Rail Accident Investigation Branch

Dangerous occurrence at Wootton Bassett junction - web site update and supplementary information

Signal passed at danger (SPAD) on the approach to Wootton Bassett junction, Wiltshire, 7 March 2015

1 The RAIB is investigating an incident which occurred at around 17:25 hrs on Saturday 7 March 2015 in which train reporting number 1Z67, the 16:35 hrs West Coast Railway Company Ltd (WCRC) charter service from Bristol Temple Meads to Southend, passed a signal at danger. The incident occurred on the approach to Wootton Bassett junction, Wiltshire. The train subsequently came to a stand across the junction.

2 The signal involved was being maintained at danger in order to protect the movement of train 1L76, the 15:28 hrs First Great Western service from Swansea to London Paddington. Fortunately, at the time that the SPAD occurred, train 1L76 had already passed through the junction and was continuing on its journey. No injuries, damage or derailment occurred as a result of the SPAD.

Location

3 Wootton Bassett junction is located between the stations at Chippenham and Swindon. It is a double track high speed junction joining the up and down Great Western main lines which run to and from Bristol Temple Meads to London Paddington (via Bath) with the up and down Badminton lines which run to and from Cardiff. The junction also has two low speed crossovers between the up and down main lines (figure 1).

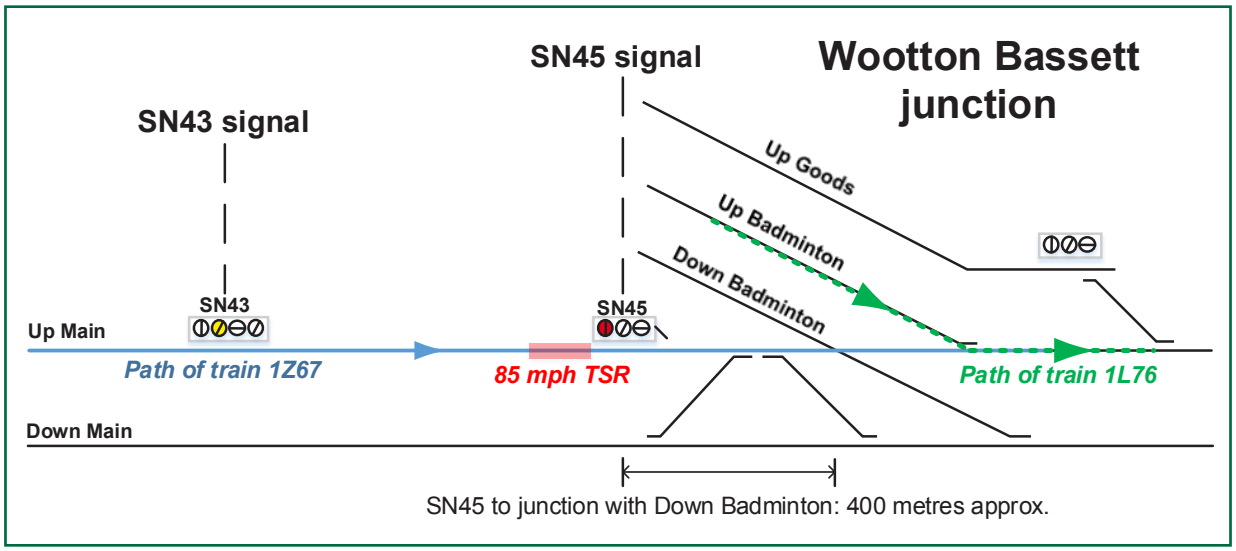

Figure 1: A diagram of the layout of Wootton Bassett junction – note that some features have been omitted for clarity (not to scale)

4 Wootton Bassett junction is protected from trains approaching on the up main line from the Chippenham direction by signal SN45, a three-aspect colour light signal. SN45 is equipped with the Automatic Warning System (AWS) and the Train Protection and Warning System (TPWS). The TPWS equipment fitted at SN45 takes the form of a train stop system (TSS), which is installed at the signal itself, and two overspeed sensor systems (OSS), situated on the approach to the signal. Signal SN45 is preceded on the up main line by signal SN43, a four-aspect colour light signal, which is also equipped with AWS and TPWS. The two signals are about 2,000 metres apart.

5 The maximum permitted line speed for trains approaching the junction on the up main line from Chippenham is normally 125 mph (201 km/h). However, on 7 March 2015, a temporary speed restriction (TSR) of 85 mph (137 km/h) was in place on the approach to signal SN45 due to the condition of the track. The associated TSR warning board and portable AWS magnet for the TSR had been placed on the approach to signal SN43 (figure 2).

