Rail Accident Investigation Branch

RAIB Bulletin 04/2012

Blowback of a locomotive fire at Wood Green tunnel, London, on 27 May 2012

Description of the accident

1 At 11:04 hrs on Sunday 27 May 2012, train 1Z54, the 09:38 hrs special service from Finsbury Park to Rowsley operated by West Coast Railways (WCR), suffered a blowback of the locomotive fire as the train entered Wood Green tunnel in north London. There were three staff on the footplate at the time and all of them were injured by the flames. Two of them, the fireman and a member of the support crew, were taken to hospital for treatment to their burns. Both were released later the same day.

2 The train consisted of a class 47 diesel locomotive at the front of the train assisting the ex-British Railways steam locomotive 70013 'Oliver Cromwell' hauling 11 coaches (figure 1). The coach immediately behind the steam locomotive was a support coach[1] and the other 10 coaches conveyed passengers.

Figure 1: The incident train later in its journey after the diesel locomotive had been detached

[1] Steam locomotives operating on the main line network are often accompanied by a support coach conveying the locomotive support crew and any necessary maintenance equipment.

Events prior to the incident

3 The train started its journey from Southall depot in west London, where the locomotives and coaches were based. The train was planned to run empty from Southall to Ferme Park sidings, 3 ½ miles (5.6 km) north of King's Cross station (figure 2) where the diesel locomotive was to run round to the opposite end of the train. It would then haul the train to King's Cross, where the passengers were to board. The diesel would then be uncoupled and the train would depart powered only by the steam locomotive.

4 The route between Southall and Ferme Park was obstructed by over running engineering work and the train was delayed by two hours. Network Rail and WCR controllers agreed to a change to the plan for the train to make up for some of this lost time. The train was diverted to Finsbury Park and the passengers joined it there. The diesel locomotive was left on the front of the train in order to both save time uncoupling it at Finsbury Park and to provide assistance to the steam locomotive, reducing the risk of its exhaust causing lineside fires (the weather had been dry during the previous week) and reducing its water consumption (the water supply in the tender had to last an extra two hours). The revised plan was to detach the diesel locomotive when the train stopped for water at Holme, to the south of Peterborough. Figure 2 shows a diagrammatic plan of the route.

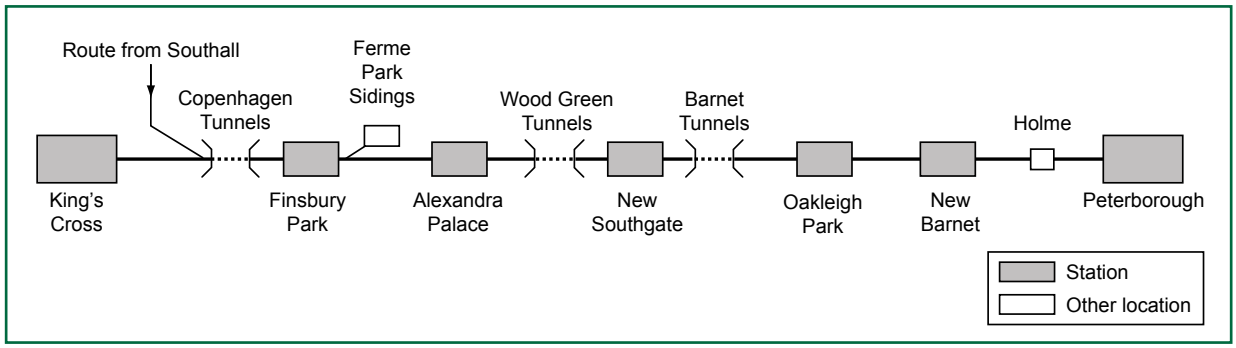

Figure 2: Diagram of line showing key locations (not to scale and some stations and tunnels omitted)

Events during the incident

5 The information in this section was obtained from the accounts of witnesses who were on the locomotive at the time of the incident or from the data recorders fitted to both of the locomotives.

