RAIB
Rail Accident Investigation Branch

Rail Accident Report

Fatal accident at Athelney level crossing, near Taunton, Somerset
21 March 2013

Report 04/2014
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This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 2005.

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Fatal accident at Athelney level crossing, near Taunton, Somerset, 21 March 2013

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Summary

At about 06:23 hrs on Thursday 21 March 2013, a car drove around the barriers of Athelney automatic half barrier crossing, near Taunton in Somerset. This took the car into the path of a train which was approaching the crossing at high speed. The driver of the car was killed in the resulting collision.

The motorist drove around the barriers without waiting for a train to pass and the barriers to re-open. The level crossing was closed to road traffic for longer than normal before the arrival of the train, because of earlier engineering work that had affected the automatic operation of the crossing. The motorist may have believed that the crossing had failed with the barriers in the closed position, or that the approaching train had been delayed. He did not contact the signaller by telephone before he drove around the barriers.

The RAIB has made two recommendations to Network Rail. These relate to reducing the risk resulting from extended operating times of automatic level crossings and to modifying the location of the pedestrian stop lines at Athelney level crossing. A further recommendation is addressed to Network Rail in conjunction with RSSB, to consider means of improving the presentation of telephones at automatic level crossings for non-emergency use. One recommendation is addressed to the Office of Rail Regulation, to incorporate any resulting improvements which are reasonably practicable into the guidance it publishes on level crossings.

Introduction

Preface

1 The purpose of a Rail Accident Investigation Branch (RAIB) investigation is to improve railway safety by preventing future railway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability.

2 Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

3 The RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of any inquest or fatal accident inquiry, and all other investigations, including those carried out by the safety authority, police or railway industry.

Key definitions

4 All dimensions in this report are given in metric units, except speed and locations which are given in imperial units, in accordance with normal railway practice. Where appropriate the equivalent metric value is also given.

5 The terms 'up' and 'down' in this report are relative to the direction of travel; the Up Athelney line runs from Cogload Junction near Taunton towards London Paddington via Castle Cary.

6 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report). These are explained in appendices A and B.

The accident

Summary of the accident

7 At about 06:23 hrs on Thursday 21 March 2013, a car drove around the barriers of Athelney *automatic half barrier crossing* (AHBC) and into the path of an approaching train (figure 1).

Figure 1: View of Athelney level crossing (courtesy British Transport Police)

8 The 05:46 hrs First Great Western service from Exeter St. Davids to Paddington, train reporting number 1A73, struck the car at nearly 100 mph (161 km/h). The driver of the car, its only occupant, was killed.

Context

<u>Location</u>

9 Athelney level crossing is located at 134 miles 79 chains[1] from London Paddington, on the main line from London to Taunton via Newbury and Castle Cary (figure 2). It is situated about 3 miles 4 chains east of Cogload Junction, where London-bound trains routed via Castle Cary diverge from trains that are routed via Bristol (figure 2).

10 The road that is crossed by the railway at Athelney is an unclassified public road. This provides the quickest, although not the most direct, route into Taunton from the hamlet of Curload, near Stoke St. Gregory, in Somerset. The railway crosses over the River Tone immediately to the west of the level crossing.

<u>Organisations involved</u>

11 Network Rail is the owner and maintainer of Athelney level crossing.

[1] There are 80 chains in a mile.

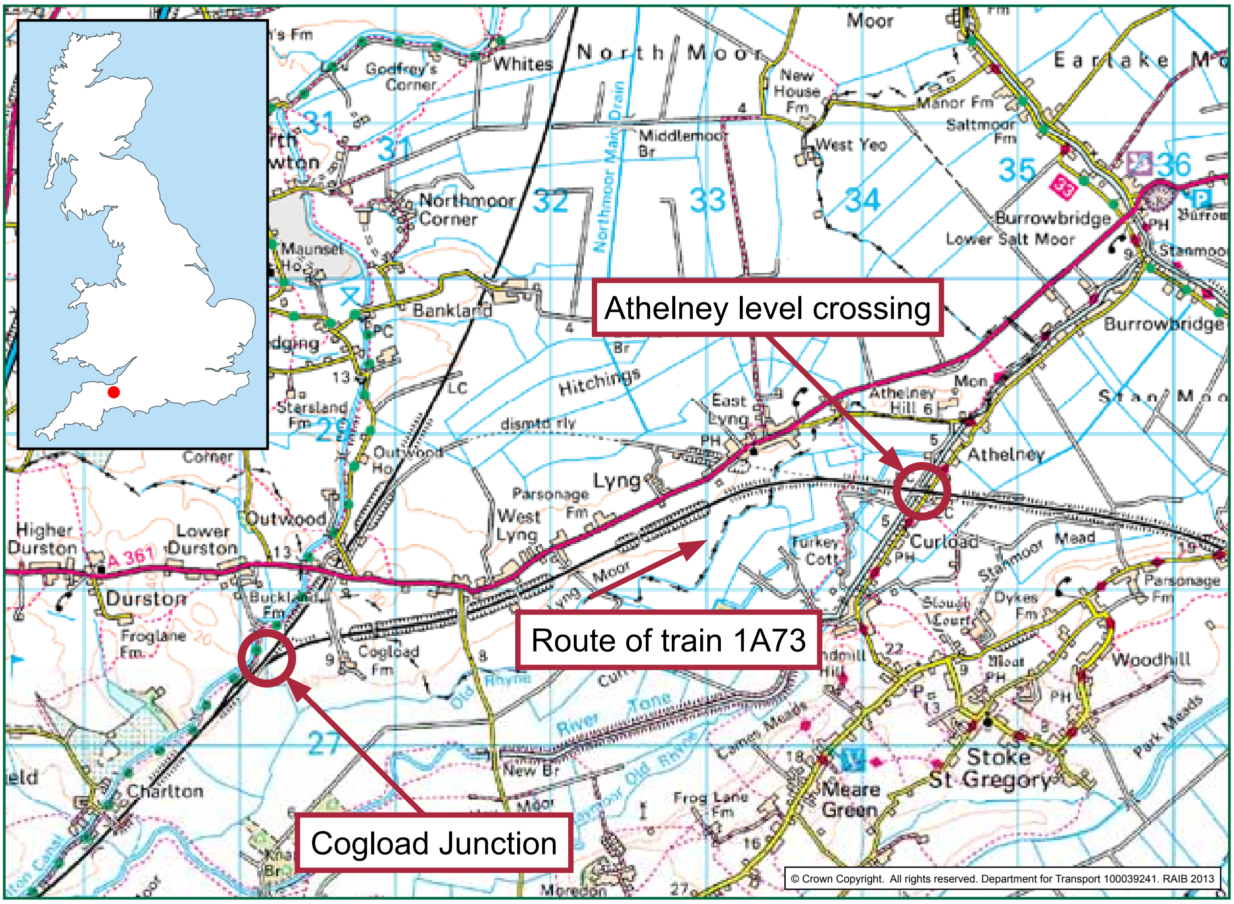

Figure 2: Extract from Ordnance Survey map showing location of incident

12 First Great Western operated train 1A73 and employed the driver and a second person who was legitimately travelling in the cab of the train.

13 Both of the organisations involved freely co-operated with the investigation.

Train involved

14 The train involved in the collision was a High Speed Train (HST)[2]. The train did not derail, although the leading power car was damaged as a result of the motor vehicle (a Peugeot 306) becoming wedged underneath the front of the train.

15 The RAIB has found no evidence to link the condition of the train, or the way it was driven, to the accident.

Rail equipment/systems involved

16 Athelney level crossing was commissioned in 1986 and is supervised from Exeter signal box. The maximum permissible speed for trains on both the Up and Down Athelney lines is 100 mph (161 km/h).

17 For trains running on the Up Athelney line, a signal (E93) is located 277 metres on the approach to the crossing. This is a *controlled signal* with an *automatic working* facility and is normally switched into automatic mode. It is the last signal before the boundary with the area controlled by Westbury signal box. The previous automatic signal (UA136) is located 2,808 metres on the approach to E93 signal (figure 3).