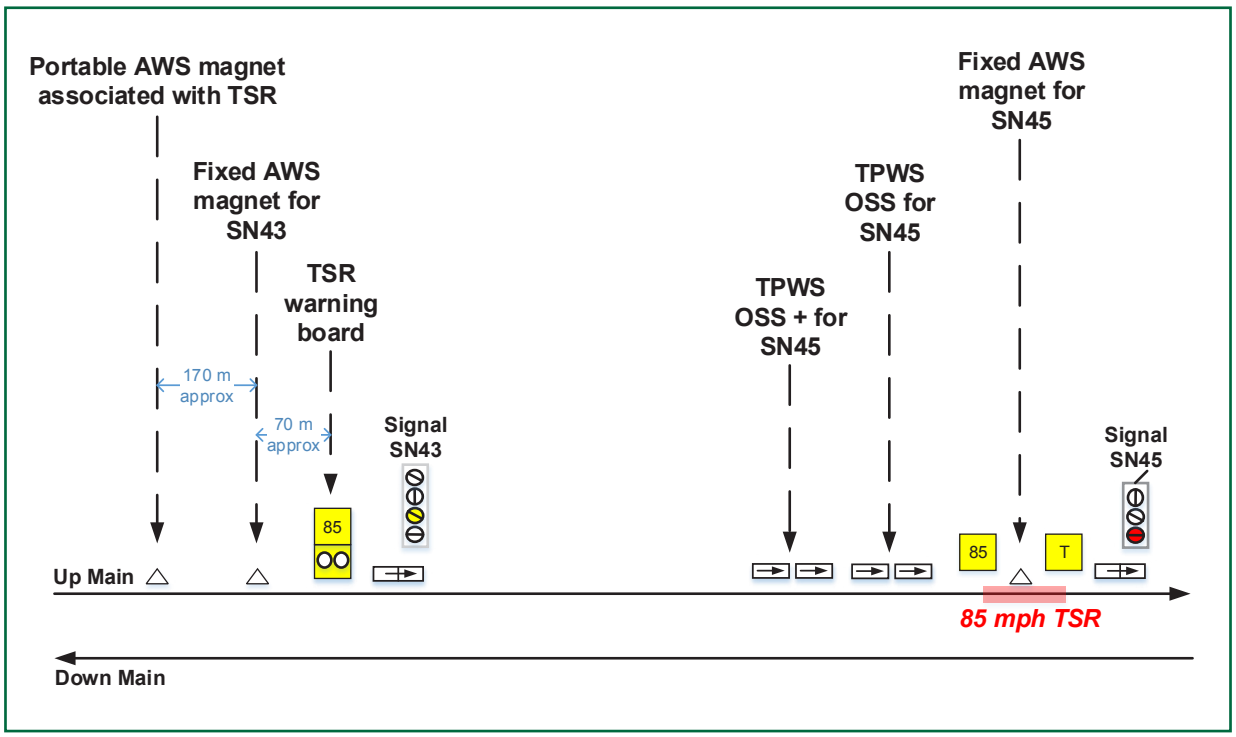

Figure 2: A diagram of the arrangements implemented for the TSR (not to scale)

6 The portable AWS magnet was positioned so that there was less than four seconds running time (for trains travelling at the maximum permitted line speed of 125 mph) between it and the fixed AWS magnet for signal SN43. In addition, the TSR warning board was placed between the fixed AWS magnet for SN43 and the signal itself. The position of the portable AWS magnet and the TSR warning board did not meet the requirements relating to TSRs contained within the railway rule book and other Railway Group Standards.

Train involved

7 Train 1Z67 was formed of 13 coaches, hauled by steam locomotive number 34067 'Tangmere'. This locomotive was built in 1947 and was withdrawn from mainline rail service by British Rail in November 1963. The driver's slip for the train stated that it was 277 metres in length, weighed approximately 605 tonnes and that it had a maximum permitted train speed of 75 mph (121 km/h). Twelve of the thirteen coaches were vacuum braked. The remaining coach, which was the support coach for the locomotive, was air braked.

