DEPARTMENT OF THE ENVIRONMENT

RAILWAY ACCIDENT

Report on a fire that occurred on a Diesel Multiple-Unit Passenger Train on 9th May 1971 at Bescar Lane near Southport

IN THE

LONDON MIDLAND REGION

BRITISH RAILWAYS

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RAILWAY INSPECTORATE,
DEPARTMENT OF THE ENVIRONMENT,
2 MARSHAM STREET,
LONDON, S.W.1.
22nd March 1972.

SIR,

I have the honour to report for the information of the Secretary of State, in accordance with the Order dated 11th May 1971, the result of my Inquiry into the fire that occurred on a diesel multiple-unit passenger train at 11.45 on Sunday, 9th May 1971, at Bescar Lane near Southport in the London Midland Region, British Railways.

The train was the 11.35 from Southport to Manchester, formed of a single 3-car set and conveying between 30 and 40 passengers. It was travelling on the Up Main line at about 50 miles/hour when the driver's attention was drawn to the fact that the leading power car was rapidly filling with smoke. He immediately brought the train to a stand near the Bescar Lane Up Distant signal, where the passengers detrained while he set about trying to fight the fire with the help of another driver travelling as a passenger.

The smoke was observed by the signalman at Bescar Lane who sent the "Obstruction Danger" signal to Southport whence the emergency services were called out. No one was injured but, despite the efforts of the fire brigade, two out of the 3 vehicles were gutted.

The weather was fine and clear with a southwesterly breeze blowing across the line of the railway.

DESCRIPTION

1. Bescar Lane station lies 4 miles from Southport on the double track line from Southport to Manchester via Wigan (Wallgate). Between Southport and Bescar Lane there is one intermediate station, at Meols Cop, one mile from Southport. The line is worked on the absolute block system with semaphore signals. In the block section between Meols Cop and Bescar Lane there are 2 automatic half-barrier level crossings, but on the day of the accident both these crossings were under maintenance and trains were being handsignalled past them.

2. The train concerned was a 3-car diesel multiple-unit set formed of 2 power cars with a trailer car coupled between them, the three vehicles being gangwayed together with full width driving cabs at the outer ends. The set was built in 1961 by the Birmingham Railway Carriage and Wagon Co. Ltd. and each power car was fitted with two Rolls-Royce diesel engines of 180 hp mounted in tandem under the centre of the car, each driving the inner axle of the adjacent bogie through a fluid flywheel and the standard mechanical transmission.

3. The leading power car, No E 52074, on which the fire originated, had a seating capacity of 45, arranged in saloon compartments without exterior doors, a first class compartment with 12 seats immediately behind the driving cab and a second class compartment with 33 seats. Between the two compartments and also at the rear of the 2nd class compartment there were cross-passages with exterior doors and behind the second cross passage there was a guard's compartment with a side corridor on the left in the direction of travel.

4. Carriage heating on the car was provided by a "Dragonair" type DVLA 80 combustion heater mounted on the left-hand side of the underframe below the leading passenger door. The hot air from the heater was distributed to the passenger accommodation through longitudinal ducting along each side of the car body, the ducting on the opposite side to the heater being fed through a transverse duct located underneath the floor of the crosspassage between the first and second class compartments. Though the ducting in the immediate area of the heater itself was of mild steel, the cross ducting and a short length of longitudinal ducting under the door opening at each side of the car were of a glass-reinforced plastics (GRP) material, lagged with glass wool and wrapped in a neoprene-glass fibre material. The junction between the cross ducting and the longitudinal ducting on the right hand side of the car was immediately below the exterior door and immediately above longitudinal steel cable trunking carrying the main electrical circuits of the vehicle. It was also close to the main fuel tank filler pipe.