[2] Also known as an InterCity 125.

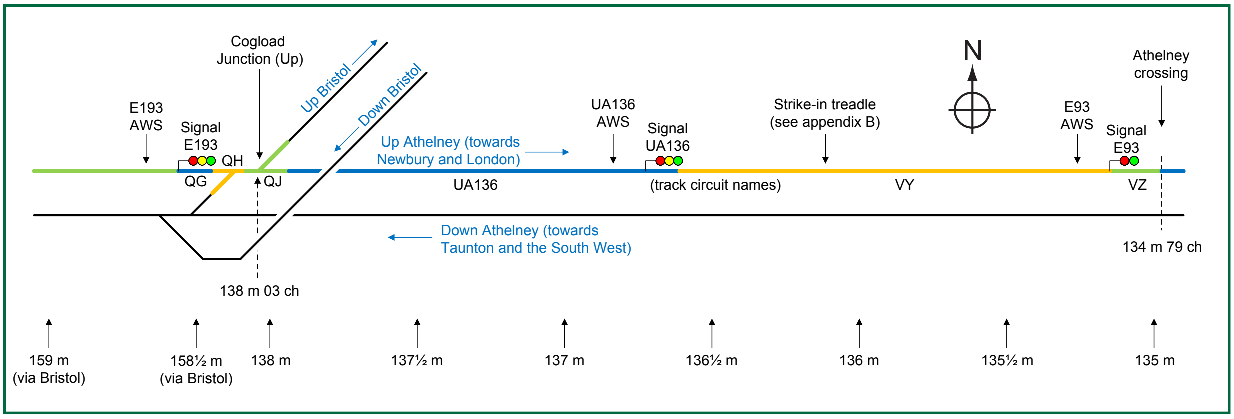

Figure 3: Track layout, showing signals and track circuit names on the Up Athelney line

18 Athelney level crossing is configured such that the crossing closure sequence for an up train starts when the train operates a *strike-in treadle* located 1.1 miles (1.8 km) from the crossing (figure 3). Occupation of VY/2 *track circuit*, which is co-located with the treadle[3], will also initiate the closure sequence. This is described as 'independent treadle and track circuit operation'. Later designs of automatic level crossing used 'treadle reinforced track circuits', in which the strike-in treadle operates the associated track circuit either by short-circuiting the *track relay* or by disconnecting the electrical supply to the track circuit.

19 Athelney level crossing has barriers that are lowered across the left side of the carriageway on the approach to each side of the crossing so that any vehicle on the crossing when the barriers come down has a clear exit. It is protected by flashing road traffic light signals, often referred to as 'wig-wags' (figure 1). An audible warning is also provided at the crossing for pedestrian users.

20 The normal sequence of events when a train initiates closure of the crossing, which is consistent with guidance published by the ORR[4], is:

- the amber lights show for approximately 3 seconds and the audible warning begins;
- as soon as the amber lights are extinguished, the red lights start to flash;
- after approximately 5 seconds the barriers start to lower; and
- a train travelling at 100 mph (161 km/h) will reach the crossing 29 seconds after the amber lights first start to show (the ORR guidance is that this period should not be less than 27 seconds).

21 Statements obtained by the police confirmed the lights and barriers had been operating normally, and the level crossing was tested after the accident by Network Rail staff. Although a number of minor issues were identified during the testing, none of these were relevant to the accident.

Staff involved

22 The signaller had worked in that role for approximately 16 years, the last 12 of which had been spent at Exeter signal box. The signaller had been assessed as competent by Network Rail, in accordance with its competence management system.

[3] Due to its length, the track circuit shown as 'VY' in figure 3 comprises individual circuits VY/1, VY/2 and VY/3.

[4] 'Level crossings: A guide for managers, designers and operators', Railway Safety Publication 7, 2011.

External circumstances

23 The accident happened about 10 minutes after sunrise. Local weather reports record that there was light rain at the time, and that visibility was good (approximately 2.2 miles (3.5 km)).

24 External circumstances had no bearing on the causes of the accident.

Events preceding the accident

25 On the night before the accident, there had been an *engineering possession* of the Up & Down Athelney lines between Castle Cary Junction and Cogload Junction (*Weekly Operating Notice*, Ref. P2012/1631698, item 105); Network Rail had booked this to run from 22:35 hrs to 06:20 hrs.

26 During the possession, a tamping machine (generally known as a *tamper*), which had been working within the possession, ran over Athelney level crossing along the Up Athelney line but in the down direction, ie towards Taunton. The tamper operated the strike-in treadle (paragraph 18) as it proceeded towards Cogload Junction, but for reasons explained in paragraph 66, the resulting electrical signal was stored by the signalling system, rather than causing the crossing to close at that time. This meant that, rather than the crossing closure sequence being operated automatically as the first up train approached, it would instead be initiated by the signaller clearing E93 signal (paragraph 17). As a consequence, the crossing would be closed for a longer period than would normally be the case when an approaching train operated it automatically. Network Rail staff refer to the level crossing controls in this condition being '*out of synchronisation*'.

27 The possession was *handed back* at 05:30 hrs and the night-shift signaller at Exeter handed over to the day-shift signaller at about 05:50 hrs. At approximately 06:03 hrs the signaller cleared E93 signal to confirm that the strike-in treadle had been operated by an out-of-sequence train movement. This caused the crossing closure sequence to begin although no train was approaching, because of the stored operation of the strike-in treadle (paragraph 26). He subsequently cancelled the route so that the signal returned to displaying a red aspect and, after a delay (provided in case a train is approaching the signal too closely to stop), the level crossing re-opened to road traffic. In the meantime, a cyclist observed that the crossing barriers were lowered and the road traffic light signals were operating from about 06:05 to 06:10 hrs. The cyclist saw no trains during this period.

28 Because no train operated over the Up Athelney line through the crossing during this time, the operation of the strike-in treadle remained stored within the system, meaning that the crossing closure sequence would again be initiated when the signaller next cleared E93 signal.

Events during the accident

29 Just before 06:22 hrs the signaller cleared E93 signal for the approach of train 1A73, which had just passed through Cogload Junction; this caused Athelney AHBC to start its closure sequence (paragraph 27).

30 A car had stopped at the lowered level crossing barrier on the down (south) side of the crossing and the driver initially waited. However, two witnesses report that they saw the car 'roll back' from the lowered barrier and then drive around it. This took the car into the path of train 1A73, which was travelling at close to 100 mph (161 km/h). The train collided with the car at 06:23 hrs.

Events following the accident

31 The car became wedged underneath the front of the train, and was extensively damaged; the driver, its only occupant, was killed. The car was pushed along until the train stopped, about 1,160 metres beyond the crossing. The train did not derail, although the leading power car lost its fibreglass skirt. There was minor damage to the level crossing infrastructure.

32 The driver of the train and a second member of First Great Western staff, who was travelling in the cab, suffered shock in the accident. There were no other injuries to the train's crew or passengers.

33 The Up and Down Athelney lines were re-opened to traffic following the completion of testing of the level crossing (paragraph 21) at 15:27 hrs.

The investigation

Sources of evidence

34 The following sources of evidence were used:

- site photographs and measurements;
- data from the train's on-train data recorder (OTDR);
- *Control Centre of the Future* (CCF) data;
- witness statements taken by the RAIB;
- witness statements and post-mortem information provided by the British Transport Police;
- the Network Rail level crossing file;
- RSSB[5] level crossing research reports (Refs. T756 and T818), which may be found at www.rssb.co.uk/research/Pages/ResearchandDevelopmentTool.aspx;
- level crossing guidance published by the Office of Rail Regulation (ORR), which may be found at www.rail-reg.gov.uk;
- Department for Transport (DfT) guidance on road traffic signals and pedestrian signals which may be found at www.dft.gov.uk/publications and www.trl.co.uk
- research published internationally on motorist behaviour at level crossings, see appendix E;
- a review of previous reported occurrences at the crossing, as recorded in the railway industry's Safety Management Information System (SMIS) database; and
- a DVD of the route, used for driver training purposes.

