that happened was that he heard what sounded to him like a single detonator. He then found himself lying on the floor of the cab. He picked himself up and went through the train to discover what had happened.

42. Mr Bain pointed out that from his position in the rear cab he could not see the signal at Bellgrove Station. He would have to get out of the train, walk up a bit and across the platform to see it. The Rule Book required him to check the signal where practical, but at Bellgrove the signal could have changed by the time he got back to his cab. Mr Bain did not believe it was practical to apply the Rule properly without a repeater signal on the platform, such as is provided at various other stations. He had received no special instructions as to what to do at Bellgrove.

Evidence of signalling staff

43. *Signalman G Crozier* said that the had worked at Sighthill Junction Signal Box nearly 5 years, and had taken up duty, alone, at 07.00. The day had been uneventful up until the time he received he said, "six beats" from the signalman at Bellgrove Signal Box, who informed him that there had been a train collision at 12.47. Mr Crozier said that it was about 13.30 before he learned more about the trains involved.

44. He told us that he had 'belled' the Down train forward to Bellgrove Signal Box, and it was accepted in the normal manner. Despite there being no requirement for logging events in a Train Register Book, Mr Crozier recalled this train, a 3 car EMU, passing his signal box some 2 minutes late at 12.41. He observed nothing unusual about the train and the last he saw of it was when it left Barnhill Station. The signalman at Bellgrove had not communicated with him concerning the acceptance of the Up.

45. *Mr McKenna* was the duty signalman on the day of the accident at Parkhead North Signal Box, on the main Airdrie line to the east of Bellgrove. With the help of his train register, Mr McKenna recalled events around the time of the accident as follows:

12.40: he accepted an Up Airdrie train from Bellgrove.

12.44: he offered a Down train to Bellgrove and it was accepted.

12.45: the Up train passed his box and he sent the 'train out of section' bell signal back to Bellgrove.

12.48-9: the Down train passed his box and he sent the 'train entering section' bell signal to Bellgrove, and put back the signals.

- 12.50: he received six beats from Bellgrove (the emergency signal).

46. On receiving the six beats he put all his signals back to Danger, acknowledged the message, set his block instruments to 'train on line' and operated his detonator placers. The next entry in his train register referred to another Down train offered to him by Shettleston Signal Box at 12.54 but not accepted, and two isolation messages following the accident.

47. *Mr J Dunne*, a signalman of some 30 years experience, was on duty at High Street Signal Box on the day of the accident. He explained that at High Street, where he had worked for five years, the keeping of a complete train register is not compulsory. The only entry in his register relevant to the accident was that at 12.48 he received 6 bells from Bellgrove, indicating "obstruction danger". On receiving this message he used a switch in his signal box to replace Queen Street Signal 225 to Danger, thus preventing the approach of any further trains in the Up direction. Later entries in the register referred to overhead power isolations.

48. As to the signalling of the Up train involved in the accident, Mr Dunne's recollection was that when the train reached signal HS126, at High Street Station, he offered it by bell signal to the Bellgrove signalman and received the 'line clear' bell signal in return. This allowed him to take off Signals HS126, HS105 and HS103, which he assumed would clear to a single yellow, allowing the train to proceed as far as BL86. Mr Dunne explained that the panel in High Street Signal Box indicates only whether the signals are on or off, and does not distinguish between green and yellow.

49. Referring to normal procedure on the line, Mr Dunne said there is no laid-down priority as between Up and Down Springburn trains. In his experience it was normal for Up trains to run straight from High Street Station to Bellgrove Station without stopping at HS103. If the Bellgrove signalman refused the 'line clear' the train would proceed to HS103 but it would have to stop and wait for a proceed signal there. He thought it might depend on whether the Down train from Springburn was delayed awaiting a connection from Cumbernauld.

50. *Train Register Boy L Ackland* said that he had been working full time at Bellgrove Signal Box since January 1988. His duties demanded that he record immediately the times of receiving or sending of bell signals associated with the Absolute Block Regulations. He had received no instructions concerning the rounding off of minutes displayed on the signal box analogue clock, but he did not record fractions of minutes.

51. On the day of the accident he had worked with Signalman D Graham. He admitted that he had not recorded all of the events that had taken place and was unable to explain apparent discrepancies in the figures entered.

52. From his observations of the signalling of trains to and from the Branch line, he considered that preference for traversing the junction was normally afforded the train, he said "coming off Springburn and

then the one (train) coming out of the tunnel (Bellgrove) and they would arrive in the station both at the same time". For the day under review, to have a train destined for Springburn waiting at Bellgrove Station before the train from Springburn had arrived there was unique in his experience.

53. From his position sitting at a table facing the indicator panel, Mr Ackland claimed to have knowledge of the actions taken by Signalman Graham to control the passage of the trains to and from the Branch. He was adamant that the Points 46, 47 and 49 had been set to facilitate the train coming from Springburn. While, earlier, these points had been lying in their Normal state, Mr Graham turned Points 47 and 49 to the Reverse position, but Mr Ackland could not recall the time that the switching took place.

54. He went on to say that both from his observation of the panel and a comment made by the signalman, he was aware of a train standing at Bellgrove Station. Next, Mr Graham turned to him and said words to the effect that the driver had passed the signal. The signalman then pulled all three detonator levers, and proceeded to wave his arms at a window as if in an attempt to attract the driver's attention. By the time Mr Ackland had got to a window facing the tracks, the front of the train had already passed the signal box and it was then, he thought, that he heard two detonators exploding. He perceived no slowing down of the train that was travelling, he estimated, at the average speed for the line, and did not hear any noise that he could associate with a brake application. And then the collision occurred.

55. Despite further questioning, Mr Ackland maintained that Points 46 were lying Normal and furthermore, that shortly before the accident they had not been altered from the Reverse position that would have set a route for traffic intending to use the Up Branch line. He did not hear any conversation between Mr Graham and the driver.

56. *Mr D Graham* a signalman of 31 years experience, was on duty at Bellgrove Signal Box on the day of the accident. He said that he was very familiar with the signal box having relieved there many times during his 12 years in the Glasgow area. He had passed as competent in the Train Signalling Regulations at his last 2-yearly examination.

57. Mr Graham described the procedure for signalling an Up train off the Main line on to the Springburn Branch and vice versa. An Up train could not be signalled on to the Branch unless the line was clear to the termination of TC 305T. A Down train could not be signalled off the Branch, and the points could not be reversed to set a route off the Branch, unless the protecting signals on the Main line were at red: BL81 on the Down Main and BL86 on the Up.

58. The record in the Down train register showed that he had accepted the Down train from Sighthill Signal Box by bell signal at 12.40, but Mr Graham thought it might have been a minute or two later. This would allow the train to travel as far as BL82 Signal. The next entry showed that he had sent 'train out of section' to Sighthill at 12.45. He recalled that he had belled the train forward to High Street at about the same time (12.45-46) and High Street had accepted, but there were no entries relating to this in the train register. He thought the register boy might have overlooked these entries in the excitement.

59. The Up train register recorded that at 12.46 a train had been accepted from High Street, allowing the High Street signalman to clear Signal HS103. The next entry showed "train entering section" received from High Street. Mr Graham said the next signal BL86 was at Danger because he was not ready to bell the train on to Sighthill. The train came to a stand at Bellgrove Up platform and he then set the route for the train from the Down Branch to the Down Main line. This involved putting Points 46 back to Normal, leaving 47 reversed and reversing both ends of 49. At the same time he cleared Signal BL82.

60. He gave priority to the Down train because it was due at Bellgrove a minute earlier than the Up. Had it been later, it would have been within his discretion as signalman to decide whether to let the Up train go first. But having got the Up train standing in Bellgrove Station (which he could see from his box) he decided to set the route for the Down train. Mr Graham said that such judgments are required in regulating trains at all signal boxes.

61. Having set the points and cleared Signal BL82 for the Down Branch train to proceed, he became aware of the train on the Up platform moving towards BL86. This would not be indicated to him on the panel until the train had passed the signal. He assumed the driver was moving up to the signal in order to get in touch with him on the signal post telephone, but the train carried on past the signal. He immediately pulled the levers to place detonators on the track as a warning to the driver. He was satisfied that the detonators were in position before the train reached that point. He heard them explode but it appeared to have no effect on the driver of the train.