5. The underframe, body framework and side and roof panelling of the vehicle were all of steel, with the exception of the roof section of the driving cab which was of a moulded GRP material, and the body was lined with laminate-surfaced hardboard. The car floor was of 1/16 inch corrugated aluminium alloy sheet, laid with the corrugations transversely, insulated on the top side with cork bedded in a bituminous compound adhesive and overlaid with $\frac{3}{4}$ inch thick multiply boarding, except over the engines and exhaust pipes where, as a fire precaution, the cork and bitumen had been removed and the multiply boarding replaced by $\frac{3}{8}$ inch Plasticell panels bonded to $\frac{1}{4}$ inch plywood. The first class compartment was carpeted and the floor of the remainder of the passenger accommodation fully covered with $\frac{1}{4}$ inch thick linoleum. The brake compartment floor was surfaced with a bituminous material. The seating in both compartments was framed in steel tubing, filled with latex foam and covered with a woollen moquette material.

6. Fire protection for the underfloor traction equipment was provided by means of a "Graviner" automatic fire extinguishing system which, when operated by means of a heat-sensitive device, released the contents of a bottle of chloro-bromo-methane through a perforated tube; it was designed, however, to protect only the area of the actual engine, gearbox and fluid flywheel. The set was also equipped with 7 portable fire extinguishers, a water/CO_2 type on each vehicle and 2 pistol-type BCF extinguishers in each driving cab.

The damage caused by the fire

7. The damage to the leading power car was very considerable. The body was completely gutted, all windows shattered and melted; all seating upholstery, interior panelling and floor covering completely destroyed. The bodyside and roof panels were severely scorched throughout and their distortion had led to a degree of collapse of the body structure. The fibre glass roof section over the driving cab had disintegrated. There was little damage below floor level apart from the GRP sections of the heater ducting, which had completely burnt away, and some charring of the stepboards. The only penetration of the floor was immediately adjacent to the leading passenger door on the offside where there was a hole of about 2 square feet in area, where the aluminium sheeting had melted.

8. The damage to the leading end of the adjacent trailer car was of a similar nature to that sustained by the power car but progressively lessened towards the rear of the vehicle. There were no penetrations of the floor and no damage below floor level. The interior of the trailing power car was blackened by smoke but it was otherwise undamaged.

9. There was no damage to the track or signalling.

Evidence

10. The train was driven by *Driver J. E. Moore*, stationed at Southport. It was his third trip to Wigan that morning with the same set, since the Southport–Manchester service was being run as a shuttle service between Southport and Wigan on account of engineering works between Wigan and Hindley, and he told me that the set had been running normally. On leaving Southport he had been advised that the automatic half-barrier level crossings at Pool Hey and Wyke Cop were under local control and that handsignalmen were in attendance.

11. Some passengers joined the train at Meols Cop and, after passing Wyke Cop crossing at reduced speed, when the speed had risen to something over 50 miles/hour, the guard, who was travelling with him in the leading cab, told him there was smoke in the leading car. He at once made an emergency brake application, bringing the train to a stand at a farm crossing near the Bescar Lane Up Distant signal. As soon as the train came to a stand Driver Moore grabbed the two BCF fire extinguishers from the driving compartment and jumped down on the cess side. Then, after seeing that the passengers were safely out of the leading car, he handed one of the extinguishers to the guard of the train and, because the cess side of the train was blanketed in smoke, ran round the front to attack the fire on the windward side, but although he had previously used a similar extinguisher on a small fire, he was not able on this occasion to release the safety catch. However, he pointed out to me that, even if he had been able to make the extinguisher work he would not have known where to point it. He could see no flames beneath the car and, by this time, the interior was full of smoke and fumes.

12. Driver Moore then set off for Bescar Lane signalbox, about $\frac{3}{4}$ mile away, and met the signalman about 200 yards from the signalbox. He then ran back to the train and had nearly reached it when he saw the fire brigade arrive. He thought that by then perhaps 12 minutes had elapsed since the train came to a stand.

13. In charge of the train was *Guard G. G. T. Gilbody*. He told me that, after leaving Meols Cop, he was with the driver in the leading cab when a passenger knocked on the sliding door and drew his attention to smoke, apparently coming from the rear of the leading car. He told the driver to stop and prepared to move the passengers through into the adjacent trailer car. At this stage he thought there was an underfloor fire of a kind he had previously experienced on this type of DMU. However, when he opened the door leading to the brake compartment there was thick smoke beyond it so he opened the exterior door on the cess side and set about helping the passengers down to the ballast. In this he was assisted by Driver Houghton and Guard Langtree, who were travelling as passengers.