Acknowledgements

35 The RAIB would like to thank Track Access Productions Ltd, who supplied video images of the train driver's view of the route through Athelney level crossing (normally used for driver training purposes).

[5] A not-for-profit company owned and funded by major stakeholders in the railway industry, and which provides support and facilitation for a wide range of cross-industry activities. The company is registered as 'Rail Safety and Standards Board', but trades as 'RSSB'.

Key facts and analysis

Background information

Level crossing risk in the United Kingdom

36 RSSB's Annual Safety Performance Report (ASPR) 2012-13[6] for Britain's main line railway indicated that there were 9.6 *fatalities and weighted injuries* at level crossings on Network Rail managed infrastructure in 2012/13, with 52% of this total being road vehicle occupants (5 fatalities). The ASPR also reports that collisions with road vehicles at level crossings have accounted for 29% of 'potentially higher-risk train accidents' (the types of train accident most likely to result in harm, such as collisions and derailments) since 2003/04.

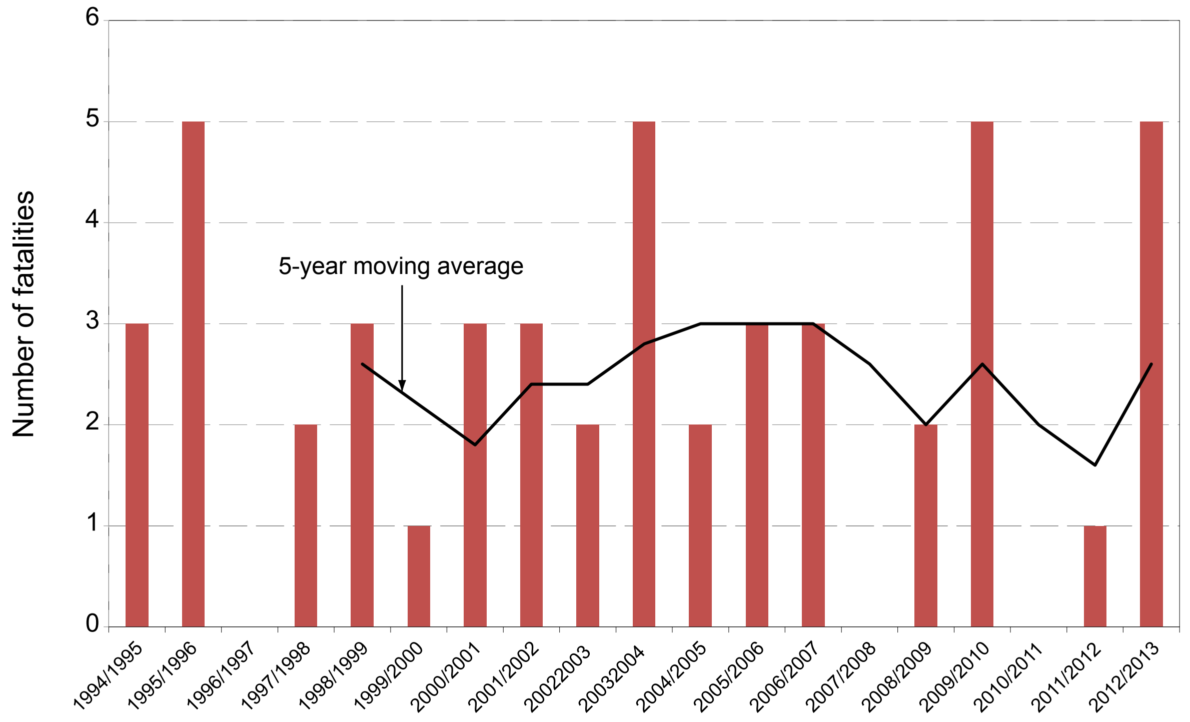

Figure 4: Fatalities of road vehicle occupants at level crossings on the GB mainline railway

37 There are over 6,000 level crossings on the mainline railway, including 450 AHBCs. RSSB data indicates that the average number of fatalities of road vehicle occupants due to accidents at level crossings has remained broadly unchanged for the last eighteen years (figure 4).

[6] Available at www.rssb.co.uk/SPR/REPORTS/Pages/Annual-Safety-Performance-Report-2012-2013.aspx.

Risk at Athelney level crossing

38 Network Rail classifies the risk associated with an individual level crossing using a model known as the All Level Crossing Risk Model (ALCRM) and by taking account of other site-specific factors which may influence the risk at a crossing. The ALCRM classifies risk in the following ways:

- individual risk of fatality (identified by a letter A (high) to M (low)), which relates to the risk of death for an individual using the crossing on a frequent basis (500 times per year); and
- collective risk (identified by a number 1 (high) to 13 (low)), which relates to the total risk of the crossing, taking into account the overall risk of death and injury for all crossing users, train crew and passengers.

39 The ALCRM scoring of the risk at the crossing was F5 before the accident on 21 March 2013; it was reassessed as E4 following the accident (with a predicted rate of 0.0015 fatalities and weighted injuries per year). Network Rail's processes give crossings with an individual risk of A-C or a collective risk of 1-3 a high priority for significant risk mitigation measures (such as closure of the crossing or provision of a bridge). The classification of Athelney level crossing as F5 meant that Network Rail did not consider it to be a high priority for the application of such measures.

40 The railway industry's Safety Management Information System (SMIS) has a record of only one instance of *misuse* of Athelney level crossing in the five years preceding the accident; this was a report that a white van had zig-zagged around the barriers in December 2012.

Guidance on level crossings provided by the Office of Rail Regulation

41 The current ORR guidance on level crossings (paragraph 20) summarises the key features of AHBCs. Of these, the following are relevant to the accident at Athelney on 21 March 2013:

- The speed of trains over the crossing should not exceed 100 mph.
- Trains should not normally arrive at the crossing in less than 27 seconds after the amber lights of the road traffic light signals first show. At least 95% of trains should arrive within 75 seconds and 50% within 50 seconds (the origins of the guidance on AHBC timing are given at appendix D)[7].

Identification of the immediate cause[8]

42 The motorist drove around the level crossing barriers while a train was approaching.

43 The motorist had stopped at the lowered level crossing barrier. A few seconds before train 1A73 arrived at the crossing, he took the decision to roll back and drive around the barriers (refer to paragraph 45).

[7] The *level crossing order* for Athelney specifies that trains should not arrive at the crossing in less than 27 seconds but does not mention the upper limits included in the ORR guidance.

[8] The condition, event or behaviour that directly resulted in the occurrence.

44 Athelney level crossing was operating for an extended period before train 1A73 arrived at it (between 75 and 103 seconds, instead of the 'normal' period of around 29 seconds, paragraph 20). This was due to a combination of the crossing controls being 'out of synchronisation' (paragraph 26) and the way in which this situation was managed at Exeter signal box (refer to paragraph 70).

Identification of causal factors[9]

The motorist's actions

The motorist's expectations

45 The motorist decided to drive around the barriers, without waiting for a train to pass and the barriers to re-open.

46 The instructions for motorists at controlled level crossings are given at Rule 293 of the Highway Code. They include the following:

- You MUST always obey the flashing red stop lights.
- You MUST stop behind the white line across the road.
- Only cross when the lights go off and barriers open.
- Never zig-zag around half-barriers, they lower automatically because a train is approaching.

47 RSSB has provided the RAIB with data on 22 accidents (ie excluding near misses) in which motorists were reported to have driven around AHBC barriers, dating back to 1992; these accidents resulted in nine fatalities. There is insufficient information to determine how many of these accidents may have been caused by motorists' impatience at extended closure times. However, around 30% of the motorists who survived claimed the lights and/or barriers had not been working.