62. Mr Graham had had no problems with the working of signals at Bellgrove and they were working satisfactorily on the day of the accident. He was quite clear that if the route for the Down train had already been set, the Up train would have been held at HS103. But on this occasion the Up train had been accepted and had come to a stand in Bellgrove Station before he set the route for the Down train from BL82.

63. On the day of the accident the train register showed that he had refused 8 Up trains offered by High Street, causing them to be held at HS103; and accepted 9 trains because there was no Down train crossing the junction at the time. Having accepted an Up train as far as BL86, he had to wait until the train had come to a stand at that signal before he could set the points for a train coming off the branch. He firmly resisted suggestions that he might have cleared BL86 to a proceed aspect and subsequently changed his mind and put it back to danger.

Evidence as to examination and testing of the track and signalling equipment

64. *Mr J G Kay, ScotRail Permanent Way Maintenance Engineer* at the time, gave evidence of a visual examination of the track after the accident. He said that both the switch rails at Points 49A bore marks consistent with a train on the Up line having run through them when the points were set at reverse. The line was patrolled on foot at weekly intervals – the last occasion prior to the accident was on Tuesday 28 February. If there had been any damage to the points at the time, he would have expected it to be brought to his attention. Mr Kay said that a single lead junction is simpler and therefore needs less resources to maintain.

65. *Mr A H Irving, ScotRail Signalling Maintenance Engineer* at Partick, described his examination of the points and signalling in the Bellgrove area after the collision. This was done on the day of the accident. (Positions of the points and signals mentioned are indicated in Diagram 1.)

66. He found Points 49 and 47 lying Reversed, and Points 46 Normal. The switches in the signal box corresponded correctly to the lie of the points on the ground. Points 49A showed signs of having been run through whilst lying in the Reverse position: there was damage to the lugs attaching the first stretcher to the switch rail and to the clamp holding the switch rail to the stock rail.

67. In Bellgrove Signal Box, No. 82 signal switch was in the reverse position but the signal was at red, with corresponding indication in the box. This would be consistent with the signal switch having been cleared to allow the passage of the train from Duke Street. The signal itself would automatically be replaced to red by the train passing it and occupying the track circuit ahead.

68. No. 86 signal was in the normal position (at red) and so indicated in the signal box. No. 83 signal was displaying a single yellow aspect, with the switch in the reverse position. TC 297T, 293T and also 467T (on the Down Main line back towards Parkhead) were showing occupied.

69. No. 86R signal (HS103) had no indication in the signal box, due to a faulty indicator light. This had no effect on the signal itself, which was found to be working when checked. If the signal lamp had failed, the signalman at Bellgrove could not have given a "line clear" to High St.

70. Examination of the position of the relays indicated that a route had been set from No. 82 signal leading up to No. 83 signal and that the train had passed No. 82 signal, so locking the points in the route ahead. The relays indicated No. 86 signal at Danger. Since they did not store previous conditions, they could not give any indication as to whether 86 had previously been cleared. At the time of his examination the state of the relays did not indicate that a route had been set from 86, either to Springburn or to Airdrie.

71. Mr Irving said that all cable ends in Bellgrove Signal Box had been thoroughly checked. There were some redundant wires but all the ends of the wires had been insulated. A wire count was carried out on all relays in the area and was satisfactory.

72. *Mr A J Simpson, Acting Signalling and Maintenance Engineer, ScotRail*, gave evidence as to the examination and testing of the signalling in the Bellgrove area following the collision. His account of the full functional tests undertaken is reproduced in Appendix C.

73. Mr Simpson said he was totally satisfied from these tests that the system was in order, apart from Signal BL105 at Alexandra Parade Station, which would not clear to green. This was a minor failure on the safe side and it had nothing to do with the accident. He was satisfied that no aberration of the signalling system occurred at the time of the incident or up to the point when testing took place.

74. Answering questions, Mr Simpson confirmed that a route could not be set for the Down train from BL82 if Points 46 were reversed. With Points 46 and 47 Reversed and 49 Normal, a route could be set for the Up Branch line but Signal BL86 could not clear until the train had occupied TC 286T.

75. As to the Approach Lock timing mechanism for BL86, he agreed that the actual timing was 104 seconds instead of 45 seconds as designed, but this caused no safety problems: on the contrary, it increased the margin of safety.

76. *Mr J P Logue* said that at the time of the incident he was *Area Maintenance Engineer, South, in ScotRail.* He assumed responsibility for all mechanical and electrical engineering activities, including the maintenance of the two trains. He said that on the day after the accident in the presence of members of British Transport Police and Mr P Summerhayes he personally undertook brake testing of the trains involved; however due to the extensive damage caused the leading vehicles of both trains, and their associated components, it was not found possible to have these coaches and components tested. But his examination of all brake blocks on the two trains revealed their condition to be within laid down standard of wear, as indeed were the results of his thorough testing of the remaining four vehicles. He added that neither train was overdue for periodic examination, and that there were no entries in the Drivers' Repair Books, that would have any bearing on the accident. As to the photographs tabled concerning the AWS indicators, Mr Logue's evidence supported that already given by Mr Summerhayes.

Evidence as to operating safety

77. *Mr I W Warburton, Director of Operations, British Railways Board,* gave evidence about single-lead junctions. He explained that such junctions are preferred by BR for a number of reasons, mainly associated with ease of maintenance, but also because they permit higher running speeds over the main route. (The full list of 8 reasons cited by Mr Warburton is set out in Appendix D.)

78. Mr Warburton said that over 20 junctions in Scotland had been converted since 1966, about half to single and half to parallel junctions (Diagram 3). Singled and parallel junctions each have the same number of point ends (4) and crossings (4) but parallel junctions require a wider track formation, which is not always available, and one additional track circuit. They are used only when the traffic capacity demands parallel movements on and off the branch line.

79. Mr Warburton accepted that the particular circumstances of the accident would not have occurred with a type 3 (parallel) junction, and that there appeared to have been room for a wider formation at Bellgrove. However, he thought there might have been other operational reasons for adopting type 2 there such as the need for light engines to have easy access to the branch from the Down main line. He said that with any type of junction there is a risk of collision if drivers do not obey danger signals. The safe working of trains depends upon the provision of such signals at which trains must stop. Sufficient advance warning of these signals is given to enable drivers to stop safely. There is an additional safety margin beyond each danger signal to allow for errors of misjudgment by drivers. This overlap was originally 440 yards with semaphore signals in Absolute Block areas, but with track circuits and multiple aspect signals it is now usually 200 yards. The safety margin covers most cases of misjudgment but it is clearly inadequate in circumstances where signals are disregarded or misread.

80. Mr Warburton said there is no evidence that safety record of the type 1 junction differs in any way from the type 2 or the type 3; or that any particular type of junction prevents or causes any particular type of accident. Collisions can occur at junctions through trains failing to stop at danger signals. On the other hand, from the Civil Engineer's point of view the risks of derailment at junctions are greatly reduced by the simpler and more easily maintained equipment used in single lead junctions.

81. At the request of the Inquiry Mr Warburton summarised the evidence he had given to the Inquiry on 29/31 March, 1989 into the accident that occurred at Purley (SR) on 4 March, about the development of a system of Automatic Train Protection (ATP). He said that the Railway Executive had adopted the provision of such a system as Board policy in November 1988, on his own recommendation and that of the Director of Signals and Telecommunications Engineering. The principle of ATP is that if a driver does not respond correctly to cautionary signals or to speed restrictions, a warning is given. If the speed is not then correctly regulated the train is stopped automatically. The system must be failsafe, reliable and provide for the safety of operations during failure. It must also safeguard against trains starting against signals at Danger.

82. During the development and installation of ATP and thereafter, it would remain necessary for drivers to observe and obey track side signals. The Board had undertaken a study of the causes of signals

passed at Danger, the incidence of which had fallen from more than 700 in 1970 to less than 500 in 1979 (the lowest figure on record) but had risen to over 800 in 1988. Mr Warburton pointed out that the figure of 800 represented, on average, each driver passing a signal at Danger once in 26 years. The Board is taking a close interest in the causes emerging from the study, which include human factors, the way that messages are conveyed to drivers by the signalling system and the influence of braking systems. These factors appear to be random and unconnected but the use of an ATP system is thought to be the most effective means to reduce the incidence of signals passed at Danger.