14. Guard Gilbody told me that before Driver Moore set off towards Bescar Lane signalbox he passed him a pistol-type extinguisher but, like the driver, he was unable to make it work, even though he had used four of them on a previous occasion. He could not get back into the brake compartment to get the water/CO_2 extinguisher on account of the smoke.

15. As soon as the passengers were safely evacuated Guard Gilbody decided, in company with Driver Houghton, that they should try and save what they could of the train and so they set about uncoupling the set between the leading power car and the trailer. However, the fire had already got a good hold of the power car and the heat and showers of breaking glass made it difficult to get the jumpers out so they transferred their attention to the other end of the trailer car and succeeded in uncoupling the rear power car and pushing it clear with the help of other railwaymen who had reached the site. In reply to questioning, Guard Gilbody confirmed that at the time of the fire the heaters on the set were switched off.

16. *Driver L. Houghton*, who was travelling as a passenger, was sitting in the trailer car when the train came to a stand. He remarked to Guard Langtree, who was with him, that perhaps something was wrong and they got up and walked forward towards the leading power car. When Guard Langtree opened the sliding door, there was smoke beyond it, and on looking out of the window he saw that the leading power car seemed to be on fire. They both jumped down and rendered assistance as described by Guard Gilbody. Driver Houghton also obtained a BCF extinguisher and succeeded in making it work, but told me he thought its use was more of a gesture than anything else since the leading car was by then well alight and past the stage at which a small extinguisher could be of any use.

17. *Fitter W. G. Page* told me that the DMU set involved had been stabled overnight at Southport and that he had examined it before its first trip on the Sunday morning. There were no faults noted in the repair book and everything seemed to be in order. At about 11.45 Page had been informed of the fire at Bescar Lane, and he reached the scene shortly after 12.00, at which time the 2 leading coaches were still ablaze. As soon as the fire brigade had extinguished the flames he made an examination to try and determine the cause of the fire, first looking at the exhaust systems on the leading power car, but he could find no faults. He was then told that something was blowing on the trailer car and he found the heater fan running. This he disconnected by pulling out the plug at the heater.

18. *Mr. J. R. Hardacre, Assistant Area Manager (Technical) at Bradford, Eastern Region,* responsible for Hammerton Street Diesel Depot to which the DMU set concerned was allocated, produced for me the maintenance history of the leading power car, No. E 52074. Its most recent examination was a 10–12,000 mile examination carried out at Hammerton Street on 3rd May, 6 days before the fire. This was a very thorough examination covering traction equipment, braking system, electrical system and all auxiliaries. The tests of the electrical system included earth leakage tests of both positive and negative circuits. No faults of any kind were found. Since that examination the car had covered approximately 1,600 miles.

19. Mr. Hardacre told me that he had been responsible for DMUs of this type since they were first introduced and had considerable experience of the troubles to which they were prone. He described to me the modifications that had been carried out to the exhaust systems and to the flooring over the engines to reduce the risk of fire. Such fires as were still being caused by exhaust faults were generally minor in character and were usually extinguished by the Graviner system. Another possible cause of fire was a malfunction of the Dragonair heater, but after a serious fire from this cause at Sowerby Bridge in 1963, modifications to the heater and to the heater ducting had effectively prevented heater fires from spreading into the interior of the car. Mr. Hardacre told me that he had personally examined the burnt-out coaches at Southport on the day after the fire and he had been unable to determine where the fire had started or how it had come to involve the interior of the vehicles. He was quite certain, however, that the fire had not originated in the Dragonair heater which was clean and undamaged.