48 The Department for Transport (DfT) publishes guidance on topics such as road traffic signals and pedestrian facilities at road crossings[10]. 'DfT Traffic Advisory Leaflet 1/06, General Principles of Traffic Control by Light Signals, Part 2 of 4', recommends that road traffic signal *cycle times* in excess of 120 seconds should not be used. However, advice given to the RAIB by DfT's traffic engineering policy department is that 90 seconds is taken as the normal maximum. Since the minimum duration that a green light should be displayed is 7 seconds, the maximum period spent waiting for a green light would normally be 83 seconds. This maximum would occur only if there was a continuous stream of traffic on the conflicting route since *traffic responsive signals* are the default method of control used in the UK. Separate guidance on temporary road traffic signals implies that the period spent waiting for a green light at a 300 metre long[11] installation would be 77 – 120 seconds, dependent on the volume of traffic coming in the opposite direction.

[9] Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

[10] Available at www.gov.uk/government/collections/traffic-advisory-leaflets.

[11] The normal maximum length for such installations.

49 Neither DfT nor TRL (the UK's Transport Research Laboratory) was able to provide the RAIB with references to any UK research or guidelines on acceptable waiting times for motorists at red traffic signals, or for pedestrians at signal-controlled crossings. The RAIB asked the national safety authorities and national investigation bodies of European Member States for information on acceptable waiting times for motorists, either at automatic level crossings or at red road traffic lights when there is no traffic on conflicting routes. None of the responses to this request provided information that was relevant to the circumstances of the accident on 21 March 2013. Some North American research on motorist behaviour at level crossings is discussed at appendix E, as well as pedestrian behaviour at road crossings with red lights. This suggests that people may become increasingly likely to violate warnings as waiting times exceed 30 - 60 seconds.

50 The motorist involved in the accident at Athelney on 21 March 2013 lived at Curload, about 900 metres from the crossing, and was on his way to work in Taunton. He was shortly to have retired from his job, which he had held for a number of years. Witness evidence indicates that his shift pattern was such that he started work either at 07:00 hrs or 10:30 hrs, and he was in the habit of arriving approximately 20 minutes beforehand. The RAIB has been unable to establish whether the normal route he took to work was via Athelney level crossing; however this was the quickest route to Taunton (paragraph 10). It is therefore probable that the motorist had frequently driven over the crossing at about 06:20 hrs on his way to work, and he may have been aware that a train (1A73) was timetabled to pass Athelney at around that time. If so, he would also have expected the train to arrive at the crossing within 30 seconds of the amber light being illuminated. Given the proximity of his house to the crossing, it is also probable that he would have been well acquainted with its operating sequence and with the pattern of train movements.

51 The motorist must initially have observed the warnings provided by the road traffic light signals and the lowered barriers because he stopped his car at the crossing (paragraph 30). However, at some stage, he decided to wait no longer and to drive around the barriers. The RAIB estimates that the maximum time he could have spent waiting at the crossing before taking this decision would have been 90 seconds, if the road traffic light signals had started flashing just as he reached the crossing, or 73 seconds if the barriers had already lowered before he arrived there. These times are based on the probable maximum crossing operation period of 103 seconds before the train arrived (paragraph 73).

52 It is not possible to know whether or not the motorist was expecting a train to be approaching when he decided to proceed. Although extended closure times can sometimes occur for a number of different reasons such as a slow-moving freight train (refer to appendix F), they are the exception rather than the rule. It is likely that the motorist would have experienced them rarely, if at all. He may have concluded that the crossing had failed, or alternatively that the train was delayed on its approach to the crossing. Each of these possibilities is considered in turn in the following paragraphs.

Possible failure of the crossing

53 **The motorist may have believed that the crossing had failed with the barriers in the closed position and that a train was probably not approaching.**

54 Since the motorist was a regular user of Athelney level crossing, he may have believed the crossing had failed when a train had not passed the crossing within the normal period within which a train would arrive, paragraph 50. It is possible that he thought that the barriers had failed to raise after the train had already passed over the crossing (but this would only apply if he had not noticed the barriers lowering before he reached the crossing). There is no record in the railway industry's Safety Management Information System of a failure of the level crossing barriers for more than three years prior to the accident, so he may not have had recent experience of failures of this type, if he had any experience of them at all. However, there is no certainty that the Safety Management Information System has complete records of all failures of level crossing barriers.

55 An alternative possibility is that the motorist had previously encountered a situation in which the crossing had been closed for an extended period, during which no train had arrived. The RAIB has been unable to establish how many times the crossing controls had been 'out of synchronisation' in the previous year (it is not recorded at Exeter signal box), but a comparison between his arrival time at work and possession timings indicates that this had not occurred earlier in the week of the accident.

Possible delay to the approaching train

56 **The motorist may have believed that the approaching train had been delayed and, incorrectly, that he would be able to see it and stop in time or else that he had sufficient time to cross before it arrived.**

57 Although the motorist was an experienced user of Athelney level crossing, he may have believed that he would be able to see an approaching train in time for him to stop. However, it would not have been feasible for him to 'look around' the barriers before proceeding (paragraph 30) and he could not have been certain which line an approaching train would be travelling on.

58 A video taken by the RAIB from the perspective of the motorist (figure 5), indicates that the yellow front end of train 1A73 would have been visible for approximately four seconds, and the headlights of the train for less than two seconds, before it reached the crossing on the Up Athelney line. It would therefore not have been possible for the motorist to react in time to avoid a collision with an approaching train.

59 Alternatively, it is possible that the motorist might have assumed that the train had been delayed if it did not arrive within approximately 60-90 seconds of the barriers lowering (the normal closure time was around 30 seconds, paragraph 50).

The telephone at the crossing

60 **The motorist did not contact the signaller for advice, even though a telephone is provided.**

61 Whatever the motorist's understanding, he did not use the telephone provided at the level crossing to contact the signaller. This may have been because he was not aware of the existence or purpose of the telephone.

Figure 5: Motorist's eye view of a passenger train approaching Athelney on the Up Athelney line

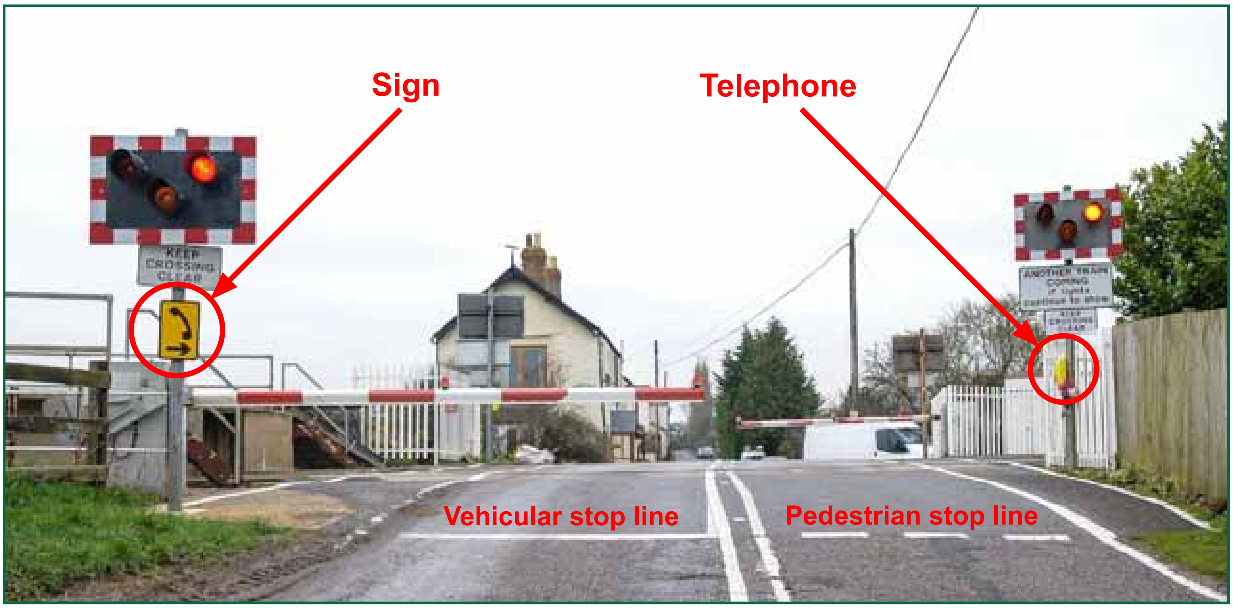

Figure 6: Level crossing telephone and signage at Athelney AHBC (courtesy British Transport Police)

62 The location of the telephone at Athelney level crossing is indicated by a yellow sign with a telephone symbol on the near side of the carriageway, with an arrow pointing to the telephone mounted on the offside road traffic light signal post (figure 6). Such telephones are described by Network Rail as 'public emergency telephones'; they are also intended for use by the drivers of large or slow vehicles. There is no signage to advise a motorist detained at closed level crossing barriers that they could use the telephone to contact the signaller.