83. Mr Warburton also gave evidence on the respective responsibilities of the guard and driver under Section H of the Rule Book. He said that in 1980, following an incident, the Rule Book had been changed to reduce the possibility of conflicting information being given to the driver by the signal and by the guard. Where practicable the guard should see the signal and not give the driver the ready to start bell unless he is satisfied that the signal is clear. He would be expected to step out of the train, but not to do more than walk across the platform in order to observe the signal. Section H is supplementary to Section C of the Rule Book which makes the driver responsible for obeying signals.

84. *Mr H Knox, Signalling and Safety Officer, ScotRail*, elucidated the provision of overlaps for Signal BL86. With the route set for the Main line, TC 305T would have to be clear, giving at least 200 yards overlap. For the Branch line, both 305T and 293T would need to be clear, giving an overlap well in excess of 200 yards beyond the junction. An overlap could be relinquished if the signalman was satisfied from his board that the train was at a stand protected by the signal.

85. Mr Knox said he was the officer responsible for submitting proposals for new works on ScotRail to the Railway Inspectorate for approval. The present layout at Bellgrove Junction was commissioned on 20 April 1987, as stagework for the Yoker Re-Signalling Scheme. The overall scheme would not be completed until September, 1990, and the complete scheme would be submitted for approval at some point prior to full commissioning. He considered that stageworks could be commissioned without advising the Department of Transport provided they were not intended to be used for longer than 2 years. He agreed that the 1958 Letter of Agreement between the Department and British Rail specified that conversions to single lead junctions should be submitted. But he pointed out that when the scheme was prepared it was thought it would not run beyond the 2 years. He also believed there had been an understanding with an Inspecting Officer that Permanent Way renewals which provided for a Single Junction in lieu of an existing Double Junction should be regarded as "like for like" and need not be submitted.

86. Answering questions, Mr Knox said the accident had not altered his view that in a single lead junction there is no inherent reduced safety as opposed to a double junction. He pointed out that at a double junction, if a driver passes a signal at Danger, there is the very real possibility of collision. In Mr Knox's view the original layout at Bellgrove was "an extremely complicated series of double junctions and was fraught with danger".

87. On the subject of detonator placers, Mr Knox said that they are no longer provided in any new Signalling Scheme and indeed have been removed in many places. Modern methods such as Track Circuitry and Sequential Locking give better control over the movement of trains. However, he agreed that there is at present no inbuilt system to warn a driver that he has passed a signal at red.

Evidence as to training of drivers

88. *Mr F Chambers, a Traction Inspector* of some three years standing, explained that his job was to examine drivers, not train them.

89. After would-be drivers had completed a 6 week induction training course, he would examine them on a one-to-one basis, on their knowledge of the Rule Book. Later, and before such persons are passed out as a train driver, a Traction Inspector would again examine them.

90. In an attempt to determine the degree of understanding retained by drivers, he said that a biennial assessment had been introduced recently whereby a driver spends one day at ScotRail's Central Training School. There, he is initially taken through any addition/alteration to the Rule Book and, later, checked as to his understanding of the rules governing his duties. Where it was felt that a driver was unsure of particular rules, re-training would be immediately arranged with a subsequent re-appraisal.

91. Only on being satisfied as to the driver's overall understanding of the rules that affected him would the driver be allowed to resume normal duty. Mr J McCafferty had not been re-assessed because of his recent appointment as a driver. Mr Chambers had not travelled on the footplate with him.

92. Mr Chambers was adamant that a driver has to be thoroughly acquainted with all aspects of the line over which he is driving and know, for instance, location of junctions, and route to be taken there; in his opinion a driver should, he said, "be quite at home with it". As he saw it only when that state of understanding of a route was achieved by way of travelling on a route learning train, route learning videos, and practical driving, should drivers sign for it. After that, they can be rostered to drive trains without supervision, on the particular route. He agreed, however, that there was no laid down procedure for testing persons as to whether they had actually learned the routes upon which they had been trained.

93. For the signalling of trains, Mr Chambers considered that the observation of signals by a driver was an absolute necessity — it was, he said "their livelihood". If a train standing at a station received the 'right away' signal from a guard, the driver would be duty bound to observe the controlling signal before moving away because, he said "something may have happened in between" (that is during the interval from receiving the signal from the guard) to cause the signalman to wish to speak to the driver, when the signalman would turn the signal to danger. Mr Chambers was of the opinion that until the signal was passed, the driver should be observing it, except perhaps for the brief time of checking the speedometer reading for his train's speed.

94. For the controlling signal at Bellgrove Station, Mr Chambers was satisfied that it could be seen quite clearly by a driver. For a guard of a refurbished 303 EMU, however, it would be necessary for him to step out on to the platform to observe this signal — an act that Mr Chambers felt gave rise to no real problem. He added that there were no specific written instructions advising the guard what to do at the specific location of Bellgrove Station.

95. *Train Crew and Training Manager R D Taylor* said that he was responsible to the Regional Operations Manager for the co-ordination of all matters on train crew and operational training throughout the Region. He told us that the type of training being given on ScotRail was similar to that applying throughout British Railways — and was the outcome of joint British Railways Board and Trade Union discussion.

96. To be eligible for a basic driver's training course, that lasts 24 weeks, persons must have achieved the age of 21 years and accumulated 500 turns of duty as a driver's assistant. The basic programme, that is designed to be continuous and with no annual leave allowed during this period, consists of a number of parts. Initially, for 5 weeks, Rules and Regulations are taught; then there is a 6 week tuition period on the technical aspects of basic traction systems which is followed by 11 weeks practical train handling, under the direction of a Traction Inspector, involving the negotiation of signals, gradients, braking and the handling of different types of trains. During this latter period the trainees may actually do the driving, but always with a Traction Inspector in attendance; the locomotives used for this are Classes 47 or 37. Following on immediately there is a one week revision of the Rules and one week technical revision. The subsequent week, on three successive days, the staff are examined as to their competence in the main topics mentioned above. To be successful, all parts have to be passed. It is not unknown for there to be failures - but over the preceding 5 years, only about 1% of candidates have failed to negotiate the tests at their final, third attempt.

97. If successful they are assigned the designation of a Relief Driver when they would be competent to act as a driver as and when required — but essentially, their knowledge of routes would be a limiting factor. In this connection, therefore, much time would need to be spent in enhancing the state of knowledge as well as becoming acquainted with new types of traction units. Mr Taylor indicated that thereafter appointment to a driver's post was by choice. A person could wait at his 'home' depot until he became the senior person there or transfer to another depot either within or without the Region to take up a position as a driver.

98. At Yoker, new appointees would he subjected to a further two stages of training. Firstly, there is a 3 week traction familiarisation training course, the final 2 days of which would be spent on satisfying a Traction Inspector as to competence in handling an EMU. Then the opportunity would be given to learn the routes. At the outset there is a classroom element concerning route learning procedures, followed by videos of the whole North Electric route. Periods are then spent in traversing the various routes, and at the end of each week, for up to an average period of seven weeks, interviews are conducted by Traction Inspectors to establish the progress being made. It is a matter for the drivers themselves to testify as to their knowledge of the routes as there is no examination. However, Mr Taylor added that where an Inspector has some doubt about a person's ability, checks, using certain contents of the Region's Sectional Appendix, are made and further training given as necessary.

99. Mr Taylor said that of the order of 30% of the drivers operating the North Electric routes out of Yoker were under the age of 24 years adding that "it's a young orientated depot". He was convinced that the training programme, the calibre of staff, and their ability to absorb the knowledge, were first class.

100. For the monitoring of drivers' performances, Mr Taylor referred to the recently introduced biennial assessment programme which he said "is working very well". It is policy to have every driver accompanied by a Traction Inspector at least once a year, but Mr Taylor thought it unlikely that Mr McCafferty had been so accompanied during the early part of 1989.

101. As to signals passed at Danger, Mr Taylor was well aware of British Railways consideration of the problem, adding that, to his knowledge, there was no indication that the younger drivers were in any way more prone to pass signals at Danger.