20. *Mr. J. Noden, Mechanical and Electrical Engineer (Carriage and Wagon), London Midland Region,* who was present at my Inquiry, described to me the subsequent careful and detailed examinations that were made of the leading power car and how they concentrated on the area beneath the leading passenger door on the offside, where the flooring had been penetrated, as being the most likely seat of the fire. It was in this area, beneath the heater ducting, that clear signs of overheating were found on the mild steel cable trunking and indications that the insulation on the positive cable from the battery charging socket had been chafing on the edge of a bushed hole in the trunking until the core came into contact with the metal bush. The presence of verdigris on the copper of the cable indicated that it had been exposed for some time.

21. It was Mr. Noden's opinion that there was a negative earth elsewhere on the vehicle and that when the positive cable core touched the bushing a short circuit occurred across the 24 volt battery. The heat arising from this short circuit during the time that elapsed before the battery fuse ruptured would, in his view, have been sufficient to cause ignition of the adjacent cable coverings which in turn ignited the diesel oil with which the adjacent heater duct lagging was saturated.

22. At that stage, it was Mr. Noden's view that the fire gained access to the interior of the vehicle by penetration of the flooring immediately over the seat of ignition and that only smoke had entered the passenger accommodation through the heater ducting.

Subsequent Tests

23. At my request Mr. Noden arranged for a number of tests to be carried out at the Plastics Laboratory of the Railway Technical Centre at Derby on the flammability of the GRP heater ducting and its lagging and wrapping, using as a test specimen a section of ducting removed from an identical vehicle. As was to be expected, neither the glass fibre lagging or neoprene/glass wrapping material were in any way inflammable but the test on the GRP material, carried out in accordance with the procedure laid down in Appendix I to British Railways Specification No. 602, showed that the material was very inflammable, the specimens continuing to burn after the removal of the ignition flame, whereas the above-quoted specification calls for extinction within 5 seconds.

24. These laboratory tests were followed by full scale tests on a section of lagged and wrapped GRP ducting with a representative section of flooring placed over it, in one case with the lagging dry and in a second with the lagging soaked in fuel oil. In each case the heat was applied by burning 100 gms of cotton waste soaked in 500 ml. of petroleum ether, placed immediately below the section of ducting. In the first case the exterior of the ducting started to burn but stopped burning as soon as the petroleum ether fire went out, but in the second case the fire spread to the inside of the ducting after 3 minutes and it thereafter burned for over 20 minutes, by which time the GRP was completely burnt away, leaving just the glass fibre lagging remaining, in a manner similar to that found on the power car after the fire at Bescar Lane.

25. It was noted that, once the ends of the GRP ducting were ignited the flames tended to "funnel" through the ducting. This funnelling was most noticeable and the flame travel through the ducting was very rapid. During the 20 minutes it took for the ducting to burn out there was no penetration of the section of flooring placed over it; the corrugated aluminium sheeting remained intact and the centre of the plywood was untouched, though the edges were charred where the flames had come up round the outside of the section of flooring.

26. A test was also carried out to determine the flammability of the latex foam filling from the seating. A piece of the foam could be lit with a match without difficulty and thereafter burned vigorously. The fire hazard introduced by the use of this material instead of a urethane foam complying with British Railways Specification No. 541, which allows a maximum afterflame time of 1 second, is very considerable.

Conclusions

27. The exact chain of events which led to this serious fire must be to some extent conjectural, but I am satisfied that the original source of ignition was a 24v DC arc set up between the copper core of the positive cable from the battery charging socket and metal bushing at the point where the conduit to the socket joined the cable trunking. The insulation of the cable had chafed through over a period of time, as indicated by the presence of verdigris on the exposed copper.

28. The intense heat arising from this arc before the fuse protecting the circuit ruptured, was sufficient to melt and set fire to the insulation on other cables in the trunking, causing a local hot spot on the upper surface of the trunking, where it was in close contact with the exterior wrapping and insulation of the transverse heater ducting near its junction with the section of longitudinal ducting beneath the doorway.