63 RSSB is carrying out research into signage at level crossings; a preliminary conclusion is that the variety of signs that road users are required to see, read, interpret and respond to should be minimised, and that a simpler sign should be provided instructing drivers of large or slow vehicles to stop and phone for permission before crossing[12]. The feasibility of providing simplified signage is now being considered in a follow-on project. Separate research recommended that the letters 'SOS' should be added to the telephone signage[13]. These changes would be unlikely to help a motorist to understand that the telephone could be used in non-emergency situations such as extended barrier closure times; neither research project considered non-emergency use of the telephones during extended closure times.

Operation of the level crossing

The crossing controls

64 The level crossing control circuits were 'out of synchronisation' following an earlier *wrong direction* train movement.

65 The strike-in treadles for Athelney level crossing (paragraph 18) were of a simple design which was unable to differentiate between operation by a train travelling in the normal direction and by one travelling in the opposite direction (ie away from the level crossing)[14]. Together with the presence of a controlled signal within the strike-in distance, this created the conditions for the signalling control circuits to store operation of the treadle by a train travelling in the wrong direction and to become 'out of synchronisation'. This condition typically occurs when engineering work has been carried out between Athelney and Castle Cary.

66 At 03:55 hrs on the morning of 21 March 2013, train 6J89, a tamper, ran over the crossing along the Up Athelney line in the down direction (ie towards Taunton), paragraph 26, and operated the strike-in treadle. At the time that this happened, the level crossing was in *local control* under the supervision of a *level crossing attendant.* The role of the attendant was to operate the crossing locally and lower the barriers when trains approached the crossing in the wrong direction, as was the case with the tamper. As the crossing was in local control, the crossing closure sequence did not initiate when the tamper operated the treadle. However, the crossing controls became 'out of synchronisation' and could only be reset by the passage of a train over Athelney level crossing in the normal direction. The level crossing attendant restored the crossing to automatic operation at 04:08 hrs.

[12] Research project T756: 'Research into signs and signals at level crossings'.

[13] Research project T818: 'Optimising public communication with signallers in emergencies at level crossings'.

[14] A more sophisticated 'directional' design is available, which requires two arms to be depressed by the wheels of a train in the correct sequence in order to operate.

67 Prior to 1988, British Railways Signalmen's General Instructions required a signaller to stop the first train in each direction before it passed over an AHBC after it had been in local control, and to advise the driver to approach the crossing cautiously until was satisfied the barriers were in the lowered position. When this requirement was superseded by the revision of the Regulations for Train Signalling and Signalmen's General Instructions in June 1988, it was expected that any continuing need to caution trains at a particular level crossing in this situation would be covered in signal box special instructions. The RAIB has seen no evidence that any special instructions had been issued at Exeter signal box that would have required the signaller to caution the driver of the first train over Athelney level crossing after it had been in local control.

68 When E93 signal is switched into its automatic mode it would normally display a green aspect, independently from operation of Athelney level crossing. The crossing would then operate automatically as an approaching train passed over the strike-in treadle. However, on the morning of 21 March 2013, the controls were 'out of synchronisation' and the signaller had to maintain E93 signal at 'danger' (displaying a red aspect) until he knew a train was approaching. This was because the crossing would operate as soon as he cleared the signal by setting the route from E93 signal to the next signal, W41 at Somerton.

69 Network Rail has advised that on the national network there are 61 AHBCs with a similar configuration to Athelney out of a population of 450. Within Network Rail's Western Route, this includes one other crossing controlled from Exeter signal box and six that are controlled from Gloucester signal box, refer to paragraph 74.

The signaller's actions

70 **The signaller cleared E93 signal when train 1A73 was approximately 3.0 miles (4.8 km) from Athelney level crossing, which resulted in the barriers being lowered for an extended period before the arrival of the train.**

71 The practice for managing AHBCs with 'out of synchronisation' controls, which had evolved at Exeter signal box since the 1980s, was to set the route over the level crossing when the train was 'on approach'. The RAIB has not seen a formal definition of this term, and witnesses report that it was commonly interpreted to mean that a signaller should clear E93 signal before the preceding signal, UA136, came into the sight of the train driver; this would prevent the driver from seeing a yellow aspect and applying the train's brakes, so delaying the train.

72 UA136 signal first becomes visible to the driver of a train on the Up Athelney line approximately 1.9 miles (3.1 km) from Athelney level crossing. The signaller stated that he cleared E93 signal when his display showed him that train 1A73 had occupied UA136 track circuit, 3.0 miles (4.8 km) from the crossing[15] (figure 3). Analysis of the train's OTDR and data from CCF show that the train occupied this track circuit 115 seconds before it reached the crossing and that UA136 signal was displaying a green aspect before the train passed the associated AWS (*automatic warning system*) inductor, 1.9 miles (3.0 km) from Athelney level crossing. This is consistent with the driver's evidence that he had seen only green signal aspects after leaving Taunton.

[15] Witness evidence indicates that the signaller had also cleared E93 signal just after 06:00 hrs (paragraph 27) in order to confirm that the controls on the up line were indeed 'out of synchronisation'.

73 Taking account of the time taken for the crossing to operate, illumination of the amber road light (the first visible event in the closure sequence at the level crossing) therefore probably occurred 75 to 103 seconds before train 1A73 arrived at Athelney level crossing[16].

74 Some of the signallers at Gloucester signal box (paragraph 69) had a different interpretation of the requirement to clear the signals 'on approach' to similar AHBCs when the controls were 'out of synchronisation'. They considered it to mean that the *protecting signal* should be cleared as a train was approaching the signal itself, rather than before the driver could see the preceding signal. Network Rail's Western Route has now issued an instruction to signallers at Exeter and Gloucester that they should delay clearance of the protecting signal in such circumstances (paragraph 89).

Other safety issues not related to the accident

The road markings

75 The road markings are not consistent with Network Rail's *ground plan* for Athelney level crossing or the ORR's level crossing guidance.

76 The telephone at Athelney level crossing is eight metres beyond the pedestrian 'stop' line (figure 7). Highway Code Rule 34 for pedestrians states 'You MUST NOT cross or pass a stop line when the red lights show'.