102. For Mr McCafferty's background, Mr Taylor said that he became, at the age of 18, a Traction Trainee on 8 May 1984, and entered a 6 week induction course. Then, on 11 February 1985, he became a driver's assistant at Polmadie Depot, near Glasgow. Subsequently, after completing 500 turns of duty on locomotives that would have taken him to Carlisle and Edinburgh, he started his basic driver training course on 2 March 1987. After successfully completing the course and passing a medical examination, he was appointed a relief driver at Polmadie Depot on 14 September 1987. On 15 August 1988 he was appointed a driver at Selhurst Depot on the Southern Region, transferring to Yoker Depot on 17 October 1988 at about the age of 22½. Between then and 23 December 1988, Mr McCafferty was engaged in conversion and route knowledge training and, from 4 January 1989, he became available as a driver at Yoker Depot. Mr Taylor had no adverse reports on Mr McCafferty's performance as a driver.

Evidence of Driver McCafferty

103. *Driver J M McCafferty* was at the controls of the Milngavie to Springburn EMU. He was unfit to give evidence at the public hearings due to the serious injuries he sustained in the accident. He was interviewed 23 weeks after the accident and gave his evidence from a wheelchair. It was pleasing to hear that he had been released from hospital the previous Tuesday; however, he needed to return regularly as an out-patient.

104. Mr McCafferty confirmed in the main the evidence given earlier by Mr Taylor concerning his background of training leading up to his obtaining, during October 1988, a driver's position at Yoker Depot: he agreed that the observance of signals was inherent in his training. Thereafter, up until nearly Christmas time of the same year, he underwent conversion (to EMUs) and route learning training. The latter, he said, involved viewing route learning videos and accompanying an Instructor on a special train over various routes. He may have spent a week, devoted to the North Side, but claimed that he only traversed once or twice the route from Milngavie to Springburn; however, he was satisfied as to his knowledge of that route and signed for it accordingly.

105. From his time of working out of Yoker Depot as a driver on his own, Mr McCafferty said that he had traversed the route Milngavie to Springburn "lots of times". He was unsure, however, when he had last driven a train over this section prior to the day of the accident. (In this connection evidence received from ScotRail indicates that the previous occasions were during week ending 28 January 1989 - although he had accomplished 8 return trips to Airdrie, involving stopping on the Up line at Bellgrove Station, during the course of the week ending 4 March 1989.)

106. For the day under review, Mr McCafferty said that he booked on early at Yoker Depot, having had sufficient rest period from the finish of his previous turn of duty. He felt "fine" and that feeling was maintained throughout the day up until the time of the collision. He received written instructions concerning his work programme. While the same guard worked with him throughout that day, he had not met him previously. Mr McCafferty could not recall precisely the services he had worked, but remembered driving to Dalmuir and Motherwell; also he recalled having a meal break at both Motherwell and Hyndland and partaking of sandwiches he had brought with him. There was minimal conversation with the guard whose name he could say was Bain, but their content escaped him.

107. As to the train in question Mr McCafferty said that it comprised 3 cars, and was a refurbished 303 set. He was alone in the leading cab while Mr Bain, he presumed, was in the rear cab. He had no misgivings concerning the handling of the train, the visibility, or the route from Milngavie to Springburn. He claimed that he had no difficulty in bringing his train to a stand at the 3 car stop markers positioned at the various stations. As far as he could remember, his train departed Queen Street Low Level Station on time. At High Street Station he said that he received two bells from the guard for otherwise, he said "I

wouldn't move without them". He acknowledged the guard's signal by repeating it, and left with the signal ahead displaying, he said, "two yellows". He considered that between that station and the next, Bellgrove, the train would have been travelling at the line speed of 30 mile/h. However Mr McCafferty was unable to say what description was given to the line he was travelling on ie whether Up or Down. After some hesitation he recalled that as he approached Bellgrove Station Signal HS103 was initially at Danger and he reduced speed accordingly, but shortly before bringing his train to a halt, the signal changed to display a single yellow and he allowed the train to run towards the station.

108. After passing Signal HS103, Mr McCafferty said, he saw BL86, which he identified from a number of photographs shown him, change from red to green, accompanied by a feather. Questioned further on this observation, his recall of events did not alter: the signal, he said, "went straight to green" (from red). He went on to say that on previous occasions his train had always been stopped when approaching Bellgrove Station. He thought nothing strange about the direct run-in to the station, and considered that the train from Springburn, which usually he had seen standing on the opposite platform, and which was usually let in first by the signalman, was running late. In the event, Mr McCafferty brought his train to a stand opposite the 3 car stop marker, that was on the platform to his right. He remained there for his normal time of about one minute; during that interval he said that he remained seated, but could not account for anything he may have done then: however, he admitted not having looked at Signal BL86. Next he said that he received two bells and he gave two bells in acknowledgement.

109. Again, he claimed that before starting away he did not look at Signal BL86; his reason for not doing so was, he said "because it was green there shouldn't have been any reason for it to change". Moreover, for the distance of 84 yards between the 3 car stop and Signal BL86, that normally is traversed in some 13 to 14 seconds, he claimed not to have observed the signal. Then he added, he had been checking the speedometer, because it did not take long for the train to achieve a speed of 30 mile/h after leaving the station.

110. A number of extracts taken from the BR Rule Book (regarding the responsibilities of drivers concerning the observance of signals) were both put and shown to Mr McCafferty. He replied that he could remember one or two of them, but he did not identify any one in particular. Some time was spent in discussing these extracts and while, initially, Mr McCafferty maintained the view that because he had received two bells from the guard there was no necessity for him to have checked subsequently the state of Signal BL86, he finally accepted that he should have looked at this signal following the indication from Mr Bain.

111. Mr McCafferty said that after leaving Bellgrove Station he heard a bang that he associated with the bursting of points that took his train up to the Branch line. He discounted the submission that the affected points were those he had first come across after leaving the station, and that the noise he had heard was that from exploding detonators, which event, he said, he had only once experienced during his railway service. On hearing the bang, he said that he looked out of the cab window on his left and saw the line that he should have been travelling on. Then, he looked up and saw a train in front of him; he immediately, he said "slammed the brakes on", but it all happened in seconds and he froze in his seat before the impact occurred.

Documents

112. In addition to oral evidence, the Inquiry took note of the documents described in the following paragraphs 113-115.

113. *Instructions to signalmen at Bellgrove Box* issued on 28 August 1988 by the Regional Operations Manager, British Railways (Scottish Region). These instructions were produced and copied to all parties at the request of the Inquiry, in order to elucidate the evidence of Signalman Graham. The instructions provide inter alia that "a train must not be accepted on the Up main line, when the facing points are set for the Up branch line, unless the line is clear to the termination of track circuit 293". Mr Graham's evidence was that only TC305T required to be clear before he could accept an Up branch line train from High Street.

114. *Determination* by Sheriff A C McKay of the Sheriffdom of Glasgow and Strathkelvin following an Inquiry on 10-25 July 1989 into the deaths of Messrs Keenan and McCaffrey. This was an Inquiry under the Fatal Accidents and Sudden Deaths Inquiry (Scotland) Act 1976, S.1(1)(a). The Inspectors appointed to hold the present Inquiry under the Regulation of Railways Act, 1871 took no part in the Sheriff's Fatal Accident Inquiry.

115. *Written submission* made on 24 August 1989 by Robin Thompson & Partners Ltd, the legal representatives of Driver McCafferty.

116. Letters from the emergency services involved in attending the incident and from the hospitals which received the injured:

Scottish Ambulance Service, Greater Glasgow Area

Strathclyde Fire Brigade

Strathclyde Police

British Transport Police

Royal Infirmary, Glasgow

Victoria Infirmary, Glasgow

Western Infirmary, Glasgow

These documents are not reproduced here but the general conclusion to be drawn from them is that there was a successful response to this incident on the part of the emergency services and a high standard of co-operation between them. This was due in part to the contingency planning and emergency exercises carried out in the past, and in part to the dedicated service rendered by all concerned on the day of the accident. We wish to pay tribute to the efforts of all the emergency services, the medical staff and the hospitals who played a part in dealing with this unfortunate accident.

117. Tribute is also due to those passengers on the 2 trains who came to the assistance of others. A particularly notable contribution was made by Mr Gilmour.

Issues raised by the Evidence and Documents

118. The evidence strongly suggests that the immediate cause of the accident was that the Up train on leaving Bellgrove Station passed Signal BL86 at Danger. Before setting out our Conclusions and Recommendations, however, it is necessary to address a number of issues which, though subsidiary to the immediate cause, are nevertheless relevant to the circumstances leading up to the accident.