6 The diesel locomotive provided most of the power to move the train as it departed from Finsbury Park, but the driver of the steam locomotive applied a small amount of power because lubrication of the locomotive cylinders was reliant on steam passing through them. This demand for power caused the fire to burn more strongly because the exhaust steam in a steam locomotive is designed to create a vacuum in the smokebox which draws the hot gases from the fire through the boiler tubes (figure 3), thereby increasing the rate of burn of the fire. This in turn further heats the water and increases the boiler pressure. Four minutes into the journey, as the train was passing Alexandra Palace station, the locomotive fire had heated the water in the boiler to the extent that the boiler pressure was approaching its maximum allowed value and the safety valves were starting to operate.

Primary air - Primary air drawn through a grate under the fire provides oxygen for the coal to burn.

Secondary air - Secondary air drawn through the firehole door provides oxygen for the volatile gases, above the hot coal, to burn.

Combustion Gas - Hot combustion gases are drawn through the boiler tubes, heating the water surrounding the tubes and firebox.

Water.

High pressure steam - High pressure steam passes through the regulator valve R (when open) and is fed to the cylinders to drive the wheels.

Exhaust Steam - Exhaust steam from the cylinders passes up through the blast pipe and reduces the pressure in the smoke box, drawing the combustion gases through the boiler.

* if the regulator valve is closed and there is no exhaust steam passing through the blast pipe, the driver can still draw the combustion gases through the boiler tubes by artificially injecting high pressure steam from the boiler in to the blast pipe. The steam is injected through the blower.

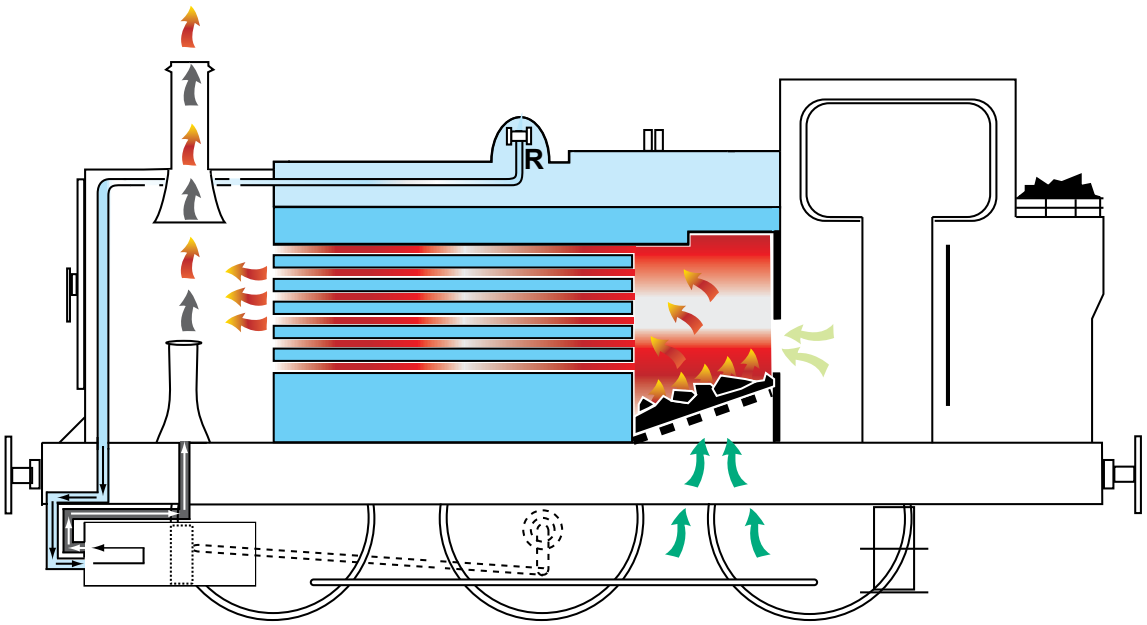

Figure 3: Diagram showing gas flows in a steam locomotive

7 The driver increased the regulator setting on the locomotive to use some of the steam, thus reducing the pressure, and also provide some assistance to the diesel locomotive on the uphill gradient. At the same time, the fireman, as part of his normal responsibilities, operated one of the injectors to put water into the boiler and so reduce the pressure.

8 The fireman noticed that the locomotive's exhaust sound had changed, indicating that some water was being carried over into the cylinders, a phenomenon known as priming[2]. He called to the driver to report this (the driver and fireman on a steam locomotive are usually on opposite sides of the cab). The driver did not hear what he said and the fireman went to the driver's side of the cab to repeat the message. The driver then started to take steps to deal with the problem by closing the regulator and moving the reverser[3] to the mid gear (neutral) position. At this time the firebox door was open and the blower[4] valve was slightly open.