29. The lagging on this section of the duct, on account of its proximity to the main fuel tank filler pipe, had, in course of time, become saturated with diesel oil and, though the lagging and wrapping were themselves entirely non-flammable, they acted as a wick and allowed the diesel oil to vaporise and become ignited by the hot spot on the cable duct. Once ignited, this fire in the lagging was fanned by the stream of air caused by the movement of the train. At this stage, such smoke as was produced would have been carried back under the leading vehicle and hence the first appearance of smoke inside the car was from the windows at the rear, in the neighbourhood of the guard's compartment.

30. By the time the train was brought to a stand the fire in the lagging had gained a good hold and it could not have been long before the GRP ducting itself became ignited allowing smoke and flames to pass along the longitudinal ducts in the passenger compartments and emerge through the inlets located beneath the seating, igniting the very inflammable latex foam with which the seat cushions were filled.

31. It is also likely that the spread of the fire into the interior of the car was accelerated by the running of the heater fan, power reaching the motor as a result of a cross connection between the wiring in the cable duct where the fire started. Though no one at the scene noted whether the heater fan on the leading power car was running as the fire developed, when Fitter Page reached the scene of the fire shortly after 12.00 he found the heater fan on the trailer car running and he disconnected it by pulling out the plug. All the heaters on the train were controlled from the guard's compartment in the leading car, the heater fans on the 3 cars in the set being on the same circuit and controlled by a single switch.

32. In view of the fire resistance exhibited by the specimen of flooring used in the tests carried out at the British Railways Plastics Laboratory, it seems unlikely that the final penetration of the floor in the area immediately over the original seat of the fire occurred until after the exterior of the car was well alight as a result of flames entering through the heater system.

33. With regard to the wiring fault which provided the source of ignition of this fire, it arose at a point where visual examination of the condition of the insulation of the cables was not possible without extensive stripping and might not have been revealed by an earth leakage test carried out only a short time beforehand. However, I was assured by the railway officers present at my Inquiry that a special examination would be made at once of the condition of the wiring on all other DMU power cars of this type and I have subsequently been informed that no similar defects have been found.

34. At the time when the train came to a stand the actual seat of the fire was not apparent and the presence of smoke both inside and outside the vehicle made it difficult to know how to set about dealing with the situation. In my view the action taken by the train crew and the railwaymen travelling as passengers in firstly concentrating on the removal of the passengers to a place of safety and then attempting to localise the fire by uncoupling the set was entirely correct. The fact that neither the driver nor the guard were able to make BCF extinguishers operate did not, in this instance, affect the outcome. The basic reason why the fire was a serious one, as in many previous DMU fires, was the bad detail design of the vehicle concerned. A minor electrical fire caused by an insulation failure should not escalate into a major fire involving the passenger accommodation and placing life at risk.

Remarks and Recommendations

35. Altogether 30 3-car diesel multiple-unit sets manufactured by the Birmingham Railway Carriage and Wagon Co. Ltd., and powered by Rolls Royce engines entered service in 1961. These were 20 sets, with the power cars numbered 51809–51848, allocated to the North Eastern Region and 10 sets, with the power cars numbered 52066–52085, allocated to the London Midland Region. They have always been employed on services in Yorkshire and Lancashire and at the present time most are based on depots at Bradford, Leeds, and Manchester.

36. Ever since their introduction, the incidence of fires on this type of DMU has been significantly higher than on any other type on British Railways. Altogether, during the 10 years they have been in service 92 fires have occurred on the 60 power cars concerned and a further 4 fires have occurred involving the heaters on the associated trailer cars. Details of all these fires have been made available to me by the Railways Board. Most of the recorded fires were caused by exhaust system faults allowing hot gases to play

on the underside of the car floor. It was to reduce the hazard from this type of fault that the bitumen and cork was removed from the portions of the car flooring above the engines and exhaust pipes and replaced by Plasticell boarding. Several previous fires, however, have involved the GRP heater ducting, including the only previous fire which led to the gutting of a vehicle. This occurred at Sowerby Bridge in January 1963, when a heater fault led to the GRP ducting becoming ignited from the inside, causing a fire which rapidly spread to the interior of the car through the hot air inlets beneath the seating.