119. We also noted the references to the Bellgrove accident in the Report by Sir Anthony Hidden QC on the Investigation into the Clapham Junction Railway Accident, which occurred on 12 December 1988. Paragraph 15.33 of Sir Anthony's report refers to valuable information gleaned from the Purley and Bellgrove accidents, which involved Mark 1 rolling stock similar to the trains in the Clapham collision. Appendix G of that report is a technical assessment of the damage to the rolling stock involved in the three accidents.

120. Damage to the rolling stock is not in our judgment a critical issue arising from the circumstances of the Bellgrove accident, and we have nothing to add to the conclusions of the Clapham report in this matter.

Was Signal BL86 at green when the Up train approached Bellgrove Station?

121. Driver McCafferty stated repeatedly that after passing Signal HSlO3, he saw BL86 change from red to green, accompanied by the "feather" or route indicator lights indicating a route to the Branch line. Signalman Graham on the other hand was equally adamant that at no time during the approach of Mr McCafferty's train had he cleared Signal BL86 to green. Mr Graham's evidence suggested some confusion about the written instructions as to the overlap required before a train can be accepted for the Up Branch line. Nevertheless Mr Irving's evidence as to the condition of the signals and points after the accident clearly shows that a route was set for the Down train at the time. Mr Simpson's evidence that the Approach Lock timer was slow indicates that if Mr Graham had changed BL86 from green to red, it would have held the Up route for almost 1 ¼ minutes before allowing the Down route to clear.

122. The evidence as to the timing of the sequence of events was not sufficiently precise for certainty. We consider that the weight of evidence favours Mr Graham's account.

Was Signal BL86 in the correct position?

123. We noted in parenthesis at paragraph 20 of this report that Signal BL86 is situated on the righthand side of the track travelled by Up trains which this Signal controls. Signals normally appear to the driver's

left. Photograph B shows that the signal is very conspicuous, and there was no evidence at our Inquiry to suggest that Driver McCafferty had any difficulty in observing it. Nevertheless we consider that the possibility of confusion should be reduced to a minimum by locating all lineside signals on the lefthand side unless the local conditions render this impracticable.

Should the Up train have been held at the preceding signal (HS103) until the Down train had cleared the junction?

124. If Signalman Graham had caused the train to be held at Signal HS103, instead of allowing it to proceed to BL86, the accident would almost certainly have been avoided, because of the inherent improbability of a driver passing two successive signals at Danger. The evidence of Mr Graham himself and of the railway officers was that this was a matter for the judgment of the signalman, and this was supported by the Train Register which showed that he had held about half the Up trains at HS103 on the morning of the accident. Mr Dunne, another very experienced signalman, took the same view. Guard Bain on the other hand laid stress on the singularity, in his experience, of the Up train being allowed to proceed straight from High Street to Bellgrove without stopping at HS103 signal. This view was supported by the evidence of Mr Ackland, the Train Register Boy at Bellgrove.

125. We have considered carefully the implications of a change in the instructions on this matter, both for Bellgrove Junction and for the system at large. Is it necessary to hold Down Branch trains at Alexandra Parade Station (BL105) if there is an Up train at Bellgrove Station, and to hold Down Main line trains at at the signal in rear of BL81 if there is a Down Branch line train at Duke Street? What would be the implications of such a rule for other busy junctions? Our conclusion is that to insist on it as a general rule would place an unreasonable restriction on the operation of the railway. We accept that with a Down train standing at Duke Street, and an Up train standing at Bellgrove (and in fact visible from the signal box), it was within the discretion of the signalmen which train should have precedence over the junction. It is the signalman's function to control the order of movement of trains.

Are single-lead junctions unacceptable on safety grounds?

126. It is clear that the circumstances of this accident could not have occurred before the realignment of Bellgrove Junction, because the earlier layout permitted trains to proceed simultaneously in each direction, from the Main line to the Springburn Branch and vice versa. The Secretary of State for Transport gave an undertaking in the House of Commons, on the day following the accident, that the Inquiry would "determine whether this was a relevant factor". We have given careful consideration to the evidence on this point, and the Inspectorate has advised British Rail that until the Inquiry reaches its conclusions, no further proposals for the conversion of double to single-lead junctions will be considered for approval under Section 41 of the Road and Rail Traffic Act, 1933. This has caused considerable disruption and delay to the British Railways Board signalling renewal programme.

127. The evidence of railway officers at the Inquiry, notably that of British Railways' Director of Operations, Mr Warburton, sought to establish four propositions:

(1) that single-lead junctions are now widely used throughout the railway system: they are easier (and cheaper) to maintain, they allow higher train speeds over junctions, and they are less prone to dangerous deterioration than the traditional double-lead junction;

(2) that the overall safety record of single-lead junctions is no different from that of double or parallel junctions; for example, the accident at Colwich in 1986 occurred at a type 1 (double) junction.

(3) that the single-lead junction is no different in principle from countless other situations where trains run in both directions over a single track under the control of the signalling system: for example at the platforms of terminal stations, on single-track branch lines and on bi-directional sections of main lines;

(4) that the safety of any railway, whatever the layout, must depend on the basic principle that drivers stop their trains at danger signals.

128. We accept these propositions. It is a matter of historical record that British Railways has been pursuing the policy of converting double lead junctions to single for many years, with the general approval of the Railway Inspectorate on the Government's behalf. As the evidence of Mr Knox made clear, the

conversion of double line junctions to single line junctions is among the "Works to be submitted for approval" set out in the Letter of Agreement issued by the Ministry of Transport & Civil Aviation on 10 November, 1958. This letter was written with the object of elucidating the kind of works requiring Ministerial approval under the somewhat general terms of the Road & Rail Traffic Act, 1933. The 1958 letter remains the basis on which new works are submitted for approval, although it is presently being revised by the Inspectorate, in consultation with railway operators. The inclusion of single line junctions in the letter suggests that such conversions were regarded by our predecessors as acceptable in principle, although requiring consideration by the Inspectorate in order to avoid any compromise of safety in individual conversions.

129. We consider that single lead junctions are acceptable in principle on safety grounds and we do not accept that improvements in the efficiency of operation and maintenance are intrinsically at variance with the maintenance of an adequate standard of safety.

130. It is necessary however to consider whether the conversion of Bellgrove Junction was acceptable as an individual application, bearing in mind the fact that it was not specifically submitted for approval, owing to uncertainty as to the proper interpretation of the 1958 Letter.

131. It is clear that there was enough space at Bellgrove for the layout to have been converted to a parallel (Diagram 3) rather than a single-lead junction. Had this course been adopted, the circumstances of the accident might have been avoided by the Up train being diverted to the Up branch line at the first set of points after passing signal BL86. It would not have prevented a conflicting movement if these points had been set at Normal, ie for the main line: nor of course if a Down train had approached on the main line at the same time as the Down branch line train was crossing the junction. On balance, we do not believe that the limited benefits of a parallel junction would justify realignment of Bellgrove Junction in that form.

132. Before leaving this subject it is necessary to add, that conversions of double line junctions to single line junctions should not be undertaken without the approval of the Secretary of State. The Department of Transport's Requirements for the Construction and Operation of Passenger Railways are currently under revision, and the opportunity will be taken to clarify the 1958 Letter and bring it up to date. Meanwhile, in case of doubt about any particular proposal to realign a junction, the railway management should consult the Inspectorate's New Works Officer before going ahead.

Should there have been an additional safety device between Signal BL86 and the junction?

133. It was submitted to us by legal representatives of Driver McCafferty, that the single-lead junction at Bellgrove is particularly unsafe because of the short distance between the station starting signal and the junction, and the short time interval between the passage of Down and Up Branch trains according to the timetable. They suggested that some form of safety device should have been provided to warn the driver in the event of his inadvertently passing Signal BL86 at Danger. The learned Sheriff, in his determination of the Fatal Accident Inquiry, also referred to "the absence of any secondary safety device .....".

134. Several of the railway officers referred in evidence to the fact that an additional safety margin or overlap is provided beyond each Danger signal to allow for errors of judgment by drivers. Mr Warburton explained that with Absolute Block working and colour light signals, the overlap is usually 200 yards. Mr Knox confirmed that the overlaps at Bellgrove Junction are at least 200 yards.