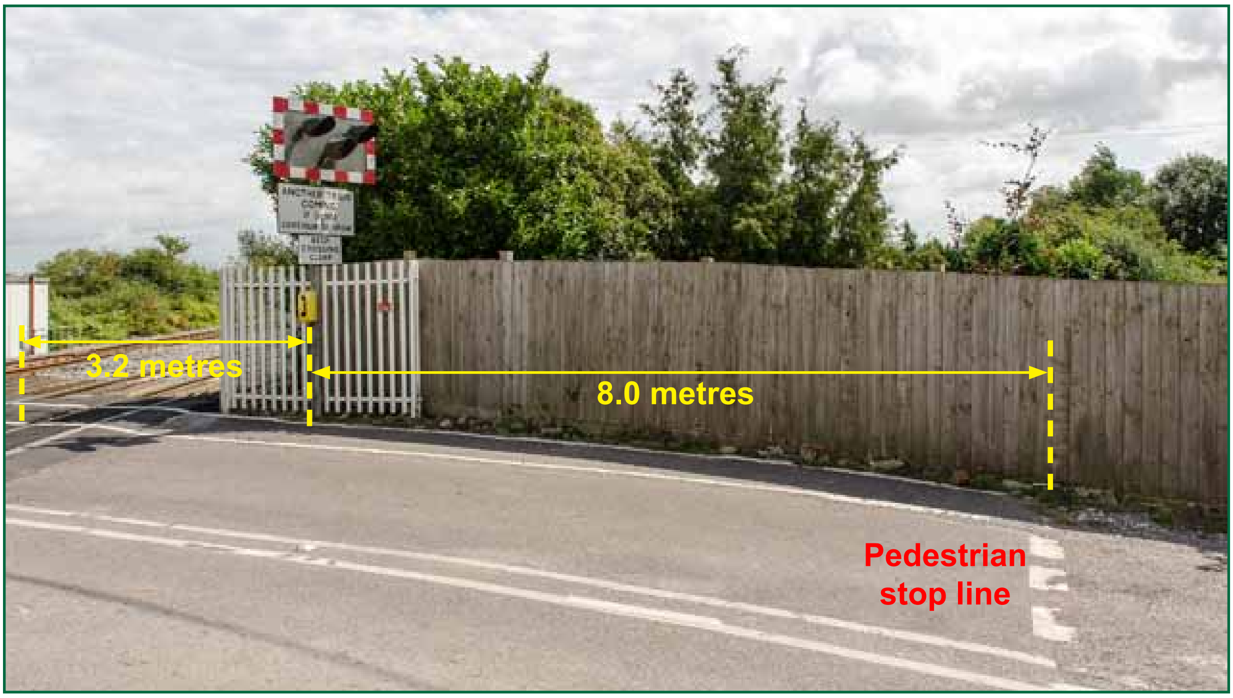

Figure 7: Location of the telephone at Athelney level crossing

[16] The actual value is not known because it is dependent on the length of time that elapsed between the train occupying UA 136 track circuit and the signaller clearing E93 signal, and there was no logging equipment that would confirm this duration, paragraph 81.

77 The line across the right hand side of the carriageway is described in the Highway Code as a 'stop line for pedestrians at a level crossing' and in the guidance document published by the ORR as a 'pedestrian Give Way line'. This line is not positioned in accordance with Network Rail's ground plan for Athelney level crossing (the level crossing order does not specify the location of the line). The ground plan is consistent with the ORR's guidance, which states the line 'should be at right angles to the carriageway. It should be located approximately 1 metre on the approach side of any road traffic light signal ... No part of the line should be less than 2 metres from the running edge of the nearest running rail.'

The cab radio system

78 The emergency call to the signaller, made by the driver of train 1A73 after the collision, was incorrectly routed by the *Global System for Mobile Communications – Railways* (GSM-R) radio system.

79 Following the collision, the driver of train 1A73 made an emergency call using the GSM-R cab radio. This was answered simultaneously by both Exeter and Bristol signal boxes; the Exeter signaller quickly and correctly took charge of the conversation.

80 Routing of an emergency call to two signal boxes is a normal feature of GSM-R where the cell is close to a boundary between the areas controlled by two different signal boxes. The emergency call made by the driver should have been routed to Exeter and Westbury signal boxes, as Athelney is close to the boundary with the area controlled by Westbury signal box, not Bristol.

The absence of a data logger

81 There was no data logging facility at Athelney level crossing or Exeter signal box; this would have facilitated the investigation into the accident and could have provided operational benefits.

82 Network Rail has advised that it did not mandate installation of logging equipment at level crossings, and nor had its predecessor, Railtrack. However during the late 1990s, Railtrack's maintenance contractor installed monitoring equipment to assist with fault-finding. This was later upgraded to enable remote downloading of the recorded data. The equipment had been supplied and supported by another contractor, but could not be repaired once that contractor withdrew from railway work and subsequently went out of business.

83 Consequently there had been no working data logger at Athelney since at least 2008. Plymouth Maintenance Delivery Unit, which is responsible for maintaining the signalling equipment at the level crossing, obtained some modern recording equipment in 2010 for installation at AHBCs, including Athelney, but the connections were different from the earlier equipment and it had no funding to install them, so Athelney remained without logging equipment.

Summary of conclusions

Immediate cause

84 The motorist drove around the level crossing barriers while a train was approaching (**paragraph 42**).

Causal factors

85 The causal factors were:

a. The motorist decided to drive around the barriers, without waiting for a train to pass and the barriers to re-open (**paragraph 45, Recommendation 1**).

b. When the motorist decided to drive around the barriers he may have believed either:

- that the crossing had failed with the barriers in the closed position and that a train was probably not approaching (**paragraph 53, no recommendation**); or
- that the approaching train had been delayed and, incorrectly, that he would be able to see it and stop in time or else that he had sufficient time to cross before it arrived (**paragraph 56, no recommendation**).

c. The motorist did not contact the signaller for advice, even though a telephone is provided (**paragraph 60, Recommendations 2, 3 and 4**).

d. The level crossing control circuits were 'out of synchronisation' following an earlier wrong direction train movement (**paragraphs 64, see paragraph 87 and Recommendation 1**).

e. The signaller cleared E93 signal when train 1A73 was approximately 3.0 miles (4.8 km) from Athelney level crossing which resulted in the barriers being lowered for an extended period before the arrival of the train (**paragraph 70 see paragraph 89**).

Other safety issues not related to the accident

86 Although not causal to the accident on 21 March 2013, the RAIB observes that:

a. The road markings are not consistent with Network Rail's ground plan for Athelney level crossing or the ORR's level crossing guidance (**paragraph 75, Recommendation 4**).

b. The emergency call to the signaller, made by the driver of train 1A73 after the collision, was incorrectly routed by the Global System for Mobile Communications – Railways (GSM-R) radio system (**paragraph 78, see paragraph 88**).

c. There was no data logging facility at Athelney level crossing or Exeter signal box; this would have facilitated the investigation into the accident and could have provided operational benefits (**paragraph 81, see paragraph 90**).

Actions reported as already taken or in progress relevant to this report

Actions reported that address factors which otherwise would have resulted in a RAIB recommendation

87 Network Rail's internal investigation report into the accident at Athelney on 21 March 2013 has recommended that its Western Route should consider modifying the strike-in treadles at affected crossings to prevent crossing controls from becoming 'out of synchronisation'. Western Route advised in June 2013 that it was in the process of fitting directional strike-in treadles to the eight AHBCs within its area that have independent treadle and track circuit operation (paragraphs 65 and 85a).

88 Since the accident on 21 March 2013, Network Rail Telecoms has reconfigured the GSM-R system so that emergency calls from Athelney are routed to Exeter and Westbury signal boxes (paragraph 86b).

Other reported actions

89 Network Rail's Western Route has issued instructions to signallers at Exeter and Gloucester signal boxes, on how to reset crossing controls which have become 'out of synchronisation' (paragraph 85e). This requires the signaller not to clear routes over an AHBC until:

- a train has been occupying the approach track circuit for 30 seconds; or
- the signaller has sent 'contact signaller' using the GSM-R and the driver has responded; or
- the signaller has received 'train waiting at signal' from the protecting signal.

90 Network Rail's Western Route has clarified its policy such that all crossings with signalling equipment controlling them should be equipped with event loggers. Where there is either no logger or one that is not fully functioning, the Route has provided funding to do this (paragraph 86c).

Recommendations

91 The following recommendations are made[17]:

1 *The intent of this recommendation is to reduce the risk resulting from extended waiting times at automatic level crossings, due to delays caused by the controls being 'out of synchronisation', which may encourage motorists to violate warnings.*

Network Rail should introduce measures to reduce the risk from extended operating times of automatic crossings caused by operation of a strike-in treadle by a train travelling away from the level crossing. This might include issuing suitable operating instructions to signallers for those crossings that might be affected or the installation of directional treadles. An engineered solution should be installed where reasonably practicable (paragraph 85a).