37. Following on this serious fire, the circumstances of which were the subject of discussions between the Railway Inspectorate and the Chief Mechanical Engineer of the British Railways Board, a series of tests was carried out at the Fire Research Establishment at Borehamwood where it was discovered that, in the event of a fire occurring in the heater, the GRP ducting could itself ignite and form a flame path into the interior of the vehicle. As a result, a number of modifications were made to the Dragonair heater itself and those portions of the GRP ducting adjacent to the heater were replaced in mild steel. Consideration was also given at the time by the Railways Board to the replacement of the remainder of the ducting and to the elimination of the inflammable latex foam seat filling but this was not proceeded with.

38. Since that time there have been no more fires in the ducting caused by defects in the heaters themselves, but there have been 2 fires, apart from the one at Bescar Lane, in which the GRP ducting has been ignited from outside, in one case by brake block sparks setting fire to the fuel impregnated lagging and in the other by hot gases from a defective exhaust system. In the former case the heat also damaged the insulation of the electric wiring in the adjacent cable trunking causing the heater fan to start running, driving the fumes into the interior of the car. Fortunately, on that occasion the fire was extinguished by the fire brigade before it was able to spread to the passenger accommodation.

39. It was recognised as long ago as 1963 that overspill of diesel fuel from the main fuel filler pipe could saturate the lagging round the heater ducting and a special collar was fitted round the filler pipe in an attempt to prevent this happening. This modification, however, has only been partially successful and splashes of fuel oil still reach and are soaked up by the lagging on the heater ducting. The presence of this saturated lagging means that there is a continuing danger of fire since it can easily be ignited by a brake block spark or, as in the case at Bescar Lane, by an electrical fault. Nevertheless, a small fire confined to the lagging would not be a serious hazard to passengers if it were not for the extreme flammability of the GRP material of which the duct itself is made and the fact that a fire inside the heater ducting can spread quickly into the passenger accommodtion where the ready flammability of the seat filling can result in a major fire in a very short time.

40. Previous fires on DMUs have shown that, even when there has been no penetration of the fire into the passenger accommodation, fatal casualties can occur, particularly if the train is travelling at speed when the fire starts and some time elapses before the train can be brought to a stand. In the present case the driver was alerted at once and quickly brought the train to a stand so that the passengers could get out before the fire spread to the interior of the car, so by good fortune there were no casualties but, nevertheless, I regard the existence of this established fire route into the passenger accommodation as an unacceptable hazard which should be eliminated as a matter of urgency.

41. I am pleased to be able to report, therefore, that the British Railways Board now propose to replace the inflammable GRP heater ducting with mild steel and to substitute a non-absorbent type of lagging for that at present in use on the DMU vehicles concerned and I have been assured that action is in hand to carry out the necessary modifications as quickly as possible. British Railways are no longer using latex foam seat filling either for new vehicles or for replacement seats and, as seat cushions require to be replaced either under normal shopping arrangements or at depots, the latex foam type of cushion will be progressively eliminated.

42. The difficulty experienced by various members of the staff in making effective use of the pistol-type BCF fire extinguishers is worthy of comment. Both Driver Moore and Guard Gilbody, though they had each used extinguishers of this type on previous occasions, were unable to make the extinguishers function when they tried to do so at Bescar Lane. It appears that, if pressure is applied to the trigger before the safety catch is released, the effect is to lock the safety catch and, in the heat of the moment, a man may then throw aside the extinguishers as useless. I have since been assured by the General Manager of the London Midland Region that, since the fire at Bescar Lane, a practical demonstration of the handling of the BCF extinguisher has been included in the basic training of all new entrants to the grades of driver and guard and that arrangements have been made to ensure that all drivers and guards in the London Midland Region will receive similar training as soon as possible. In addition, Running Inspectors will in future include questions on the use and operation of all fire fighting equipment when accompanying drivers. I recommend that these measures be extended to cover all regions of British Railways.

I have the honour to be,
Sir,
Your obedient Servant,
I. K. A. McNAUGHTON,
Lieutenant Colonel.

The Permanent Secretary,
Department of the Environment.

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