135. There was also as it happened a secondary safety device in the form of the detonator placer opposite Bellgrove Signal Box. We heard evidence from Signalman Graham that he operated the detonator placer in the hope of warning the driver. But this proved to be ineffective, either because Driver McCafferty failed to recognise the sound of the detonators exploding, or because the sound did not reach him, due to his cab having already passed before the detonators were actually in place. Even if he had been able to respond, the distance from the detonators to the point of impact was less than the braking distance of the train from 30 mile/h.

136. We do not believe that detonator placers have a major contribution to make to safety in the context of modern signalling systems. Nor do we accept the suggestion that the timetable should have been arranged so as to avoid trains crossing the junction in quick succession in opposite directions. The history of railway operation clearly demonstrates that reliance on time intervals between trains, far from contributing to safety, can be positively dangerous: it has in fact been the primary cause of some serious accidents. We accept the contention of the railway officers, based on long experience and accepted by the Inspectorate, that safety must depend on the integrity of the signalling system and correct observance of the signals by drivers.

137. A secondary safety device in the form of trap points, linked to Signal BL86, on the Up line between that signal and the crossover before Points 49, could avert a collision by diverting an Up train to the cess after passing BL86 at Danger. But lack of space prohibits the strategic positioning of such a device to divert, without undue repercussions on safety, a Down train passing Signal BL82 at Danger. Because of physical constraints and other considerations, there can be no question of making the use of trap points a general rule. Moreover, the introduction of ATP would render them quite unnecessary. Nevertheless, at the design stages of single lead-junctions the merits of introducing such trap points should be considered in the light of available space, anticipated repercussions from deliberately diverting trains from the running lines, timescale for the installation of Automatic Train Protection and, not least, the safety of users and others who may be affected.

138. Mr Warburton referred in his evidence to British Railways' proposals for the development of a system of Automatic Train Protection. We were encouraged to hear that the proposed system is to incorporate a safeguard against trains starting against signals at Danger.

Was Driver McCafferty adequately trained?

139. Mr Taylor indicated that Mr McCafferty's training conformed to that agreed between British Railways Board and the Trades Unions. Mr McCafferty had undergone 7 weeks, about the average period, conversion to traction training and route learning knowledge at Yoker just prior to becoming available as a driver at the depot on 4 January 1989. Mr McCafferty himself said that he was satisfied as to his knowledge of the Milngavie to Springburn route.

140. Although Mr Taylor told us that he had received no detrimental reports concerning Mr McCafferty he considered it unlikely that the driver had been accompanied by a Traction Inspector during the early part of this year.

141. While we believe that the training given Mr McCafferty was adequate, the comments made by Mr Bain concerning the driver's performance on the day and Mr McCafferty's own admission that he did not observe the aspect of Signal BL86 both while waiting at Bellgrove Station and subsequently approaching the signal, have led us to consider the monitoring of drivers' performance. We believe it would be prudent to have such monitoring by Traction Inspectors occur within 2 months of a person becoming available as a new driver in order that there may be consolidation and reinforcement of lessons learnt: thereafter repeat checks on performance should take place at least once per year, notwithstanding the biennial assessment.

Is the Rule Book sufficiently clear as to the relative responsibilities of driver and guard?

142. Mr Bain, the guard on the Up train, frankly admitted his failure to observe Signal BL86 before giving the driver the bell signal to start. However, he was critical of Rule H 5.1.3 in its application to Bellgrove Station and considered that a repeater should have been provided on the platform to assist him. Driver McCafferty's representatives submitted that the amended Rule H 5.1.3 had created some "diffusion of responsibilities", an expression cited from the Sheriff Principal's Determination at a Fatal Accident Inquiry in 1979 following an accident on 16 April 1979 at Paisley Gilmour Street Station. Sheriff McKay referred to this matter in his Determination of the Fatal Accident Inquiry following the Bellgrove accident, finding some diversity of interpretation of the rules as between staffed and unstaffed stations and also as between the responsibilities of the driver and guard of a train.

143. Neither of these matters was a central issue at our Inquiry, but some evidence of relevance was given by Mr Mackie and Mr Chambers. Mr Mackie, the Regional Operations Superintendant, explained how following the 1979 accident the Rule Book was amended to place a responsibility on the guard to check the starting signal. British Railways then examined locations where the amended Rule would apply, to determine whether special "off" indicators were needed, for example where severe curvature made it impracticable for the guard to observe the starting signal even after leaving his train and walking across the platform. At Bellgrove Station it was considered practicable for the guard to leave his compartment and comply with the Rule visually without additional aids.

144. Mr Chambers described the respective responsibilities of the driver and guard under the Rule Book. He did not consider that either would have any difficulty in complying with their duties at Bellgrove.

145. We do not think it necessary to address the question whether it is desirable for the driver or guard to be formally designated the person in charge of the train. Both the Sheriff Principal and the Inspecting Officer of Railways who inquired into the accident at Paisley, in 1979, expressed concern about the possibility of confusion as to the responsibilities of drivers and guards. Nevertheless we conclude that

neither the circumstances of the present accident, nor a study of the Rules, support the view that responsibilities are confused. Where a fixed signal is provided at an unmanned station, the guard must satisfy himself *where practicable* that the signal has been cleared before signalling to the driver that the train is ready to start (Rule H 5.1.3). Responsibility then clearly rests with the driver to observe the signal himself before starting the train.

146. If there is a criticism to be made of Rule H 5.1.3, it is in the use of the expression "where practicable" which is liable to create uncertainty in the guard's mind as to whether he has discharged his responsibility. Safety rules should be clear and unequivocal: this one is not.

Conclusions and Recommendations

147. We conclude that the immediate cause of the accident was that Driver McCafferty drove the Up train No. 2A02 past BL86, the starting signal at Bellgrove Station, at Danger. Contributory causes were that Guard Bain signalled the driver that the train was ready to start, without having first checked the aspect of the starting signal BL86; that the Rule Book on this particular point was not as clear as it should be; and that there was no other effective safeguard against a train starting against BL86 signal at Danger. We do not consider that Driver McCafferty was inadequately trained, or that Signalman Graham's handling of the signals went beyond reasonable limits of discretion. There was no evidence to justify any criticism of the conduct of Driver Keenan, who sadly lost his life in the accident.

148. We make the following recommendations:

(1) British Railways should proceed as quickly as possible to the development and installation of an effective system of Automatic Train Protection.

The system must incorporate means of bringing a train under control automatically in the event of the driver starting against a signal at Danger.

(2) Rule H 5.1.2 and H 5.1.3 should be reviewed with the object of eliminating any uncertainty arising from the use of the expression "where practicable".

This could be achieved either by defining clearly the meaning of the expression, or preferably by ensuring that the equipment provided at every station is sufficient to remove any doubt as to the practicability of compliance with the Rule.

(3) Arrangements should be made for the performance of all drivers to be monitored within 2 months of passing-out and thereafter at yearly intervals. Such monitoring should take the form of a Traction Inspector accompanying the driver in the cab on a representative sample of journeys.

(4) At Bellgrove Station British Railways should review the siting of signal BL86.

We recommend that BL86 Signal should be moved to the lefthand side of the Up line, the normal position for a lineside signal. Consideration should also be given to providing a repeater signal or "off" indicator on the platform where it can easily be seen by a guard from his position on the train.

(5) British Railways should also review the layout of Bellgrove Junction, giving consideration to the question of introducing trap points, at least on the line leading to the Up Branch line, pending the introduction of ATP.

(6) Pending revision of the 1958 Letter of Agreement, British Railways should submit all proposals for the conversion of double line junctions to single line junctions for approval by the Secretary of State, irrespective of whether they are stages of major works.

(7) Finally, bearing in mind the fundamental importance of the correct observance of signals, even after the installation ATP, British Railways should continue to give high priority to the current management effort in respect of Signals Passed at Danger (SPAD).

This involves steps to secure the reporting and investigation of all SPADS, and continuing analysis of the causes of these incidents with a view to identifying the circumstances in which they are most likely to occur and designing appropriate strategies for prevention.

EXTRACTS FROM BRITISH RAILWAYS RULE BOOK, JUNE 1988

SECTION H - WORKING OF TRAINS

5. Duties of Drivers and Guards and Persons in charge of a station, platform or yard - when starting the train.

5.1.2. The Person in charge of the platform must give a handsignal to the Guard to indicate when station work is complete, that all doors are properly closed and, where practicable, that the signal (where provided) is cleared. By day this handsignal must be given by raising one arm above the head and at night, if the use of a handlamp is necessary, by a white light held steadily above the head.