[2] Priming is a serious problem for a steam locomotive as the cylinders are designed to contain only compressible fluids. Water is not compressible and its presence in the cylinder can lead to mechanical damage to the cylinder or piston.

[3] The reverser on a steam locomotive controls the amount of steam admitted to the cylinders on each stroke, as well as whether the locomotive will move in forward or reverse direction.

[4] The blower is a device fitted to steam locomotives which draws the hot gas from the fire towards the chimney.

9 As the fireman returned to his side of the cab he noticed that the diesel locomotive was just entering the single track bore of Wood Green tunnel. The fireman stated that he would normally close the firebox door and that he or the driver would further open the blower valve before entering a tunnel[5]. However, there was insufficient time to do this before the locomotive entered the tunnel and the fire blew back, filling the cab with flames. The speed of the train at this time was 56 mph (90 km/h).

10 The fireman and the support crew member, who was standing behind the driver, tried to shelter from the flames. There were no controls within their reach that they could use to stop the blowback. The driver, who was partly shielded from the flames by some of the cab equipment (figure 4), fully opened the blower valve and this stopped the blowback while the locomotive was still in the tunnel.

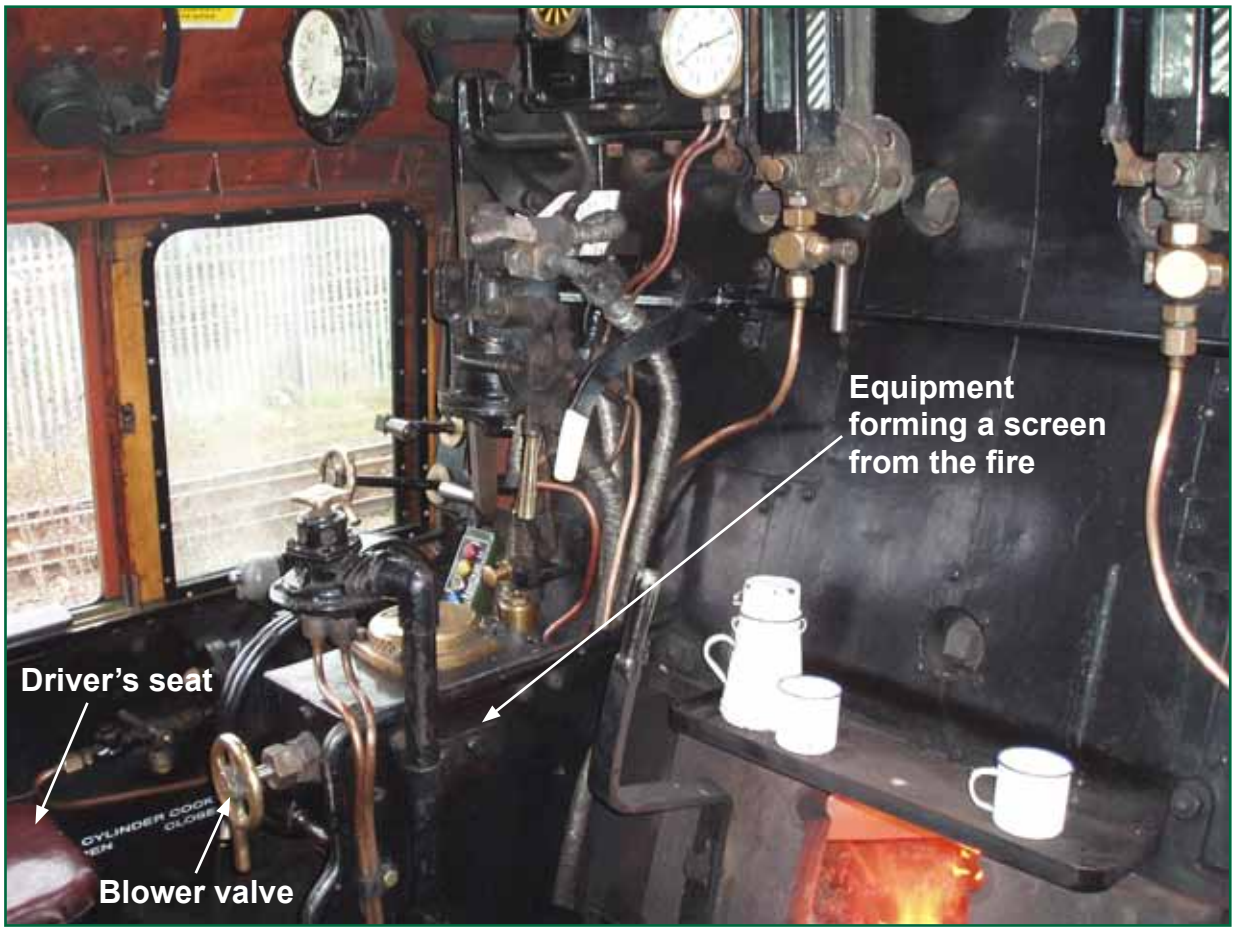

Figure 4: Cab interior of 70013 (courtesy of J. Street)

[5] The reason for opening the blower before entering a tunnel is to create a strong updraft in the chimney to counteract the pressure pulse in the air around the front of the train generated when it enters the tunnel. The magnitude of this pressure pulse depends on the size of the train in comparison to the size of the tunnel (the 'blockage ratio'); consequently it is much stronger in a single track bore tunnel, which was the type of tunnel the train entered at Wood Green.

Events following the incident

11 The steam locomotive driver called the diesel locomotive driver using the two way radios carried for this purpose and reported the incident. He asked for the train to be stopped at the next station so that help could be obtained for the injured crew.

12 The train stopped just beyond Oakleigh Park station and the driver of the diesel locomotive left his cab and went back to the steam locomotive to assess the situation. First aiders from the support coach assisted the injured fireman and support crew member.

13 The incident was reported to the Network Rail control office using the radio in the diesel locomotive and a call was also made to the signaller using a signal post telephone. Ambulances were called to the next station, New Barnet, and the train was drawn forward into the station to meet them. The injured crew members were then taken to hospital for treatment.