2 *The intent of this recommendation is to identify how to improve public awareness of the availability of telephones to contact the signaller in non-emergency situations.*

Network Rail in conjunction with RSSB should review past and current research into level crossing signage and emergency communication with signallers and consider means of improving the presentation of public emergency telephones for non-emergency use at automatic level crossings (paragraph 85c). This might include changes to signage or to the location of telephones, and should take account of Rule 34 of the Highway Code.

3 *The intent of this recommendation is to improve public awareness of the availability of level crossing telephones for contacting the signaller in non-emergency situations.*

If the RSSB research into improving the presentation of public emergency telephones for non-emergency use at automatic level crossings (Recommendation 2) identifies that reasonably practicable improvements can be made, the Office of Rail Regulation should incorporate these into the level crossing guidance it publishes.

continued

[17] Those identified in the recommendations, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail Regulation to enable it to carry out its duties under regulation 12(2) to:

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 200 to 203) can be found on RAIB's website www.raib.gov.uk.

4 *The intent of this recommendation is to improve public awareness of the availability of the level crossing telephones at Athelney level crossing.*

Network Rail Western Route should modify the location of the pedestrian stop lines at Athelney level crossing as required to make these conform to the current guidance published by the Office of Rail Regulation (paragraphs 85c and 86a).

Appendices

Appendix A - Glossary of abbreviations and acronyms

AHBC	Automatic half barrier crossing
ALCRM	All Level Crossing Risk Model
ASPR	Annual Safety Performance Report
AWS	Automatic warning system
CCF	Control Centre of the Future
DfT	Department for Transport
GSM-R	Global System for Mobile Communications – Railways
ORR	Office of Rail Regulation
SOS	International signal of distress

Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (*), have been taken from Ellis's British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com.

Automatic half barrier crossing	An automatic level crossing fitted with half barriers, traffic lights on the highway and a telephone to the relevant signal box.*
Automatic warning system (AWS)	A safety system for alerting drivers about the signal aspect or speed restriction ahead, sounding a horn in the cab for a red, single or double yellow aspect, or a bell to indicate a green signal.
Automatic working [of a signal]	Colour light signal set to operate based on occupation and clearance of certain track circuits beyond it without intervention by a signaller.*
Control Centre of the Future (CCF)	A system used by control centre staff and others which provides a visual schematic display of train position, both real-time and historic, and presents information on train running.
Controlled signal	A signal that is cleared from red by a signaller on each occasion it is required to show a proceed aspect.
Cycle times	The time taken to complete one complete operating sequence of the signals at a road junction.
Engineering possession	The closure of a specific section of line to normal railway traffic to allow engineering work to take place on the infrastructure in accordance with module T3 of the railway Rule Book.
Fatalities and weighted injuries	A measure used within the railway industry as a way of assessing and comparing risks. The figure is calculated by assigning a value of 1 for each fatality, 0.1 for each serious injury and 0.005 for each minor injury.
Global System for Mobile Communications – Railways (GSM-R)	A national radio system which provides secure voice communications between trains and signallers, relaying calls via radio base stations built alongside the railway or on suitable vantage points.
Ground plan	A document that includes information on the dimensions of a level crossing including road and footway measurements.
Handed back [Engineering Possession]	The return to the signaller of responsibility for control of the infrastructure by engineering staff.
Level crossing attendant	A person appointed to operate an automatic level crossing manually. This would happen, for example, if the crossing equipment had failed, and also in circumstances where road traffic over the crossing is being disrupted (eg if there are temporary traffic signals in the vicinity) or rail traffic is not operating normally (eg if an engineering possession is in place).

Level crossing order	A statutory instrument made under the Level Crossings Act 1983 describing in detail the method of operation and control to be employed at a particular level crossing.*
Local control	Manual operation of an automatic level crossing, over-riding the crossing control circuits. This requires the signaller to hand over control of the crossing to a level crossing attendant, situated adjacent to the crossing itself.
Misuse (taken from the Operations Manual, as it applies to an AHBC)	Crossing of the line during the warning sequence by vehicles or pedestrians [or] irregular use of the crossing by a long, low or slow moving vehicle.
Out of synchronisation (applies to the controls for an automatic level crossing)	A situation in which the electrical signal from operation of the strike-in treadle is stored by the signalling system, so that the crossing closure sequence is initiated when the signaller clears the signal on the approach to the crossing. As a consequence, the crossing is closed for longer than when an approaching train operates it automatically.
Protecting signal	The last signal on the approach to a level crossing that the signaller may place at danger in the event of an emergency situation.
Signal box special instruction	Instructions that may exist in a specific signal box, that are only applicable to that location and are supplementary to the Rule Book. They generally deal with situations peculiar to that signal box, such as quarry blasting.*
Strike-in treadle	A switch operated by a railway wheel passing over it that normally initiates the closure sequence of an automatic level crossing.
Tamper	An on-track machine that can lift and slew the track and simultaneously compact the ballast under the sleepers.
Track circuit	An electrical or electronic device used to detect the absence of a train on a defined section of track using the running rails in an electric circuit.*
Track relay	An electro-mechanical device which is de-energised when the current flowing round a track circuit is diverted through the axles of a train. When it becomes de-energised it makes and breaks a number of electrical contacts.
Traffic responsive signals	Road traffic signals with a dynamic control system that responds to changing inputs from traffic detectors.
Weekly Operating Notice	A document published by Network Rail on a route by route basis, providing information about engineering work, speed restrictions, alterations to the network and other relevant information to train drivers.*

Wrong direction	In a direction opposite to that which trains normally run on the line concerned.*

Appendix C - Key standards current at the time

'Traffic Signs Regulations and General Directions 2002'	Statutory Instrument No. 3113
'Highway Code – Level crossings (291 to 299)'	HM Government https://www.gov.uk/road-works-level-crossings-tramways-288-to-307/level-crossings-291-to-299
'Highway Code – Rules for pedestrians (1 to 35)'	HM Government https://www.gov.uk/rules-pedestrians-1-to-35
'Level crossings: A guide for managers, designers and operators', December 2011	The Office of Rail Regulation, Railway Safety Publication 7
Operations Manual Procedure: 5-16 'Level crossing risk assessment and mitigation', Issue: 2, June 2011	Network Rail

Appendix D - Development of the timing requirements for AHBCs

D1 The safety of automatic half barrier level crossings depends on deterring motorists from taking risks by driving around the lowered barriers while the crossing is operating. This was expressed in the following documents:

Level Crossing Protection – Report by officers of the Ministry of Transport and Civil Aviation and of the British Transport Commission (1957)

'It is necessary therefore that the way in which [the barriers] fall shall present an unvarying and urgent warning to the road user which he dare not disobey. To achieve this the barriers must be timed to fall so that a train will invariably pass within a few seconds; they must also be timed to rise immediately after the train has passed … the unmistakable warning given by the flashing lights and the fall of the half-barriers immediately before the arrival of the train will tend to decrease the incentive to disobedience by road users.'

Requirements of the Minister of Transport in regard to automatically operated half-barriers at public level crossings (July 1966)

'The guiding principle … is that road traffic must be stopped for the shortest possible time. The half-barriers should be fully lowered only just before the arrival of a train at the crossing, and be raised immediately after it has passed unless another train on another track is about to arrive.'

'The timing of the barrier movement to be such that on the approach of a train the road signals start to flash and the bells begin to ring 6-8 seconds before the barriers start to fall ("warning period"); the lowering of the barriers to occupy 6-8 seconds and to switch on the barrier lights; the barriers to be fully lowered approximately 8 seconds before the arrival at the crossing of a train travelling at the maximum speed but not more than 48 seconds before one travelling at the slowest speed in normal conditions.'[18]

D2 The criterion that 95% of trains should arrive within 75 seconds (paragraph 41) was first alluded to in a report which made recommendations on reducing the cost of automatic level crossings, following cost increases which had occurred in the wake of the Hixon inquiry in 1968:

Report on Level Crossing Protection including visits to the Netherlands, French, West German and Swiss Railways by officers of the Department of Transport and of the British Railways Board (1978)

'… speed discrimination should … be applied if more than 5% of trains take over 75 seconds to arrive at a crossing. However … we expect new crossings to be designed on the basis that most trains will arrive at the crossing without undue delay.'