8 Tangmere is fitted with three separate braking systems. These are the air braking system (which controls the brakes of rail vehicles connected to the locomotive via the automatic air brake pipe), the vacuum braking system (which controls the brakes on the locomotive's tender and any other rail vehicles connected to the locomotive via the automatic vacuum train pipe) and the steam braking system (which controls only the brakes on the locomotive). These braking systems are connected to each other by a series of proportional relay valves. These are arranged so that a brake application commanded via the driver's air brake valve will result in a proportionate brake demand being created within the vacuum and steam braking systems. A brake application commanded via the vacuum brake controller valve, however, will only apply the brakes within the vacuum and steam braking systems and will not affect the air braking system.

9 Between 2001 and 2004 an extensive programme of work was undertaken to restore Tangmere to a condition in which it could again run on the main line railway. Tangmere was fitted with air braking and TPWS systems as part of this programme. The fitting of these systems meant that the existing AWS equipment on the locomotive was modified; this included the fitting of a modern AWS/TPWS control unit and the replacement of the existing air-operated AWS horn with an electronic horn, similar to those found in modern traction units. It was noted at the time of installation of this equipment, that the new electronic AWS horn might potentially be difficult for drivers to hear over the relatively high ambient noise levels found within steam locomotive cabs. For this reason an orange flashing light was also fitted in the cab and connected so that it would illuminate whenever the AWS horn sounded. The standards in place at the time that Tangmere's AWS system was modified required that the drivers be given a period of up to 2.7 seconds to acknowledge any AWS warning. Both the AWS and TPWS systems on Tangmere command braking applications via an electro-pneumatic valve, which forms part of the air braking system.

10 An AWS shut down cock is located to the rear of the driver's seat. The AWS shut down cock is normally left open in service; if closed, it will pneumatically and electrically isolate the AWS system. An AWS isolating cock is also situated to the rear of the driving position, close to the cab floor plates (figure 3). The AWS isolating cock is normally left closed in service; if opened it will admit air into the electro-pneumatic valve and lock it into the 'ISOLATED' position. Once the electro-pneumatic valve is locked in this position, any brake demands made by the AWS/TPWS control unit will be rendered ineffective.

Figure 3: The AWS isolating cock

11 The AWS isolating cock is intended to allow Tangmere to maintain a functioning automatic air brake pipe in certain operational circumstances where the AWS shut down cock has been operated eg where there has been an AWS system fault or where the locomotive is to be hauled by another traction unit. If the AWS isolating cock is opened without the AWS shut down cock also being closed, the TPWS and AWS system will lose their ability to command a brake application but will otherwise appear to function normally.

12 The vehicle maintenance instruction for Tangmere requires the AWS isolating cock to be sealed and that this seal be checked to ensure that it is intact as part of the daily 'fitness to run' examination. The railway rule book does not allow drivers to enter a passenger train into service if an AWS isolating seal is found to be broken.

13 The RAIB has found no evidence of any malfunction of the traction and rolling stock, signalling, AWS or TPWS equipment involved in the incident.

Sequence of events

14 The following sequence of events is based on the evidence available to the RAIB at this stage of its investigation.

15 Train 1Z67 left Bristol Temple Meads at 16:38 hrs, around 3 minutes late. The locomotive's crew consisted of the driver, fireman and two members of the locomotive's support crew who were also present in the cab. Witness evidence suggests that the journey to Wootton Bassett junction was uneventful with the exception that the driver was experiencing poor visibility forwards through his windscreen (figure 4). This was because the locomotive's exhaust was being blown towards the left hand side of the boiler, where it was accumulating and blocking his view. It is also probably the case that condensation from a steam leak was forming on the driver's windscreen, further degrading his visibility. In order to improve his sighting, the driver decided to drive the train with his head positioned outside of the cab's side window.

16 The driver controlled the train's brakes throughout the journey using the vacuum brake controller valve. This had the effect of controlling the brakes on the locomotive, its tender and the twelve coaches connected to the automatic vacuum train pipe.

Figure 4: The driver's windscreen on Tangmere – note this image was taken after the incident with the train at a stand and does not show the extent of driver's visibility on 7 March 2015

17 At around 17:24 hrs train 1Z67 was approaching signal SN43 at 59 mph (95 km/h), when it passed over the portable AWS magnet associated with the TSR. Around a second after this, the AWS horn sounded and the orange light connected to it began to flash in the locomotive's cab. Data from the locomotive's On Train Data Recorder (OTDR) shows that it took the driver 4.2 seconds to acknowledge this warning, by which time the AWS system had already demanded a full brake application. The AWS system is designed to maintain a brake demand for at least 59 seconds and this should have resulted in the train being brought to a stand. In these circumstances, the railway rule book requires the driver to immediately contact the signaller.