RAIB investigation

14 The RAIB obtained information from WCR, witnesses, the steam locomotive's on train data recorder (OTDR) and Network Rail's signalling system records.

15 The WCR competence management system requires that steam locomotive drivers qualify as fireman before they can be authorised to drive. The driver was passed as competent as a fireman by WCR on 31 March 2006 and was passed as competent to drive steam locomotives on 15 May 2010. He was aware of the risk of blowback when entering a tunnel as he had experienced a blowback incident much earlier in his career. He was also familiar with the route over which the train was operating.

16 The fireman was passed as competent to fire a steam locomotive by WCR on 29 May 2008 and was most recently reassessed on 25 May 2012.

17 The WCR fireman competence assessment procedure includes a set of questions that the candidate must answer correctly. The need to open the blower valve fully before entering a tunnel is included in these questions.

18 The RAIB has concluded that both the driver and fireman of the steam locomotive were aware that their passage through Wood Green tunnel would require the firebox doors to be closed and the blower valve to be opened. Had they executed these actions the accident would not have happened. However, they were distracted by having to deal with the priming at a critical moment as they approached the tunnel, and were unaware how close to the tunnel they were.

19 Their restricted view of the line ahead, caused by the presence of the diesel locomotive, may also have been a factor, in that it would have delayed the time at which the tunnel first became visible to the crew.

Learning points

20 The RAIB has decided not to conduct a full investigation of this incident as it does not believe that an investigation would lead to the identification of any formal recommendations that would improve the safety of railways or prevent railway accidents and incidents. However, the incident highlights the risk of blowbacks occurring when a steam locomotive enters a tunnel and the need for increased vigilance when working a train coupled behind another locomotive, due to the reduced visibility of the line ahead.

21 WCR issued a train crew notice (No. 02/12) to all its drivers and firemen on 28 May 2012 advising them of the circumstances of this incident and reminding them to carry out the following precautions when approaching a tunnel:

'● *driver to pre-warn the fireman when approaching a tunnel*

● *firebox doors completely closed*

● *blower on full*

● *regulator opened if possible.'*

22 The RAIB notes that these precautions are also applicable to other operators of steam locomotives, on the main line and on heritage lines.

This bulletin is published by the Rail Accident Investigation Branch, Department for Transport.

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