[18] These times are equivalent to a minimum of 23-27 seconds and a maximum of 63-67 seconds before arrival of the fastest and slowest trains respectively following the start of the operating sequence (illumination of the amber road aspect).

D3 The current guidance was first expressed as follows:

Department of Transport – Railway Construction and Operation Requirements – Level Crossings (1981)

'Trains shall not arrive at the crossing in less than 27 seconds after the amber lights first show, but should arrive as soon as possible thereafter … At least 95% of trains must arrive within 75 seconds and 50% within 50 seconds.'

It is not clear how the thresholds of 50 and 75 seconds were arrived at; the RAIB has seen no evidence that they were based on any studies of motorists' behaviour. However they suggest that British officials recognised the need to shorten the cycle times for AHBCs in the light of the 1978 report, whilst making provision for some slower trains; an AHBC would not be suitable if there were too many. Making provision for 5% of trains to arrive at a crossing in a longer time than the slowest 'normal' train allowed for engineering trains, special workings and other contingencies.

Appendix E - Extracts from North American research papers

E1 The RAIB has identified a number of American research papers that address the reasons why motorists violate warnings provided at level crossings. These are not exactly comparable with the accident at Athelney level crossing on 21 March 2013 for the following reasons:

- A proportion of violations involve motorists who continue driving when they encounter a level crossing that is already operating, ie they have not first stopped before making a decision to proceed.
- American level crossings and road layouts are configured differently to British AHBCs. The lowest level of protection is provided by passive 'crossbucks' (signs); additional protection is provided by equipping some crossings with flashing lights, while the highest level of protection is provided at crossings with flashing lights and barriers. While these latter crossings have similarities to an AHBC, the type of road on which they are installed (eg urban highway) is very different to the country road that crosses the railway at Athelney.

Nevertheless, the American research identifies issues regarding motorist behaviour at level crossings; the RAIB has been unable to find any corresponding British research.

E2 The first paper attempts to define suitable warning periods both for crossings with flashing lights and for those with flashing lights and gates (barriers):

<u>'Assessment of Warning Time Needs at Railroad-Highway Grade Crossings with Active Traffic Control', Stephen H Richards and K W Heathington (1990)</u>[19]

'Drivers begin to lose confidence in the traffic control system if the warning time exceeds approximately 40 seconds at crossings with flashing light signals and 60 seconds [at crossings with automatic gates, flashing lights and a bell].'

The paper suggests the following guidelines for warning times at crossings with gates and flashing light signals:

- 20 seconds minimum
- 25-30 seconds desirable
- 60 seconds maximum

'The suggested range of warning times for gated crossings are relatively narrow, i.e. 5 seconds. These narrow ranges are strongly supported by the research results. Recognizing practical limitations of train operations and train detection hardware, some longer warning times would be allowed. However, if more than 10 percent of the warning times exceed 60 seconds, then the installation of motion sensors or train predictors[20] is strongly urged.'

[19] Published in *Transportation Research Record 1254*, pp. 72-84. Copyright, National Academy of Sciences, Washington, D.C., 1990. Referenced with permission of the Transportation Research Board.

[20] Known as 'level crossing predictors' in the UK. These are intended to provide a constant warning time for the arrival of a train at a level crossing, based on a calculation of its speed.

E3 A second paper examines factors in accidents at level crossings with signs and at those with flashing lights (ie it did not include crossings with barriers):

'Causal factors in railroad-highway grade crossing accidents', William D Berg, Karl Knoblauch and Wayne Hucke (1982)[21]

'Warning times in excess of 30 seconds represented an unnecessarily long advance warning of the approach of a train [at crossings equipped with flashing lights] ... The frequently observed pattern of motorists crossing railroad tracks while flashers are operating is believed to be due in large part to extended warning times.'

E4 Another paper correlated the accident histories of 37 level crossings in Michigan with violations observed at the same crossings, to determine the relative risk of the crossings and also to identify mitigations:

'Driver behaviour at rail-highway crossings', John Abraham, Tapan K Datta, and Sue Datta (1998)[22]

Respondents to a survey of drivers who 'violated a traffic control device' at rail-highway crossings 'stated that they violated the traffic law because the "train was not in sight" or the "train was stopped for an unreasonable amount of time".'

E5 The RAIB also considered whether there was any relevant research into pedestrian behaviour at red lights, in case this had parallels with motorists at level crossings. The following paper summarised the results of published research at the time:

'Review of European and North American Practice of Pedestrian Signal Timing', K G Baass (1989)[23]

- An American study found that the number of pedestrians crossing illegally increased significantly if the waiting time at a red light was longer than 40 seconds.
- A German study found that 38% of pedestrians would cross on a red light if the waiting time was 40-60 seconds, but only 18% would cross on red if it was shorter than 30 seconds.

It should be remembered that, in both the USA and Germany, pedestrians are required by law to observe red lights. Whilst this is different to UK law for pedestrians, these findings may be illustrative when considering possible impatience on the part of motorists waiting at level crossings.

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[21] Published in *Transportation Research Record 847*, pp. 47-54. Copyright, National Academy of Sciences, Washington, D.C., 1982. Referenced with permission of the Transportation Research Board.

[22] Published in *Transportation Research Record 1648*, pp. 28-34. Copyright, National Academy of Sciences, Washington, D.C., 1998. Referenced with permission of the Transportation Research Board.

[23] Presented to the 1989 Roads and Transportation annual conference. Referenced with permission of the Roads and Transportation Association of Canada.

Appendix F - Extended operation of Athelney level crossing

F1 The reasons why Athelney level crossing might operate for longer than the designed 29 seconds include:

a. Freight trains operate at lower speeds and take longer to travel between the strike-in treadle and the crossing. Network Rail's internal investigation into the accident records that a timetabled class 7 freight train (limited to a maximum speed of 45 mph (72 km/h)) had run over Athelney level crossing between 06:10 and 06:30 hrs seven times during February 2013, in the down direction. On each of these occasions, the crossing would have been operating for at least 79 seconds before the train arrived. However this train had not operated in the five weeks prior to the accident.

b. Delays in trains arriving at the crossing could also result from the imposition of an emergency or temporary speed restriction after the strike-in treadle (these are typically applied when a track defect has been reported).

c. If the preceding signal, UA136, was displaying a yellow 'caution' aspect when a train passed it, the train driver would know that E93 signal was displaying a red aspect at that time. The driver would therefore slow down before E93 signal came into view. This situation would arise if a train reached UA136 signal before a preceding train had passed the next controlled signal at Somerton, 9.2 miles (14.7 km) beyond. A similar delay would have occurred on 21 March 2013 if the signaller had delayed clearing E93 signal until train 1A73 had passed UA136 signal.

d. If a train had stopped at E93 signal, it would take an estimated 60 seconds from the time the signal cleared for the train to cover the distance to the crossing, assuming a typical acceleration rate and only a short delay between the signal clearing and the driver taking power.

e. The crossing would operate for a period typically between 240 and 480 seconds if the signaller cleared E93 signal, or the equivalent signal on the down line, E12, with no train approaching, while the control circuits on that line were 'out of synchronisation.' The exact timing would depend on when the signaller replaced the signal to 'danger' by cancelling the route[24]. This had occurred shortly after 06:00 hrs on 21 March 2013 (paragraph 27).

f. If the level crossing had failed, the barriers would remain lowered indefinitely. In this situation, the signaller is required to stop trains and advise train drivers to proceed at caution, as members of the public waiting at the level crossing would be faced with the barriers closed and the road traffic light signals flashing, with no indication of whether or when a train was actually approaching.

[24] A time-out sequence would prevent the crossing from re-opening to road traffic until 240 seconds had elapsed after cancellation of the route. Conversely, an alarm would sound if a train did not arrive within a separate, but possibly concurrent, period of 240 seconds. The crossing would operate for longer if the signaller did not cancel the route until after the alarm had sounded.

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