18 The driver indicated to the fireman that an AWS brake demand had occurred. His expectation was that the fireman would open the AWS isolating cock in order to by-pass the AWS brake demand and release the brakes. The fireman has stated that he believed that he was following the driver's instructions when he subsequently crossed the cab and opened the AWS isolating cock. Witness evidence suggests that the AWS isolating cock was not sealed before the fireman opened it.

19 The railway rule book permits the drivers of trains that are in service to isolate the AWS system only if it has become defective or if it is inoperable due to the configuration of the infrastructure. In these circumstances, the railway rule book requires drivers to immediately bring their trains to a stand and then contact the signaller. Certain conditions must then be met before the train can proceed any further.

20 However, in this case, the train was not brought to a stand and instead continued on its journey. OTDR data shows that the brake demand made by the AWS system ceased to be effective around 12 seconds after it was initiated. The brief brake application which resulted from the AWS brake demand before it was by-passed reduced the train's speed by a total of 8 mph (13 km/h). Witness evidence and OTDR data show that the AWS isolating cock remained open during the remainder of the incident; this had the effect of making any subsequent AWS or TPWS brake demands ineffective.

21 During this 12 second period, a second AWS warning occurred. This was created by the fixed AWS magnet located around 275 metres on approach to signal SN43, which was displaying a single yellow caution aspect. This warning occurred around 2.5 seconds after the AWS warning from the TSR had been acknowledged; OTDR data shows that it was acknowledged by the driver within 0.5 seconds. Witness evidence suggests that the driver was unaware that he had received two separate AWS warnings and that he instead believed that he had received a single warning. Because he had seen the TSR warning board, he also believed that the warning he had acknowledged was associated with a TSR. The driver did not see signal SN43 and, therefore, was not aware that it was displaying a caution aspect.

22 Just over a minute after the AWS brake demand had been triggered, train 1Z67 approached signal SN45, which was displaying a red danger aspect, at a speed of around 52 mph (84 km/h). As it did so, it passed over the first TPWS OSS for this signal, located approximately 750 metres on the approach. This OSS is configured so that the TPWS system fitted on any train passing it at a speed greater than 65 mph (105 km/h) will demand a brake application. Because the train was travelling more slowly than this set speed, the TPWS system on Tangmere did not generate a brake demand.

23 Train 1Z67 then passed over the second OSS at a speed of around 53 mph (85 km/h). This OSS is located approximately 360 metres on the approach to the signal and has a set speed of 45 mph (74 km/h). The TPWS system correctly identified that the train was travelling over the set speed and demanded a full brake application. However, because the AWS isolating cock was still open, this demand had no effect on the train's braking systems.

24 At some point on the approach to SN45, the driver of 1Z67 saw that the signal was at danger and fully applied the train's brakes. Analysis of the OTDR data available suggests that the earliest point which the driver could have applied the brakes would probably have been around 220 to 230 metres on approach to the signal. By the point where the driver applied the brakes, there remained insufficient distance to bring the train to a stand at signal SN45. The train subsequently came to a stand around 550 metres beyond the signal, standing on both the crossovers and the up and down Badminton lines, at just after 17:26 hrs.

25 Once train 1L76 had cleared the junction points, the signaller at Swindon had set the route for 1Z67 in anticipation of its movement across the junction. Because train 1L76 had not cleared the overlap of the signal beyond SN45 at the time that the SPAD occurred, signal SN45 remained at danger. However, the setting of the route by the signaller meant that the points across the junction had normalised to the correct position for the passage of train 1Z67. This meant that no damage was sustained by either the train or the infrastructure.

The RAIB's ongoing investigation

26 The evidence available to the RAIB indicates that the SPAD at SN45 was not the only occasion on which the AWS isolating cock was used by a train crew operating Tangmere in order to by-pass an AWS brake demand. The extent of this practice continues to be the subject of further investigation.

27 The RAIB's investigation will also continue to examine other possible factors that led to signal SN45 being passed at danger. These will include;

- the competence of the train crew involved and how this was managed by WCRC;
- how AWS system isolations were managed by WCRC;
- the design (including ergonomics) and certification of the AWS and TPWS systems on Tangmere and how these systems were maintained and inspected by WCRC;
- the way in which the TSR was designed and implemented by Network Rail; and
- any relevant underlying factors, such as safety management and safety culture.

28 The RAIB's investigation is independent of any investigation by the Office of Rail and Road. The RAIB will publish its final report, including any recommendations to improve safety, at the conclusion of its investigation. These findings will be available on the RAIB website.