5.1.3. After ensuring that all is in order so far as he is concerned and that station work is complete at an unstaffed platform, the Guard must where practicable see that the signal (where provided) is cleared and then indicate to the Driver that the train is ready to start.

5.6. ***Signal to be cleared***
The 'Ready to Start' signal indicates only that the station work is complete. The Driver must ensure before starting the train that the signal (where provided) is cleared. He must not move his train towards the signal to await clearance unless the Signalman's permission has been obtained or, when in a siding, he is instructed to do so by the Person in charge.

6.1.1. The Driver must as far as practicable ensure that his train runs punctually but he must observe all signals and speed restrictions applicable to his train. When signals are not visible at the usual distance because of fog or falling snow or for some other reason, he must adjust speed as necessary.

EXTRACT FROM BRITISH RAILWAYS BOOKLET:

"CLASS 303 EMU TRAINS - WORKING INSTRUCTIONS FOR STRATHCLYDE SERVICES"

21. STARTING OF TRAINS

21.1 At manned stations ie Glasgow Central, Gourock and Wemyss Bay the 'Ready to Start' signal will be given by the person in charge of the platform in accordance with the Rule Book, Section H.

21.2 At unmanned stations the Driver must act in accordance with the instructions in the Rule Book, Section H, and satisfy himself that all is in order for the train to proceed. Closed Circuit Television (CCTV) equipment or mirrors are provided on certain platforms where required to enable the Driver to carry out this duty.

EXTRACT FROM EVIDENCE OF MR A J SIMPSON, ACTING SIGNALLING AND MAINTENANCE ENGINEER, SCOTRAIL

After the incident I carried out full functional tests of Bellgrove Interlocking including the Route Holding, Approach Control, Approach Locking, Point Locking, Approach Locking Release and various other controls within Bellgrove Signal Box. I completed these tests at 03.20 on the 8th March 1989. All the tests were found to be correct in accordance with the current control tables. I carried out aspect sequence checks on BL86 Signal, BL86R, BL86RR and also on BL82 and BL105. All the aspect sequences were found to be correct. I carried out lamp voltage checks on BL86, BL86R, BL86RR, BL82 and BL105, all lamp voltages were within the specification. I carried out tests on the operation of the Track Circuits 273, 276, 284, 285, 286, 305, 293, 297, 296, 474, 475, 472 and 813. I also checked these Track Circuits for gaps. All Track Circuits were operating to specification and no gaps were found. I carried out tests on the AWS magnets on BL81, BL82, BL86, BL86R and BL86RR. All AWS equipment was in order. I tested the tail cables for Signals BL82, BL86, BL86R, BL86RR and the respective AWS's. The test was an insulation test on the tail cables, and also on the tail cables for 49 Points. All insulation tests were within specification. I carried out a full wire count in Bellgrove Relay Room, Garngad Relay Room and the locations associated with 46, 47, 49 and BL86 and BL82 signal to prove that they were wired in accordance with the design. All checks were found to be correct. I carried out a test for residual voltage on BL86 location equipment and again all tests were within specification. Bellgrove Relay Room was tested for Earths on the electrical Bus Bars and all Bus Bars were found to be earth free. I carried out a test on all Signal Post telephones for security of speech and again all tests were correct.

APPENDIX D
(paragraph 77)

EXTRACT FROM EVIDENCE OF MR I W WARBURTON, DIRECTOR OF OPERATIONS, BRB, AS TO SINGLE-LEAD JUNCTIONS

There are eight reasons why single leads in junction design are preferable from a Civil Engineering point of view. They are:

1. Alignment and top are much easier to maintain with the switch and crossing work "spread out" laterally, as changes in the support system occur much more gently.

2. Fixed obtuse crossings are not suitable for speeds over 90 mph as both crossings occur simultaneously causing heavy impacts to both track and rolling stock.

3. Switch diamond crossings are difficult to maintain as there is difficulty packing sleepers.

4. Short rails necessary in "double" junctions are avoided reducing wear and problems spacing insulated joints.

5. Rail creep due to traffic or temperature is much reduced and simplicity of components means that any remaining problem is easier to deal with.

6. Worn out components are easier to replace with less disruption to traffic.

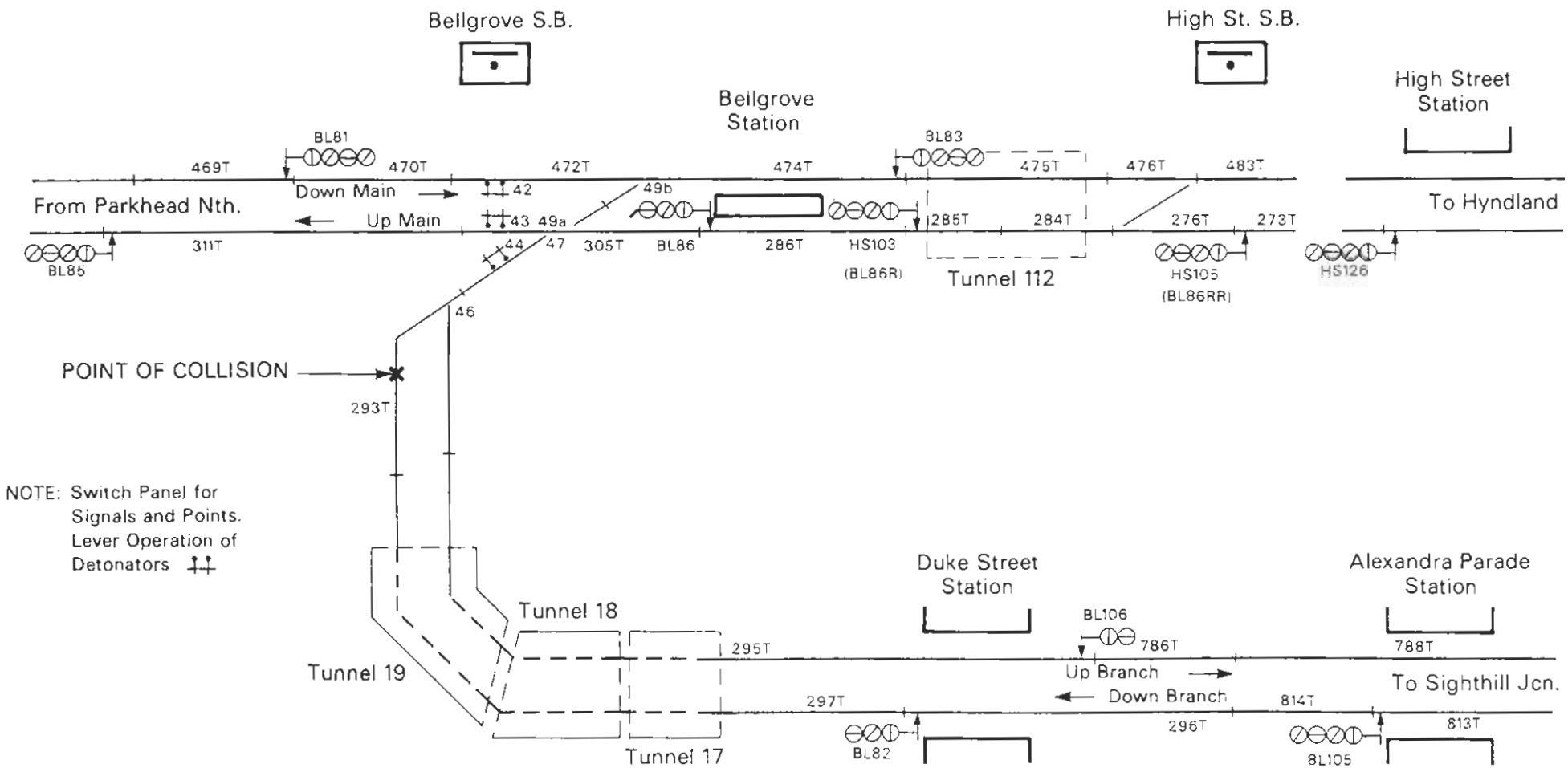
7. Single lead type 2 and 3 junctions use standard components whereas type 1 junctions use a considerable number of special components due to conflicting curvature (they are site specific, custom built and produce delays in repair as a result).

8. Switch diamonds cause problems in maintaining the tolerances for effective detection within the signalling system.

Printed in the UK for HMSO
Dd 292782 7/90 C3 488/4 O/N 114108 9864

DIAGRAM 1

BELLGROVE ACCIDENT PLAN



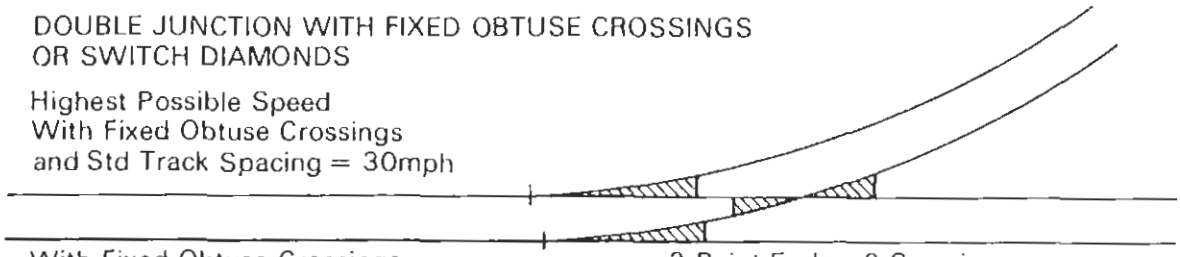
DTp Graphics Unit
90/541/IM

TYPES OF DOUBLE TRACK JUNCTIONS

"TYPE 1"

DOUBLE JUNCTION WITH FIXED OBTUSE CROSSINGS
OR SWITCH DIAMONDS

Highest Possible Speed
With Fixed Obtuse Crossings
and Std Track Spacing = 30mph



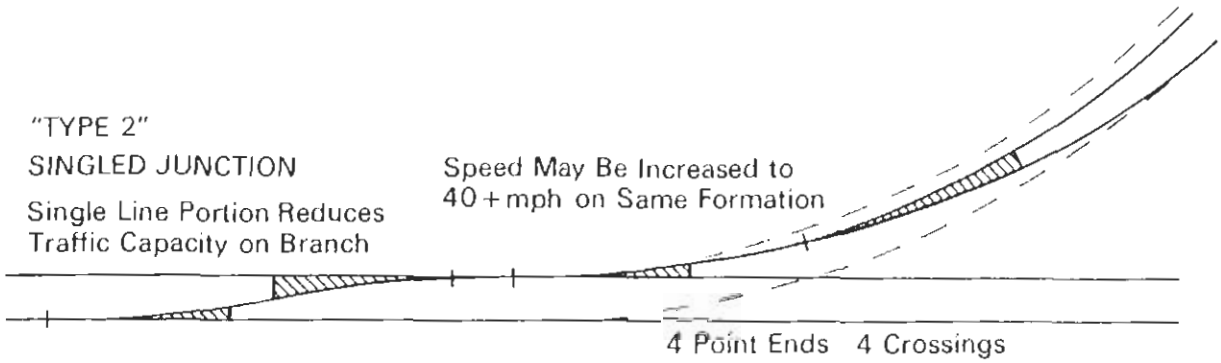
With Fixed Obtuse Crossings — 2 Point Ends 6 Crossings
With Switched Diamond Crossings — 4 Point Ends 4 Crossings

"TYPE 2"

SINGLED JUNCTION

Single Line Portion Reduces
Traffic Capacity on Branch

Speed May Be Increased to
40+mph on Same Formation



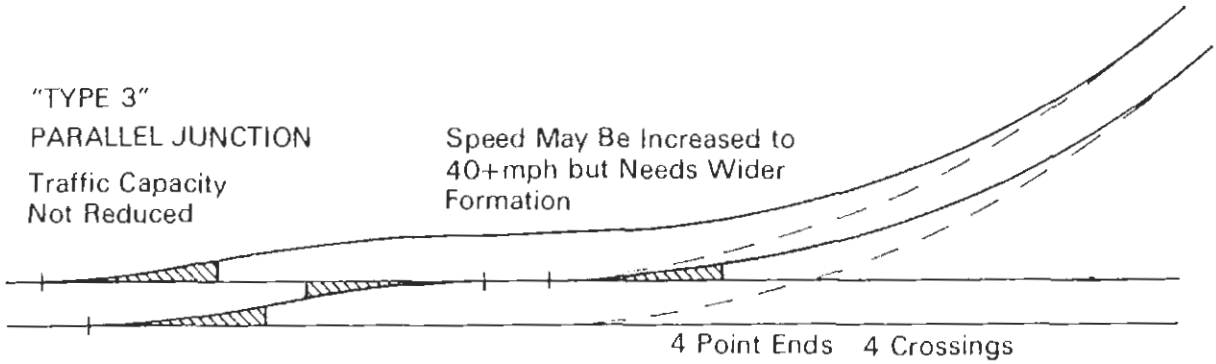
4 Point Ends 4 Crossings

"TYPE 3"

PARALLEL JUNCTION

Traffic Capacity
Not Reduced

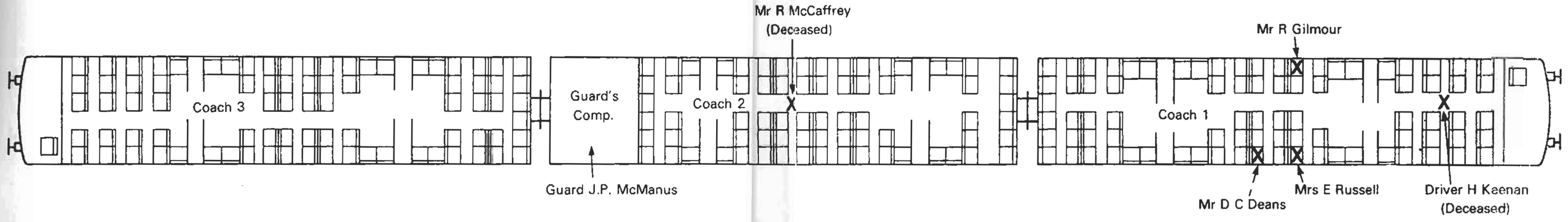
Speed May Be Increased to
40+mph but Needs Wider
Formation



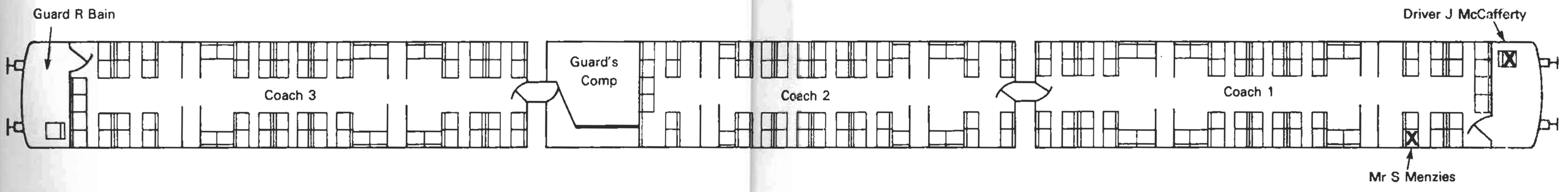
4 Point Ends 4 Crossings

LAYOUT OF TRAINS

2A01 SPRINGBURN TO MILNGAVIE (DOWN)



2A02 MILNGAVIE TO SPRINGBURN (UP)



Report of the inquiry into the collision at Bellgrove Junction on 6 March 1989

HMSO

HMSO publications are available from:

HMSO Publication Centre
(Mail and telephone orders only)
PO Box 276, London SW8 5DT
Telephone orders 01-873 9090
General enquiries 01-873 0011
(queuing system in operation for both numbers)

HMSO Bookshops
49 High Holborn, London, WC1V 6HB 01-873 0011 (Counter service only)
258 Broad Street, Birmingham, B1 2HE 021-643 3740
Southey House, 33 Wine Street, Bristol, BS1 2BQ (0272) 264306
9-21 Princess Street, Manchester, M60 8AS 061-834 7201
80 Chichester Street, Belfast, BT1 4JY (0232) 238451
71 Lothian Road, Edinburgh EH3 9AZ 031-228 4181

HMSO's Accredited Agents
(see Yellow Pages)

and through good booksellers

From 6 May 1990 the London telephone numbers above carry the prefix '071' instead of '01'.

£5.60 net

ISBN 0 11 550959 3